REPUBLIC OF BULGARIA
MINISTRY OF ENVIRONMENT AND WATER

EXECUTIVE ENVIRONMENT AGENCY

NATIONAL INVENTORY REPORT 2021

GREENHOUSE GAS EMISSIONS IN BULGARIA 1988-2019

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EXECUTIVE SUMMARY

ES 1 Background information on greenhouse gas inventories and climate change

Over the past century, atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and halogenated hydrocarbons, i.e. greenhouse gases, have increased as a consequence of human activity. Greenhouse gases prevent the radiation of heat back to space and cause warming of the climate. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (AR4) (IPCC 2007)[1], the atmospheric concentrations of CO_2 have increased by 35%, CH_4 concentrations have more than doubled and N_2O concentration has risen by 18%, compared with the pre-industrial era.

Changing climate has effects on both human and natural systems (e.g. human settlements, human health, water and food resources, ecosystem and biodiversity). Some of the effects on environmental and socio-economic systems will be beneficial, some damaging. The larger changes and the rate of changes in climate, the more adverse effects will predominate. In Bulgaria the adverse impacts are related, for example, the winter tourism, increased floodings and droughts and the prevalence of pests and diseases. Positive impacts could be possible growth of productivity in agriculture and forestry and decreased need for heating energy. According to the "Fifth National Communication of Bulgaria on Climate Change"[2] from the year 2010 the average temperature in the country could rise. Extreme weather events, such as storms, droughts and heavy rains, are likely to increase.

According to the HadCM3[3] model significant summer warming in the Western Balkan countries were projected for 2080. Air temperatures during this time of the year are expected to increase between 5°C and 8°C over most of the countries in the peninsula. Summer precipitation is projected to decrease in the region.

Acknowledging the importance of the climate change issue and the need for international cooperation to address this problem, Bulgaria signed the UNFCCC in Rio de Janeiro in June 1992 and the Parliament ratified it in March 1995. In compliance with Article 4.6 and 4.2(b) of the UNFCCC, Bulgaria as a country in transition has adopted 1988[4] as a base year for the implementation of the Convention instead of 1990. As an Annex I Party of the UNFCCC the Republic of Bulgaria adopted the target to stabilize emissions of greenhouse gases by 2000 at a level not exceeded that in 1988. The same year was used when comparing, evaluating and projecting greenhouse gas emissions. The 2000 target was successfully achieved.

The Kyoto Protocol (KP) is adopted at the III-rd Session of the Conference of the Parties (COP) to the Convention (December 1997, Kyoto). The KP is ratified by Bulgaria in August 2002. After Russia ratified the KP in November 2004, it entered into force on 16 February 2005.

With the KP, the Parties to the Convention took the commitment not only to stabilize the GHG emissions, but also to reduce them by percentage, defined with respect to the base year of each Party.

Bulgaria ratified the the KP in August 2002 taking the commitment to reduce its national GHG emissions for the first commitment period (2008-2012) by 8% compared to 1988 (base year). Under these international agreements Bulgaria is committed to provide annually information on its national anthropogenic greenhouse gas emissions by sources and removals by sinks for all greenhouse gases not controlled by the Montreal Protocol.

The inventories started with the country base year – 1988. The first inventories covered the period 1988-1994 as a part of the international project "Country Study to Address Climate Change[5]".

ES 2 Summary of national emission and removal-related trends

The annual inventory and reporting of greenhouse gas emissions and removals provide an information base for the planning and monitoring of climate policy. The Kyoto Protocol obliges its

[1] Fourth Assessment Report of the Intergovernmental Panel on Climate Change (AR4) (IPCC 2007): Working Group I Report "The Physical Science Basis"; Working Group II Report "Impacts, Adaptation and Vulnerability"; Working Group III Report "Mitigation of Climate Change";

http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm

[2] http://unfccc.int/resource/docs/natc/bgr_nc5.pdf

[3] http://www.ipcc-data.org/sres/hadcm3_info.html

[4] FCCC/CP/1996/15/Add.1/Corr.17 June 1999 http://unfccc.int/resource/docs/cop2/15a01c01.pdf#page=1

[5] http://www.gcrio.org/CSP/pdf/bulgaria_snap.pdf

parties to establish a national greenhouse gas inventory system by the end of 2006. Bulgaria's National Greenhouse Gas Inventory System was set up at the beginning of 2007.

The national system produces data and background information on emissions and removals for the UNFCCC, the Kyoto Protocol and the EU Commission. In addition, the scope of the system covers the archiving of the data used in emission estimations, the publishing of the results, participation in inventory reviews and the quality management of the inventory.

The Regulation[6] of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol obliges the Member States (MS) of the European Union (EU) to participate in the compilation of the EU's common greenhouse gas inventory and other climate policy, as well as in the monitoring and evaluation of its detailed measures. This procedure causes a two-phased submission of MS inventory reporting to the Commission with annual deadlines for submission 15 January and 15 March.

This National Inventory Report (NIR) of Bulgaria for the 2021 submission to the EU, the UNFCCC and the Kyoto Protocol includes data of the anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHG_S) not controlled by the Montreal Protocol, i.e. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC_S), hydrofluorocarbons (HFC_S), nitrogen trifluoride (NF_3) and sulphur hexafluoride (SF_6).

Each of these gases has a different warming effect. As an example, the gases HFCs, PFCs and SF_6 (so called F-gases) have much greater warming effect, in some cases over one hundred times, compared to methane (25), nitrous oxide (298) and carbon dioxide (1).[7]

Because of that, a common assessment criterion for the effect of each GHG on the atmosphere warming should be introduced. This criterion is the so-called Global Warming Potential (GWP), representing GHG emissions as CO_2-eq. emissions. It allows totalling the effect of all GHGs, adjusted to a common base.

For defining of GWP, the Parties to the Convention and Kyoto Protocol accept values, over a time horizon of 100 years, as mentioned in the IPCC Fourth Assessment Report of 2007[8].

Indirect CO_2 emissions resulting from atmospheric oxidation of CH_4 and NMVOC emissions from non-biogenic sources are also included in the inventory. These have been separately estimated for fugitive emissions in the Energy sector and sources in the Industrial Processes and Product Use sectors using the methodology given in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006, see Section 7.2.1.5). For fossil fuel combustion, indirect emissions are included in the methodology to estimate CO_2 emissions.

The NIR includes also estimates of so-called indirect greenhouse gases carbon monoxide (CO), nitrogen oxides (NO_X) and non-methane volatile organic compounds ($NMVOC_S$) and sulphur dioxide (SO_2) meaning sulphur oxides and other sulphur emissions calculated as SO_2. Indirect greenhouse gases and sulphur dioxide do not have a direct warming effect, but influence on the formation or destruction of direct greenhouse gases, such as troposheric ozone. These gases are not included in Annex A of the Kyoto Protocol.

Other gases have indirect warming effect to the atmosphere (as NO_X, CO and NMVOCs), or cooling effect as SO_X. These gases are precursors of the greenhouse gas – troposphere ozone, and are subject of regional control protocols. They do not have global effect on the climate changes as the main GHG. That is why in the NIR only the total GHG emissions – precursors, as well as the total SO_X emissions were reported.

The emission estimates and removals are presented by gas and by source category and refer to the year 2019. Full time series of the emissions and removals (with exception of F-gases) from 1988 to 2019 are included in the submission.

The structure of this NIR was reelaborated in order to follow the Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention (Decision 15/CP.17). The annotated outline of the NIR'[9], and the guidance contained therein, developed by the UNFCCC secretariat in 2011, has been followed. Chapter 1 provides an introduction to the background of greenhouse gas inventories and the inventory preparation process and Chapter 2

[6] Regulation No 525/2013

[7] Global Warming Potential referenced to the updated decay response for the Bern carbon cycle model and future CO_2 atmospheric concentrations held constant at current levels. http://unfccc.int/ghg_data/items/3825.php

[8] http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14

[9]http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/ application/pdf/annotated_nir_outline.pdf

presents the overall emission trend in Bulgaria from the year 1988 to the year 2019. In Chapters 3 to 9 more detailed information of GHG emission estimates are given for the seven sectors:

- CRF 1: Energy
- CRF 2: Industrial processes and product use
- CRF 3: Agriculture
- CRF 4: Land use, land-use change and forestry
- CRF 5: Waste
- CRF 6: Other
- CRF 7: Indirect CO_2 and nitrous oxide emissions

In Chapter 10 improvements and recalculations since the previous submission are summarised. Chapter 11 provides description of KP-LULUCF, Chapter 12 information on accounting of KYOTO units, Chapter 13 information on changes in national system and Chapter 14 information on changes in national registry. Chapter 15 gives information on minimisation of adverse impacts in accordance with Article 3, paragraph 14.

Annex 1 contains the mandatory key category reporting tables. A national reference calculation for CO_2 emissions from energy combustion can be found in Annex 4 (Comparison of CO_2 emissions calculated from the Energy balance with fuel combustion emissions as reported in the CRF tables). Annex 7 contains the mandatory uncertainty reporting table . Annex 6 includes 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.

As an Annex I Party to the UNFCCC Bulgaria reports annually its GHG inventory from the base year to the year proceeding the year of reporting.

Annex I Parties to the KP should report also additional elements as assigned amount information, changes in national system, changes in national registry and submission of information relating to activities under Articles 3, paragraphs 3, of the Kyoto Protocol.

The inventories are prepared according to the UNFCCC Guidelines[10] and establishing the NIR structure in compliance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.[11]

The general objective regarding the preparation of the annual GHG inventories is to improve „TACCC" in emission estimates. The Report presents the National GHG inventory for 2019. The following are described as well:

- Methods and indices for uncertainty assessment of the annual GHG emissions and trends;
- Key GHG emission sources according to method of the type Approach 1 and Approach 2, specified in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;
- Assessment of the quality assurance and control system.
- Activity data and emission tables for 1988-2019 in the Common Reporting Format (CRF) for annual GHG inventories are submitted together with the Report and are uploaded on:

http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php

http://cdr.eionet.europa.eu/bg/un/unfccc

ES 3 Overview of source and sink category emission estimates and trends

In 2019 Bulgaria's greenhouse gas emissions totalled 55 955 Gg CO_2 eq. without reporting of sequestration from LULUCF sector. The emissions decreased by 51.26 % compared with the base year. Emissions in 2019 were 2.3% decreased in comparison with the emissions of the previous year.

The net emissions including reporting of sequestration from LULUCF sector were 46 393 Gg CO_2 eq. The emissions decreased by 51.6% compared with the base year.

The main reasons for the declining GHG emission trend in Bulgaria are the structural economic changes due to the radical transition process from a centrally-planned economy to a market-based economy. This led to a decrease of power production from thermal power stations (and an increase of the shares of hydropower and nuclear power), structural changes in industry (including a decline in

[10] http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf

[11] http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/items/2759.php

production by energy-intensive enterprises and energy-efficiency improvements), introduction of energy efficiency measures in the residential sector and a shift form solid and liquid fuels to natural gas in energy consumption. This also led to a decrease in GHG emissions from the agricultural sector stemming from the decline in the cattle and sheep populations and the use of fertilizers.

Bulgaria experienced a steady declining population trend during the period 1988-2019, which resulted in the reduction of population by 22.6%.

ES 4 Background information of the Kyoto Protocol

Bulgaria has made a commitment to follow the UNFCCC that entered into force on 21 March 1994. The Kyoto Protocol negotiated in 1997 under the UN Framework. The Kyoto protocol took effect on 16 February 2005 and became legally binding.

The Kyoto Protocol (Article 5.1) requires that the parties have in place a National System by the end of 2006 at the latest for estimating anthropogenic greenhouse gas emissions by sources and removals by sinks not controlled by the Montreal Protocol. The guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol (Decision 19/CMP.1[12]) provide the requirements for the general and specific functions of the national systems. Bulgaria’s inventory system was reviewed as part of the review of the Bulgaria’s initial report under Convention in 2007 (FCCC/IRR/2007/BGR)[13].

Under the UNFCCC and the Kyoto Protocol, Bulgaria is required to submit annually to secretariat of the Convention a national greenhouse gas inventory covering emissions and removals of direct greenhouse gases from the five sectors (Energy, Industrial processes and product use, Agriculture, Land Use, Land-Use change and Forestry and Waste) and for all years from the base year or period to the most recent year. The preparation and reporting of the inventories are guided by the UNFCCC guidelines (UNFCCC 2014) and are based on the following IPCC methodologies to ensure the transparency, accuracy, comparability, consistency and completeness of the inventories;

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006 GL)[14]
- 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP supplement)
- 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement)
- EMEP/EEA air pollutant emission inventory guidebook – 2019.

The national greenhouse gas inventory for 2019 is submitted to the European Commission by Bulgarian Ministry of Environment and Water in fulfilment of Bulgaria’s obligation under Article 7 of Regulation 525/2013[15] of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC. The purpose of Regulation 525/213 is to monitor all anthropogenic greenhouse gas emissions not controlled by the Montreal Protocol and to evaluate the progress towards meeting the commitments under the UNFCCC and the Kyoto Protocol.

[12] http://www.ciesin.columbia.edu/repository/entri/docs/cop/Kyoto_COP001_019.pdf

[13] Report of the review of the initial report of Bulgaria: http://unfccc.int/resource/docs/2008/irr/bgr.pdf

[14] http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

[15]http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:165:0013:0040:EN:PDF

PART 1: ANNUAL INVENTORY SUBMISSION

1 INTRODUCTION

1.1 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES, AND CLIMATE CHANGE

1.1.1 BACKGROUND INFORMATION ON CLIMATE CHANGE

Over the past century, atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and halogenated hydrocarbons, i.e. greenhouse gases, have increased as a consequence of human activity. Greenhouse gases prevent the radiation of heat back to space and cause warming of the climate. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007), the atmospheric concentrations of CO_2 have increased by 35%, CH_4 concentrations have more than doubled and N_2O concentration has risen by 18%, compared with the pre-industrial era.

Changing climate has effects on both human and natural systems (e.g. human settlements, human health, water and food resources, ecosystem and biodiversity). Some of the effects on environmental and socio-economic systems will be beneficial, some damaging. The larger changes and the rate of changes in climate, the more adverse effects will predominate. In Bulgaria the adverse impacts are related, for example, to the winter tourism, increased floodings and droughts and the prevalence of pests and diseases. Positive impacts could be possible growth of productivity in agriculture and forestry and decreased need for heating energy. According to the Fifth National Communication of Bulgaria on Climate Change from the year 2010 the average temperature in the country could rise. Extreme weather events, such as storms, droughts and heavy rains, are likely to increase.

Significant summer warming in the western Balkan countries, were projected by the HadCM3 model for 2080. Air temperatures during this time of the year are expected to increase between 5ºC and 8ºC over most of the countries in the peninsula. Summer precipitation is projected to decrease in the region.

Acknowledging the importance of the climate change issue and the need for international cooperation to address this problem, Bulgaria signed the UNFCCC in Rio de Janeiro in June 1992 and the Parliament ratified it in March 1995. In compliance with Article 4.6 and 4.2(b) of the FCCC, Bulgaria as a country in transition has adopted 1988 as a base year for the implementation of the Convention instead of 1990. As an Annex I Party of the UNFCCC the Republic of Bulgaria adopted the target to stabilize emissions of greenhouse gases by 2000 at a level not exceeded that in 1988. The same year was used when comparing, evaluating and projecting greenhouse gas emissions. The 2000 target was successfully achieved.

The Kyoto Protocol (KP) is adopted at the III-rd Session of the Conference of the Parties to the Convention (December 1997, Kyoto). KP is ratified by Bulgaria in August 2002. After Russia ratified the KP in November 2004, it entered into force on 16 February 2005.

With the KP, the Parties to the Convention took the commitment not only to stabilize the GHG emissions, but also to reduce them by percentage, defined with respect to the base year of each Party.

Bulgaria ratified the KP in August 2002 taking the commitment to reduce its national GHG emissions for the first commitment period (2008-2012) by 8% compared to 1988 (base year). Under these international agreements Bulgaria is committed to provide annually information on its national anthropogenic greenhouse gas emissions by sources and removals by sinks for all greenhouse gases not controlled by the Montreal Protocol.

The inventories started with the country base year – 1988. The first inventories covered the period 1988-1994 as a part of the international project "Country Study to Address Climate Change".

1.1.2 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES

The annual inventory and reporting of greenhouse gas emissions and removals provide an information base for the planning and monitoring of climate policy. The Kyoto Protocol obliges its parties to establish a national greenhouse gas inventory system by the end of 2006. Bulgaria's National Greenhouse Gas Inventory System was set up at the beginning of 2007.

The national system produces data and background information on emissions and removals for the UNFCCC, the Kyoto Protocol and the EU Commission. In addition, the scope of the system covers the archiving of the data used in emission estimations, the publishing of the results, participation in inventory reviews and the quality management of the inventory.

The Regulation of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol obliges the Member States (MS) of the European Union (EU) to participate in the compilation of the EU's common greenhouse gas inventory and other climate policy, as well as in the monitoring and evaluation of its detailed measures. This procedure causes a two-phased submission of MS inventory reporting to the Commission with annual deadlines for submission 15 January and 15 March.

This National Inventory Report (NIR) of Bulgaria for the 2021 submission to the EU, the UNFCCC and the Kyoto Protocol includes data of the anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHGs) not controlled by the Montreal Protocol, i.e. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), nitrogen trifluoride (NF_3) and sulphur hexafluoride (SF_6).

Indirect CO_2 emissions resulting from atmospheric oxidation of CH_4 and NMVOC emissions from non-biogenic sources are also included in the inventory. These have been separately estimated for fugitive emissions in the Energy sector and sources in the Industrial Processes and Product Use sectors using the methodology given in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006, see Section 7.2.1.5). For fossil fuel combustion, indirect emissions are included in the methodology to estimate CO_2 emissions.

The NIR includes also estimates of so-called indirect greenhouse gases carbon monoxide (CO), nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2) meaning sulphur oxides and other sulphur emissions calculated as SO_2. Indirect greenhouse gases and sulphur dioxide do not have a direct warming effect, but influence on the formation or destruction of direct greenhouse gases, such as troposheric ozone. These gases are not included in Annex A of the Kyoto Protocol.

The emission estimates and removals are presented by gas and by source category and refer to the year 2019. Full time series of the emissions and removals (with exception of F-gases) from 1988 to 2019 are included in the submission.

The structure of this NIR was reelaborated in order to follow the Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention (Decision 24/CP.19). The annotated outline of the NIR, and the guidance contained therein, developed by the UNFCCC secretariat in 2014, has been followed. Chapter 1 provides an introduction to the background of greenhouse gas inventories and the inventory preparation process and Chapter 2 presents the overall emission trend in Bulgaria from the year 1988 to the year 2019. In Chapters 3 to 9 more detailed information of GHG emission estimates are given for the seven sectors: (i) energy, (ii) industrial processes and product use, (iii) agriculture, (iv) land use, land-use change and forestry, (v) waste, (vi) other and (vii) indirect CO_2 and nitrous oxide emissions. In Chapter 10 improvements and recalculations since the previous submission are summarised. Chapter 11 provides description of KP-LULUCF, Chapter 12 information on accounting of KYOTO units, Chapter 13 information on changes in national system and Chapter 14 information on changes in national registry. Chapter 15 gives information on minimisation of adverse impacts in accordance with Article 3, paragraph 14.

Annex 1 contains the mandatory key category reporting tables. A national reference calculation for CO_2 emissions from energy combustion can be found in Annex 4 (Comparison of CO_2 emissions calculated from the Energy balance with fuel combustion emissions as reported in the CRF tables). Annex 7 contains the mandatory uncertainty reporting table (table 3.3 of 2006 IPCC GL). Annex 6 includes 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.

As an Annex I Party to the Convention Bulgaria reports annually its GHG inventory/emissions from the base year to the year proceeding the year of reporting.

Annex I Parties to the KP should report also additional elements as assigned amount information, changes in national system, changes in national registry and voluntary submission of information relating to activities under Articles 3, paragraphs 3 and 4, of the Kyoto Protocol.

The main greenhouse gases to be reported pursuant to UNFCCC are as follows:

- Carbon dioxide - CO_2;
- Methane - CH_4;

- Nitrous oxide - N_2O;
- Hydrofluorocarbons – HFCs;
- Perfluorocarbons – PFCs;
- Sulphur hexafluoride - SF_6;
- Nitrogen trifluoride - NF_3.

Each of these gases has a different warming effect. As an example, the gases HFCs, PFCs, NF_3 and SF_6 (so called F-gases) have much greater warming effect, in some cases over one hundred times, compared to methane (25), nitrous oxide (298) and carbon dioxide (1).
Because of that, a common assessment criterion for the effect of each GHG on the atmosphere warming should be introduced. This criterion is the so-called Global Warming Potential (GWP), representing GHG emissions as CO_2-eq. emissions. It allows totalling the effect of all GHGs, adjusted to a common base.
For defining of GWP, the Parties to the Convention and Kyoto Protocol accept values, over a time horizon of 100 years, as mentioned in the IPCC Fourth Assessment Report of 2007.
Other gases have indirect warming effect to the atmosphere (as NOx, CO and NMVOCs), or cooling effect as SOx. These gases are precursors of the greenhouse gas – troposphere ozone, and are subject of regional control protocols. They do not have global effect on the climate changes as the main GHG. That is why in the NIR only the total GHG emissions – precursors, as well as the total SOx emissions were reported.
The inventories are prepared according to the UNFCCC Guidelines and establishing the NIR structure in compliance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
The general objective regarding the preparation of the annual GHG inventories is to improve „TACCC" in emission estimates. The Report presents the National GHG inventory for 2019. The following are described as well:

- Methods and indices for uncertainty assessment of the annual GHG emissions and trends;
- Key GHG emission sources according to Approach 1 and Approach 2, specified in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;
- Assessment of the quality assurance, control system and verification.
- Activity data and emission tables for 1988-2019 in the Common Reporting Format (CRF) for annual GHG inventories are submitted together with the Report and are uploaded on:

http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php
http://cdr.eionet.europa.eu/bg/un/unfccc

1.1.3 BACKGROUND INFORMATION ON SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1, OF THE KYOTO PROTOCOL AND INTERNATIONAL AGREEMENTS

Bulgaria has made a commitment to follow the United Nations Framework Convention on Climate Change that entered into force on 21 March 1994. The Kyoto Protocol negotiated in 1997 under the UN Framework. The Kyoto protocol took effect on 16 February 2005 and became legally binding.
The Kyoto Protocol (Article 5.1) requires that the parties have in place a National System by the end of 2006 at the latest for estimating anthropogenic greenhouse gas emissions by sources and removals by sinks not controlled by the Montreal Protocol. The guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol (Decision 19/CMP.1) provide the requirements for the general and specific functions of the national systems. Bulgaria's inventory system was reviewed successfully as part of the review of the Bulgaria's initial report under Protocol in 2007.
Under the UNFCCC and the Kyoto Protocol, Bulgaria is required to submit annually to secretariat of the Convention a national greenhouse gas inventory covering emissions and removals of direct greenhouse gases from the five sectors (Energy, Industrial processes and product use, Agriculture, Land use, Land use change and Forestry and Waste) and for all years from the base year or period to the most recent year. The preparation and reporting of the inventories are guided by the UNFCCC guidelines (UNFCCC 2014) and are based on the following IPCC methodologies to ensure the transparency, accuracy, consistency, comparability and completeness of the inventories:

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC GL)

- 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP supplement)
- 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement)
- EMEP/EEA air pollutant emission inventory guidebook – 2019.[15]

The national greenhouse gas inventory for 2019 is submitted to the European Commission by Bulgarian Ministry of Environment and Water in fulfilment of Bulgaria's obligation under Article 7 of Regulation 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC. The purpose of Regulation 525/2013 is to monitor all anthropogenic greenhouse gas emissions not controlled by the Montreal Protocol and to evaluate the progress towards meeting the commitments under the UNFCCC and the Kyoto Protocol.

1.2 DESCRIPTION OF THE NATIONAL INVENTORY ARRANGEMENTS

1.2.1 INSTITUTIONAL, LEGAL AND PROCEDURAL ARRANGEMENTS

REQUIREMENTS FOR NATIONAL SYSTEMS FOR GREENHOUSE GAS INVENTORIES AS SPECIFIED IN THE GUIDELINES FOR ARTICLE 5.1 OF THE KYOTO PROTOCOL

The Bulgarian National Inventory System (BGNIS) is developed following the requirements of the provisions of Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol.

In order to reinstate the eligibility under Kyoto Protocol a Compliance Action Plan for ensuring the effective and timely functioning of BGNIS in accordance with the requirements of Article 5.1 of the Kyoto Protocol and Decision 19/CMP 1 was developed and implemented in 2010.

The conclusions and recommendations of ERT set out in the Report of the individual review of the 2010 annual submission of Bulgaria (FCCC/ARR/2010/BGR) indicate that all activities for improvements of institutional, legal and procedural arrangements within the National Inventory System as well as for improvement of quality of inventory are adequately planned and implemented by the Bulgarian government in 2010.

The main results are written in the paragraph §203 from the annual review report FCCC/ARR/2010/BGR - "The ERT concludes that the national system of Bulgaria is performing its required general and specific functions, as set out in the annex to decision 19/CMP.1 with respect to the institutional, legal and procedural arrangements to perform these functions; that the institutional, legal and procedural arrangements established and formalized by the "Ordinance on the way and order of organization of the national inventories of hazardous substances from greenhouse gases in the ambient air" (Ordinance No. 215) that entered into force on 21 September 2010 are fully operational; and that Bulgaria has in place the institutional arrangements and the capacity, including the arrangements for the technical competence of staff involved in the national system, to plan, prepare and manage inventories on an annual basis". As a result from implemented activities for improvements "No questions of implementation were identified by the ERT during the review" (FCCC/ARR/2010/BGR § 207).

In accordance with Decision of Enforcement Branch CC-2010-1-17/Bulgaria/EB from 4 February 2011 Bulgaria is now fully eligible to participate in the mechanisms under Articles 6, 12, and 17 of the Kyoto Protocol.

The activities for improvement of quality of GHGs inventory are planned in order to implement the recommendations of the Expert Review Team set out in the annual review report FCCC/ARR/2014/BGR.

HISTORY OF GHG INVENTORY PREPARATION

The Bulgarian National Inventory System changed over time two times because of decisions of the particular government. In the following table the national circumstances are outlined:

[15] In the following referred as EMEP/EEA Guidebook (2016)

BGNIS until 2007 (submission 2007)	Present BGNIS (submission 2008-2021)	Prospected BGNIS
←	Centralized inventory	→
Single institute	Single agency	→
Out-sourced inventory	In-sourced inventory	→
Private consultants	**Public/Governmental** (submission with cooperation of consultants)	→
National Inventory Focal Point: Private consultants	National Inventory Focal Point: ExEA	→
←	National Focal Point: MoEW	→

Until 2007 the national emissions inventory as well as the relevant NIR under UNFCCC was prepared by an external company through an open tender procedure under the rules of the Public Procurement Law.
Since 2008 the Executive Environment Agency (ExEA) is responsible for the whole process of inventory planning, preparation and management.
The national system defines the "road map" in which Bulgaria prepares its inventory. This is outlined in the national inventory preparation cycle (see below part Fulfilment of paragraph 10(a) from Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol).
As it is illustrated in figure 1 and outlined in the following chapters the preparation of the inventory has an institutional "home" that is ultimately responsible for managing the process and has a legal authority to collect data and submit it on behalf of the Bulgaria.
Bulgaria's reporting obligations to the UNFCCC, UNECE and EC are being administered by the MoEW. All activities on preparation of GHG inventory in Bulgaria are coordinated and managed on the state level by MoEW.

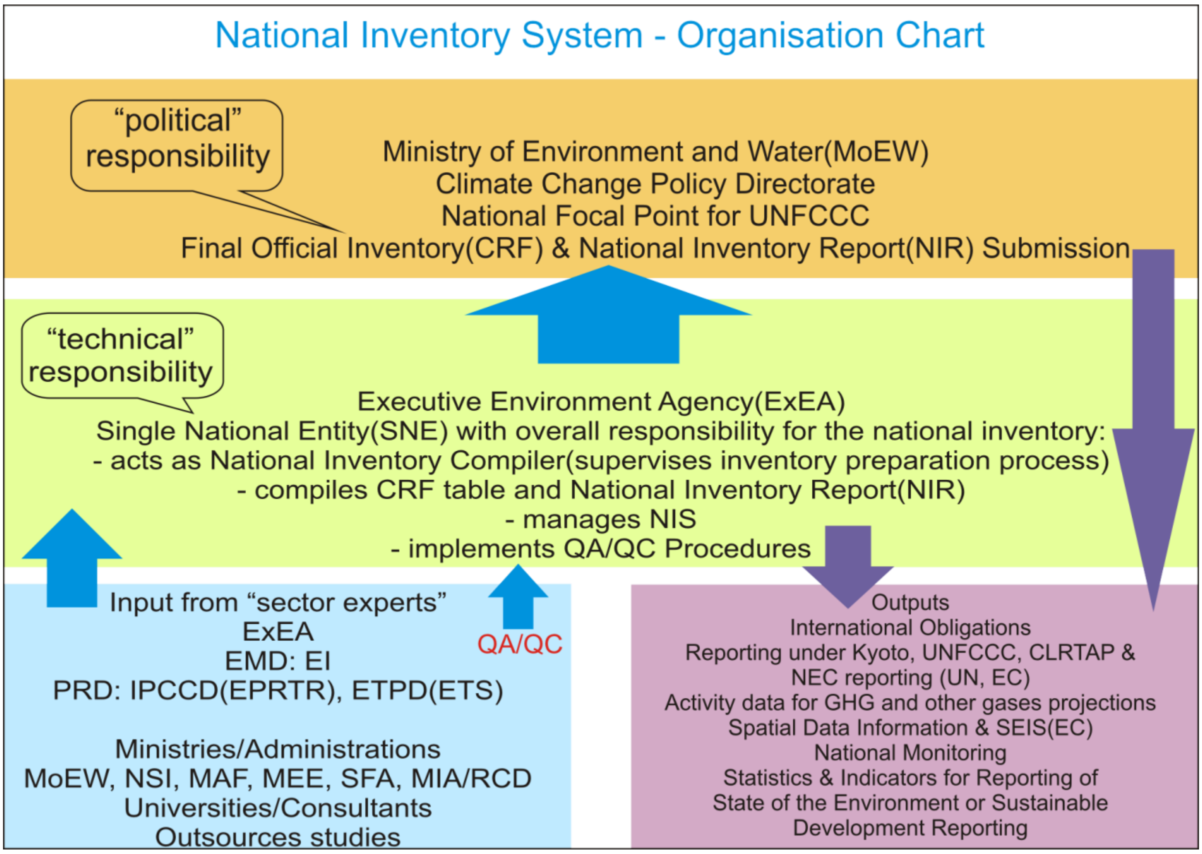

Figure 1 Organizational Chart of the Bulgarian National Inventory System

The Bulgarian Government by MoEW (Climate Change Policy Directorate) has the political responsibility for compliance with commitments under the UNFCCC and the Kyoto Protocol, including for functioning of BGNIS in accordance with the requirements of Decision 19/CMP.1 under Article 5, paragraph 1, of the Kyoto Protocol. In order to meet all challenges in this sphere, the Climate Change Policy has been transformed in a separate directorate. Now, it consists of 12 persons in total.
The following strategic goals in climate change area were achieved by the Ministry of Environment and Water in 2019:

Climate change mitigation law

Climate change mitigation law adopted on first reading in the National Assembly on 23.10.2013, in order to incorporate the requirements of the new legislation in 2013. It regulates public relations in implementation of the policy on climate change - powers and duties of the competent authorities and individuals. Absolute prerequisite for the timely implementation of Bulgaria's obligations as a party to the UNFCCC and the Kyoto Protocol and as a country - member of the European Union, is the effective involvement of the competent authorities and private operators in the procedures, which requires clear and comprehensive regulation of their powers, rights and obligations. As a member of the European Union the Republic of Bulgaria has a number of obligations on the legislative package "Climate & Energy" and participating in the scheme for trading greenhouse gas emissions within the European Union (EU ETS), introduced by Directive 2003/87/EC. This fact is linked to the performance of many obligations that form the whole sector in climate policy and the implementation of which our country should strike a balance between the interests of industry and the ambitious EU targets for the progressive reduction of greenhouse gases.

National Green Investment Scheme

In order to exploit the possibilities for financing projects to reduce greenhouse gas emissions through the National Green Investment Scheme is a decision of the Council of Ministers № 546/12 September 2013 for addition to the agreement with Austria for the purchase of AAUs in Scheme green investments. It is accepted and a decision of the Council of Ministers № 547/12 September 2013 in connection with the implementation of projects under the Green Investment Scheme.
The funds from the sale of AAUs of the Republic of Austria have implemented projects for energy efficiency of the 77 public facilities state and municipal property in Bulgaria. Public projects to improve energy efficiency in municipal buildings, kindergartens and primary schools. Realized are energy efficiency projects at 13 public sites throughout the country.
In 2015 was started the Investment Climate Programme, which is a kind of continuation of the National Green Investment Scheme. The new programme is implemented by Trust Eco-Fund and it is financed by the revenues from so called "early auctions" of greenhouse gas emissions allowances from installations paid into the budget of the Ministry of Environment and Water by 31st December 2012. The funds are designated to be used for financing of the projects aiming at improving of energy efficiency of state and municipal public buildings, as well as for promoting the use of electric and hybrid vehicles by public institutions (since 2016).

National adaptation strategy

Steps have been taken to prepare national adaptation strategies in order to determine the necessary adaptation measures for vulnerable sectors to the impacts of changing climatic conditions in the region and climatic zone (due to climate change). As a first step was draft document "Analysis of the contribution of the insurance sector and financial instruments to the prevention of risks posed by climate change and the management of loss and damage in Bulgaria" prepared by the Ministry, with the support of the World Bank. Its purpose is to analyze the role and importance of the insurance business for the prevention of risks that occur as a result of climate change and taking measures to adapt. The analysis will be included in the national adaptation strategy.
The ExEA has been identified as the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Kyoto Protocol and designated as single national entity (see below Legal bases; Chapter 1.2.11).
The ExEA is represented and managed by an Executive Director. The organizational chart of the ExEA is presented in Figure 2.
The ExEA's directorates and departments, which are directly involved in operation of the BGNIS are Environmental Monitoring and Assessment Directorate with the Emission Inventory Department (EID)

and Waste Department (WD) and Permit Regime Directorate with the Integrated Pollution Prevention and Control Department (IPPCD) and Emission Trading Permit Department (ETPD).

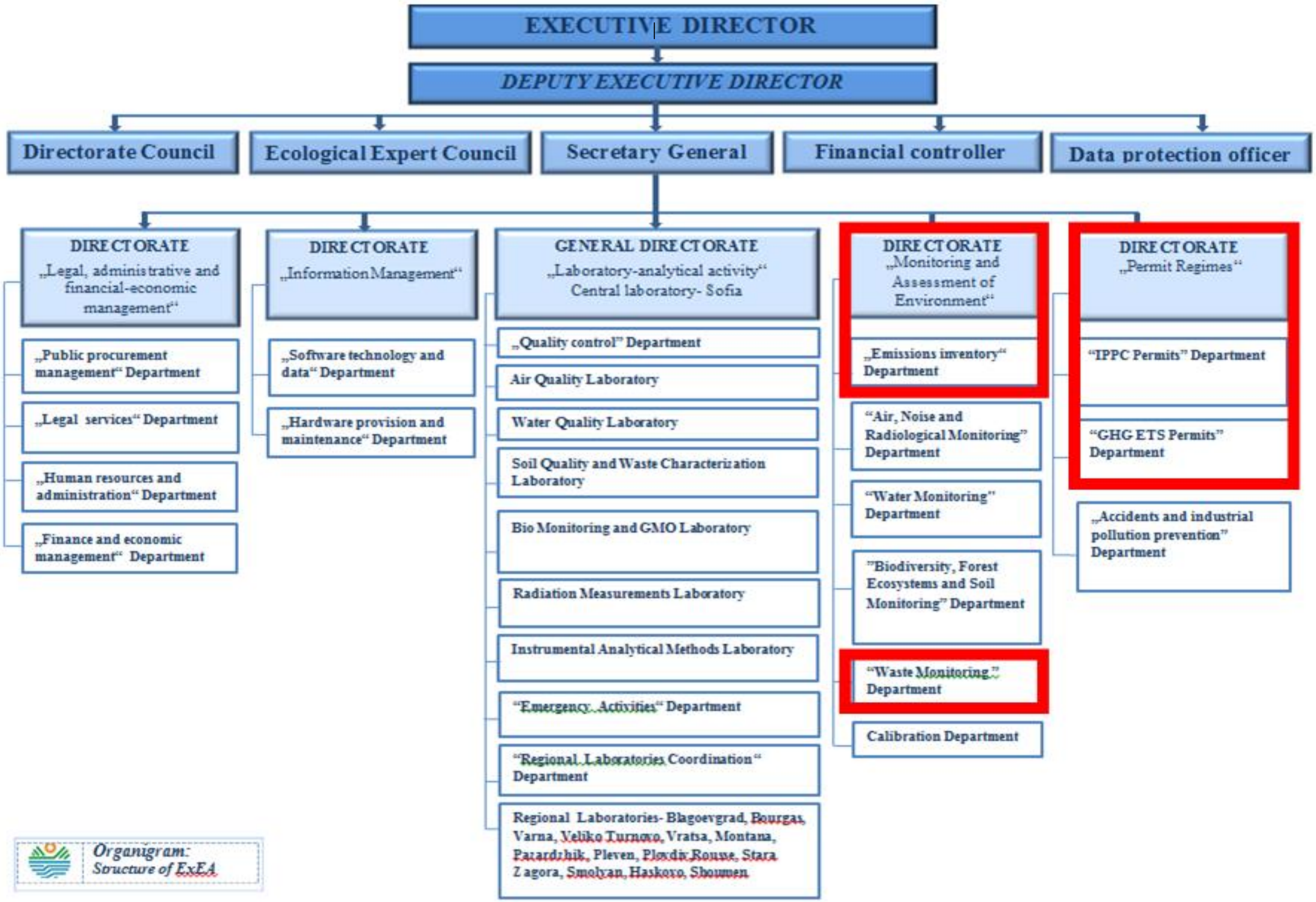

Figure 2 Organizational Chart of the Executive Environmental Agency (ExEA)

Since 1 January 2012, the Emissions Inventory Unit, responsible for preparation of the GHG Inventory, has been promoted as Emissions Inventory Department (see Figure 2).
The specific responsibilities of the different departments are presented below in part Legal arrangements of the Bulgarian National Inventory System (Figure 4: Bulgarian National Inventory System – Responsibilities).
The definitions provisions of Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol, are incorporated in BGNIS which is outlined below.
The overall objective of the BGNIS is annually to produce a high quality inventory (National CRF, Kyoto and SEF tables and NIR) for compliance with its Kyoto commitment and to submit it by the required deadline.
The objective of a BGNIS is annually to produce a high quality inventory, with "quality" being defined by the TACCC criteria. (see also chapter 1.2.12)

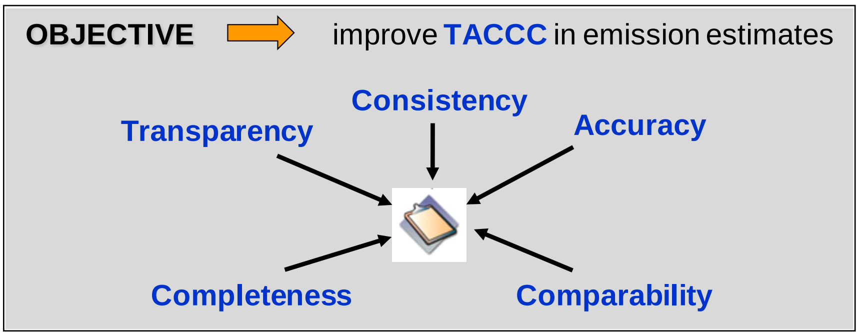

Figure 3 Objectives of the Bulgarian National Inventory System

1.2.2 OVERVIEW OF INVENTORY PLANNING, PREPARATION AND MANAGEMENT

Legal basis of the Bulgarian NIS – General functions

Fulfillment of paragraph 10(a)

The Republic of Bulgaria joined the UNFCCC in 1992 and the Parliament ratified it in March 1995. As an Annex I Party to the Convention, Bulgaria is committed to conduct annual inventories on greenhouse gas (GHG) emissions by sources and removals by sinks, using the GHG inventory methodology, approved by the UNFCCC. The inventories started with the country base year – 1988. The first inventories covered the period 1988-1994 as a part of the international project "Country Study to Address Climate Change".

Legal basis of the BGNIS

As illustrated in Figure 1 and outlined shortly the Bulgaria's reporting obligations to the UNFCCC, UNECE and EC are being administered by the MoEW. All activities on preparation of GHG inventory in Bulgaria are coordinated and managed on the state level by MoEW. The Bulgarian Government by MoEW has the political responsibility for compliance with commitments under the Kyoto Protocol, including for functioning of BGNIS in accordance with the requirements of Decision 19/CMP.1 under Article 5, paragraph 1, of the Kyoto Protocol:
National Focal Point;
QA experts from Climate Change Policy Directorate;
Approval of inventory;
Submission of CRF / NIR / Kyoto Tables / SEF.
The ExEA has been identified as the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Kyoto Protocol and designated as single national entity. ExEA has the technical responsibility for the national inventory:

- acts as National Inventory Compiler (supervises inventory preparation process);
- manages BGNIS;
- compiles CRF tables and NIR;
- coordinates the work of engaged consultants for supporting inventory;
- coordinates and implements the activity of National QA/QC Plan;
- National Inventory Focal Point.

The bases for BGNIS are:
Environmental Protection Act (EPA, State Gazette No. 91/25.09.2002; corrected, SG No. 96/2002; last amendment June 2020);
Statute on the organization and structure of ExEA (Decision of Council of ministers 162/03.08.2012 – final update 20.09.2019);
Order № 344/01.12.2020 by the Executive Director of ExEA (Sector experts/QC experts);
Order № RD-218/05.03.2010 by the Minister of Environment and Water (QA experts).
Regulation of the Council of Ministers 227/16.10.2017 SG 84/2017 on the way and order of organization of the National Inventories of hazardous substances and greenhouse gases in the ambient air

Add 1.

EPA (State Gazette No. 91/25.09.2002; corrected, SG No. 96/2002; last amendment November 2012), which establishes the National Environmental Monitoring System, make clear the responsibility for preparation inventories under both conventions and lists of its tasks:

Chapter One: GENERAL DISPOSITIONS

Article 11: The Minister of Environment and Water shall perform the following functions:

(2) direct the National Environmental Monitoring System through the **Executive Environment Agency**;

Article 13:

(1) The Executive Environment Agency with the Minister of Environment and Water shall direct the National Environmental Monitoring System.

(2) The Executive Environment Agency shall be a legal person.

(3) The Executive Environment Agency shall be managed and represented by an Executive Director.

(4) The operation, the structure, the organization of work and the staffing of the Executive Environment Agency shall be determined by Rules of Organization adopted by the Council of Ministers.

Chapter Eight: NATIONAL ENVIRONMENTAL MONITORING SYSTEM

Article 144: (1) The National Environmental Monitoring System shall comprehend:

1. the national networks for:
2. a system for information on, and control of, air emissions and the state of waste waters;

Add 2.

EPA establishes the national Executive Environment Agency (ExEA) according to **Regulation on the organization and structure of ExEA** (Decision of Council of ministers 162/03.08.2012 - final update 20.09.2019), which regulate it's responsibilities for monitoring of environment as well as the responsibility for preparation of emission inventories.
The Emissions Inventory Department of ExEA prepares and annually updates the air emissions inventories [according to article 14 (12) of the above Regulation].

Add 3.

To increase the capacity in ExEA for adequate planning, preparation and management of emissions inventory an Order № 344/01.12.2020 by the Executive Director of ExEA has been issued. The order regulates the name and responsibilities of experts from different departments within the ExEA, which are engaged in preparation of National GHGs emission inventory (Sector experts/QC experts).

Add 4.

To assure the quality of information reported to UNFCCC and UNECE and to support the single national entity, the Minister of Environment and Water has issued an order № RD-218/05.03.2010. The order regulates the names and responsibilities of the MoEW and ExEA QA experts for implementation of the requirements of National QA/QC Plan in emission inventory of sectors Energy, Industry, Solvents, Agriculture, LULUCF and Waste.

Add 5.

The BGNIS has been enshrined in law through a special Regulation of the Council of Ministers 261/05.09.2014 SG 76/2014 (last update 227/16.10.2017 SG 84/2017). The regulation establishes and maintain the institutional, legal and procedural arrangements necessary to perform the general and specific functions of BGNIS, defined in Decision 19/CMP.1 for national systems. The regulation reinforces the existing institutional agreements by specifying the roles of all data providers.

INSTITUTIONAL ARRANGEMENTS

In order to strengthen the institutional arrangements and to fulfil the required general and specific functions of BGNIS an official agreements between MoEW and the main data providers were signed in 2010:

- National Statistical Institute (RD21-35/12.02.2010);
- Ministry of Agriculture and Food and its body Executive Forest Agency (04-00-517/26.02.2010 and RD 50-47/15.03.2010);
- Ministry of Economy, Energy and Tourism (14/06/2010);
- Ministry of Interior (MI) (08/06/2010).

The agreements ensure the support from these organisations regarding the choice of the activity data and EFs and methods, in the compilation of emission estimates and QA/QC of these estimates.

The ExEA as Single National Entity coordinates all activities, related to collecting inventory data and aggregates the data relevant for GHG emissions on a national level by the following state authorities:

- National Statistics Institute (NSI);
- Ministry of Agriculture, Food and Forestry (MAFF) and their relevant services (Agrostatistic Directorate and Executive Forest Agency);
- Ministry of Energy (ME);
- Ministry of Interior (MI);
- Ministry of Environment and Water (MoEW);
- Ministry of Transport, Information Technologies and Communications (MTITC).

OTHER ARRANGEMENTS OF THE BULGARIAN NATIONAL INVENTORY SYSTEM

The Executive Environment Agency (ExEA) coordinates all activities, related to the large industrial plants and Branch Business Associations.

- Large industrial plants – official letters (questionnaire)
- Branch Business Associations – official letters (questionnaire)

For validation of the activity data we gather reliable country specific data from Branch Business Associations in Bulgaria and aggregate the data relevant for GHG emissions on a national level. Please see the list of all branch business associations in Bulgaria: http://www.bia-bg.com/memberCategory/278. The data must be representative for the whole period since 1988 (base year for Bulgaria).

EXPERT CAPACITY

Expert capacity in ExEA - Emission Inventory Department

The EID has the main role in BGNIS as National Inventory Compiler (supervises inventory preparation process, compiles CRF tables and NIR, manages BGNIS implements QA/QC procedures on a national level)

The responsibilities of the Sector experts - Within the inventory system specific responsibilities for the different emission source categories are defined ("sector experts"), as well as for all activities related to the preparation of the inventory, including QA/QC, data management and reporting.

The sector experts are in charge of specific responsibilities related to choice of methods, data collection, processing and archiving. Sector experts are also responsible for performing Quality Control (QC) activities that are incorporated in the Quality Management System (QMS) (see below).

Engaged departments within ExEA - In order to improve the capacity of the BGNIS in planning, preparation and managing its annual submissions the extension of the ExEA staff has been realised in the beginning of 2010.

TECHNICAL CAPACITY

Training of Bulgarian experts

Workshops and Training on the job

To raise the technical competence of staff involved in the inventory development process, a training programme for Bulgarian inventory experts was updated within the Twinning project with the Federal Environment Agency of Austria[16]. The program covered all inventory sectors in a series of workshops realised in the period December 2009 to September 2010.

Further collaboration with Austrian Environment Agency for training of Bulgarian staff is envisaged for the next submissions.

Online training

[16] The Twinning Partner "Austrian Federal Environment Agency" has already experience as supporting role / expert in preparing GHG and air emission inventory and reporting (UNFCCC, UNECE/LRTAP and NEC); FCCC/ARR/2008/LUX para 8: "…. The ERT noted that three relevant studies have been outsourced to external experts and that the improvements are mainly the result of research activities and intensive cooperation with the Austrian Federal Environment Agency."

To raise the technical competence of staff involved in the inventory development and review process, sector experts from ExEA applied for having an access to the Online training by the UNFCCC and GHG Management Institute (GHGMI)[17].

Basic Course[18]

This course covers technical aspects of the review of GHG inventories of Annex I Parties. It consists of seven modules: one general module, "Overview of UNFCCC Review Process and General IPCC Inventory Guidance" and individual modules on the review of individual IPCC sectors: Energy (Fuel Combustion and Fugitive Emissions), Industrial Processes, Agriculture, LULUCF and Waste. Each of the modules provides important background information and references for the sector, instruction on general procedures for review, exercises on key topics and specific emission categories, and practical case studies that simulate an actual review.
The courses are also available to trainees all year round, without instructor.

Fulfilment of paragraph 10(c)

See above and below

UNFCCC reporting guidelines

Fulfilment of paragraph 10(d);

Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention following incorporation of the provisions of decision 24/CP.19"

Fulfilment of paragraph 10(c)

See below

LEGAL BASIS OF THE Bulgarian NIS – SPECIFIC FUNCTIONS
SINGLE NATIONAL ENTITY

Fulfilment of paragraph 12(a)

An overview of the general responsibilities in the inventory development and reporting process is given in Fulfilment of paragraph 10a.
Bulgaria's reporting obligations to the UNFCCC, UNECE and EC are being administered by the Ministry of Environment and Water (MoEW). All activities on preparation of GHG inventories in Bulgaria are coordinated and managed on the state level by MoEW. The MoEW (Climate Change Policy Directorate) has the political responsibility for compliance with commitments under the Kyoto Protocol, including for functioning of BGNIS in accordance with the requirements of Decision 19/CMP.1 under Article 5, paragraph 1, of the Kyoto Protocol.
The Executive Environment Agency (ExEA) has been identified as the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Kyoto Protocol and designated as single national entity. ExEA has the technical responsibility for the national inventory:

- acts as National Inventory Compiler (supervises inventory preparation process);
- compiles CRF tables and NIR;
- manages BGNIS;
- implements QA/QC procedures.

Fulfilment of paragraph 12(b)

The postal and electronic addresses of the single national entity are:

[17] http://ghginstitute.org/2010/03/03/the-unfccc-expert-reviewer-training-programme-is-ongoing

[18] http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_training/items/2763.php
http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_training/items/2764.php

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Fulfilment of 12(c)

An overview of the general responsibilities in the inventory development and reporting process is given in Fulfilment of paragraph 10a. As mentioned before, the ExEA has the overall responsibility for the national inventory, comprising greenhouse gases as well as other air pollutants. Within the inventory system specific responsibilities for the different emission source categories are defined ("sector experts"), as well as for all activities related to the preparation of the inventory, including QA/QC, data management and reporting.
The sector experts are in charge of specific responsibilities related to choice of methods, data collection, processing and archiving. Sector experts are also responsible for performing Quality Control (QC) activities that are incorporated in the Quality Management System (QMS) (see below).

1.3 INVENTORY PREPARATION, DATA COLLECTION, PROCESSING AND STORAGE

Collection of activity data by ExEA

The information is collected on the annual basis.
The ExEA sends every year letters with request for provision of the necessary activity data to every one of the information sources, including the deadline for response.
For NSI, MAFF, MI and ME the type of the necessary data, as well as the deadlines for submissions to the ExEA are regulated by the official agreements mentioned above as well as by the Regulation of the Council of Ministers 227/16.10.2017 (SG 84/2017).

The annual national energy and material balances as well as the data related to the solid waste generation and the wastewater treatment are prepared by NSI. NSI uses up-to-date statistical methods and procedures for data collection, summarizing and structuring that are harmonized with EUROSTAT.
The GHG inventory use data, received directly from large point sources in the energy sector and in the industry and these data are summarized by ExEA.

Table 1 Sources of activity data for preparation of national GHGs emission inventory

Sectors	Data Source of Activity Data	Activity Data supplier	
1. Energy			
1.A Fuel Combustion	Energy balance (IEA - EUROSTAT – UNECE Energy Questionnaire)	NSI	National Statistical Institute
1.A.3 Transport	Energy balance (IEA - EUROSTAT – UNECE Energy Questionnaire)	NSI	National Statistical Institute
	Statistics vehicle fleet	MI/RCD	Ministry of Interior/ Road Control Department
	Country specific parameters used in the COPERT 5 related to car fleet and vehicle split	MTITC	Ministry of Transport, Information Technologies and Communications
1.B Fugitive emissions	Energy balance (IEA - EUROSTAT – UNECE Energy Questionnaire)	NSI	National Statistical Institute
	National statistics	ME	Ministry of Energy
2. Industrial processes and product use	National production statistics	NSI	National Statistical Institute
	National registers (EPRTR and ETS)	ExEA	Executive Environment Agency
	National studies	MoEW/ ExEA	Ministry of Environment and Water/ Executive Environment Agency
	National VOC register	ExEA	Executive Environment Agency
3. Agriculture	National agriculture statistics	MAFF	Ministry of Agriculture, Food and Forestry /Statistics Department
	Synthetic fertilizers	NSPP	National service for Plant Protection
4. LULUCF	National Forest Inventory	EFA	Executive Forest Agency
	National statistics of the balance of territory of Bulgaria	MAFF	Ministry of Agriculture, Food and Forestry
5. Waste	National statistics	NSI	National Statistical Institute
	National database	ExEA	Executive Environment Agency/ Waste Monitoring Department

Inventory preparation

The inventory preparation process covers:

- Identification key source categories[19];
- Prepare estimates[20] and ensure that appropriate methods are used to estimate emissions from key source categories;
- Collect sufficient activity data, process information, and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks;
- Make a quantitative estimate of inventory uncertainty[21] for each source category and for the inventory in total recalculations[22] of previously submitted estimates of anthropogenic GHG emissions by sources and removals by sinks;
- Compile the national inventory in accordance with Article 7, paragraph 1, and relevant decisions of the COP and/or COP/MOP;
- Implement general inventory QC procedures (tier 1) in accordance with its QA/QC plan following the 2006 IPCC GL;
- Apply source category specific QC procedures[23] (tier 2) for key source categories and for those individual source categories in which significant methodological and/or data revisions have occurred;
- Collection of all data collected together with emission estimates in a database (see below), where data sources are well documented for future reconstruction of the inventory.

The Figure 4 presents the general responsibilities of all engaged institutions in functioning of Bulgarian National Inventory System.

The ExEA coordinates all activities on preparation of inventory under UNFCCC.

The Executive director of the ExEA through internal administrative order and based on the Regulation on the organization and structure of ExEA appoints sector experts for preparation of emission inventory in Energy, Industrial processes and products use, Agriculture, LULUCF and Waste.

The ExEA, agreed with the MoEW engages external consultants for preparation of tasks, which are out of competence of the Agency and are related with improvement of the inventory.

[19] following the methods described in the 2006 IPCC GL (chapter 4, section 4.2);

[20] in accordance with the methods described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

[21] following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

[22] prepared in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and relevant decisions of the COP and/or COP/MOP;

[23] in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

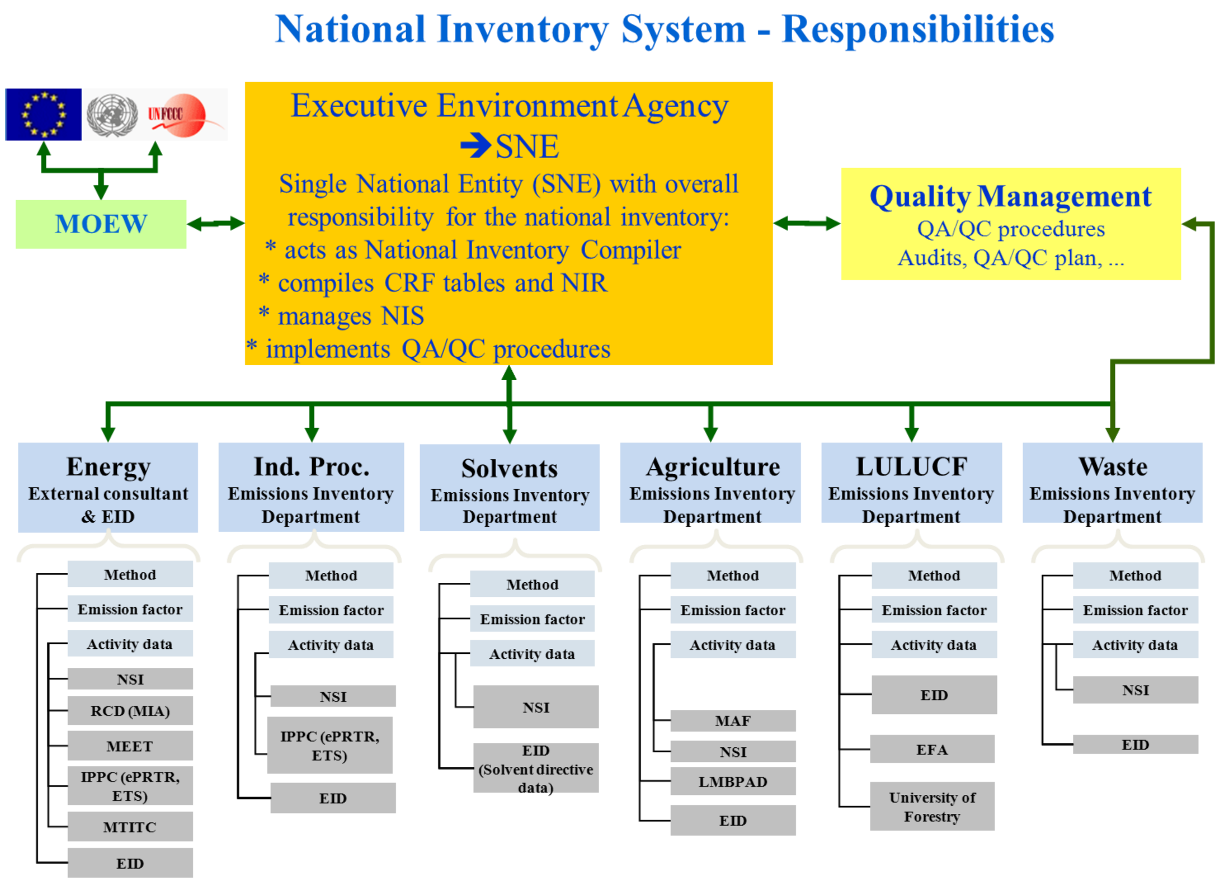

Figure 4 Bulgarian National Inventory System – Responsibilities

The following table presents the responsibilities of all engaged institutions for preparation of GHGs emission inventory for 2021 submission.

Table 2 Preparation of GHGs emission inventory for 2021 submission

Sector CRF	Activity data	Methodology and selection of emission factors	Preparation of Sector inventories
Energy CRF1A1 CRF1A2 CRF1A4	NSI	ExEA, NSI	Sector expert ExEA External consultants
Energy/Transport CRF1A3	NSI MI MTITC	ExEA, NSI MI, MTITC	Sector expert ExEA External consultants
Energy CRF1B	NSI ME	ExEA, NSI, ME	Sector expert ExEA External consultants
Industry processes and product use CRF2	NSI ExEA MOEW NSI ExEA	ExEA, NSI, Installations operators	Sector expert ExEA

Sector CRF	Activity data	Methodology and selection of emission factors	Preparation of Sector inventories
Agriculture CRF3	MAFF	ExEA, MAFF	Sector expert ExEA
	NSPP		
LULUCF CRF4	EAF	ExEA, EAF	Sector expert ExEA External consultants
	MAFF		
Waste CRF5	NSI	ExEA, NSI	Sector expert ExEA
	ExEA		

The National Inventory Compiler compiles the national GHGs inventory (CRF-tables and NIR) for the submission under the UNFCCC.

Documentation and data archiving

In August 2010 a new system for sector expert workflow organization, inventory documentation and data archiving has been implemented in the ExEA.

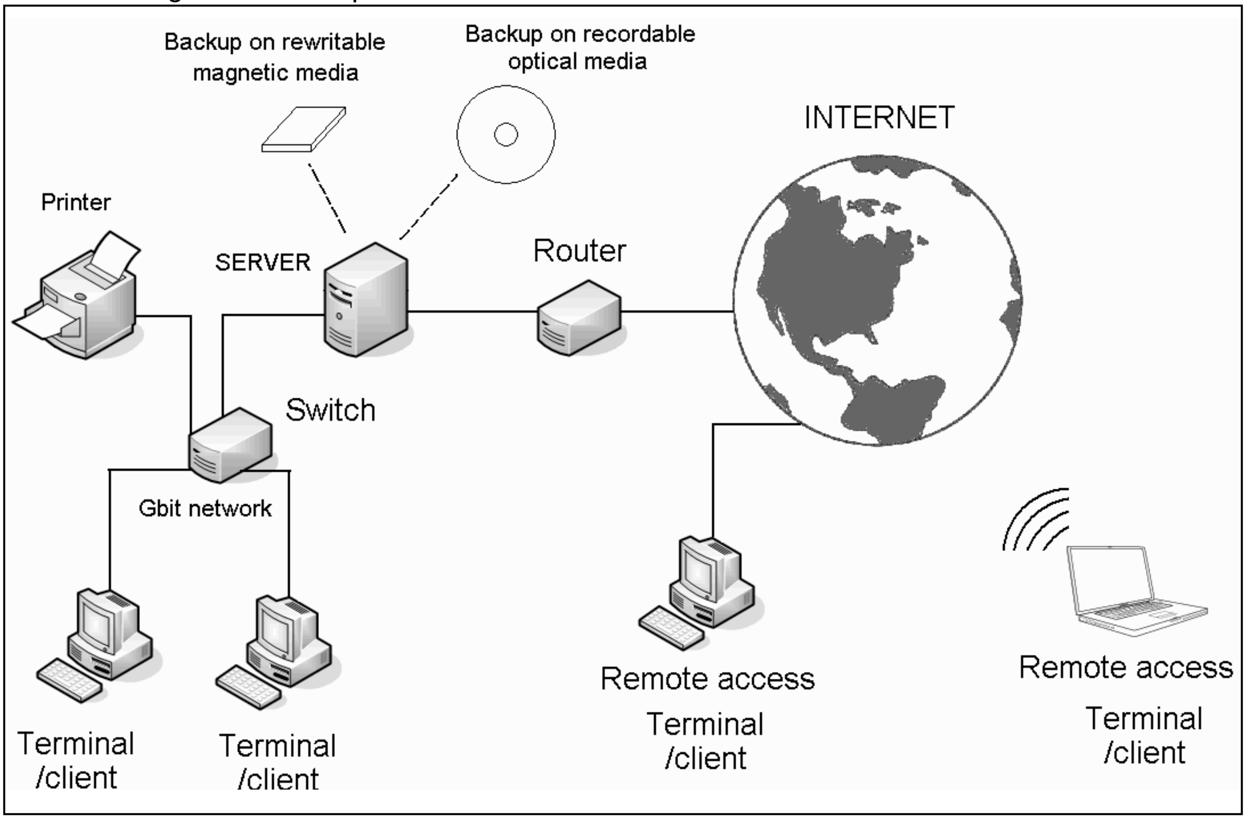

Figure 5 Documentation and data archiving in ExEA

1.3.1 QUALITY ASSURANCE, QUALITY CONTROL AND VERIFICATION

Fulfilment of paragraph 12(d)

As it is written above the Executive Environment Agency is responsible for the preparation of the GHGs Emission Inventory and the relevant National Inventory Reports under UNFCCC.
The ExEA is also responsible for coordination and implementation of QA/QC activities for the national inventory. A quality manager is in place.
The Bulgarian Quality Management System was established in the frame of project with Bulgarian Academy of Science, Geophysical Institute. The project was carried out and finished in 2008.

The QA/QC plan is an internal document to organise, plan and implement QA/QC activities. Once developed for the next submission, it is referenced and used in subsequent inventory preparation, or modified as appropriate.
The QA/QC plan has been updated in 2014 in order to implement the new established legal, institutional and procedural arrangements within the BGNIS. The updated National QA/QC Plan was approved by the Ministry of Environment and Water in December 2014.
National QA/QC Plan includes following elements:

- Responsible institutions;
- Data collection;
- Preparation of inventory;
- Category-specific QC procedures;
- QA and review procedures;
- Uncertainty analyses;
- Organisation of the activities in quality management system;
- Verification activities;
- Reporting, documentation and archiving.

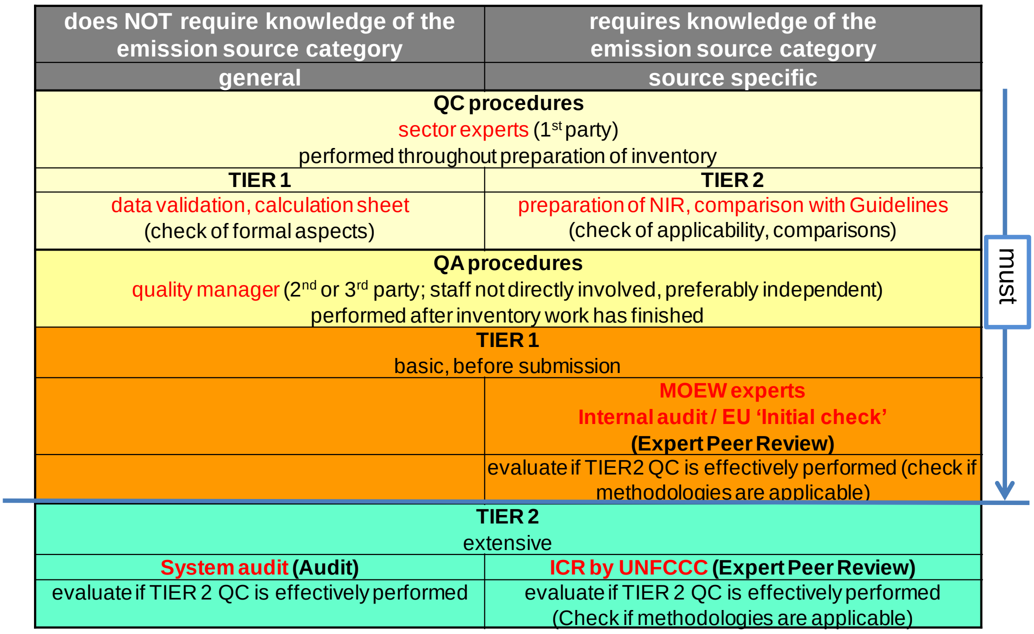

Figure 6 National quality assurance and quality control program

The legal and institutional arrangements within the BGNIS regulate the responsibilities of all engaged institutions for implementation of the requirements of the National QA/QC Plan.
The QC procedures are performed by the sectors, who are directly involved in the process of preparation of inventory with their specific responsibilities.
The QC procedures are implemented by all activity data provider and ExEA's sector experts (Order № 344/01.12.2020 by the Executive Director of ExEA) and/or external consultants.

Table 3 QC experts within the BGNIS

Responsibility	QC experts
Activity data	MAFF, MI, MTITC, ME, NSI, EAF, ExEA, MOEW
Methodology and selection of emission factors	ExEA, MAFF, MI, MTITC, ME, NSI, EAF, MOEW
Sector inventories preparation	Sector experts ExEA and/or external consultants

The QC experts are:

- experts, responsible for activity data provision;
- experts, involved in the choice of method and selection of emission factors;

- sector experts and/or consultants, who prepare the sector inventories, including preparation of reporting tables and respective chapters from the national reports;

All institutions, engaged in the functioning of BGNIS are responsible for quality of information, which are provided by their competence to the ExEA for preparation of national emission inventories. The institutions are obligated to implement all requirements of the international and national standards for collection, processing and provision of activity data from them competence.

Quality Assurance (QA) is a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. The quality assurance process includes expert review was conducted in two stages: a review of the initial set of emission estimates and, a review of the estimates and text of the Inventory Report.

QA experts could be:

- Sector experts from the MoEW, which are engaged through internal administrative order by the minister of environment and water ;
- Experts from research institutes in accordance with them competence;
- Other external reviewer (national and/or international).

The QA procedures include the following checks in accordance with FCCC/SBSTA/2006/9:

Transparency means that the data sources, assumptions and methodologies used for an inventory should be clearly explained, in order to facilitate the replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of the information. The use of the common reporting format (CRF) tables and the preparation of a structured national inventory report (NIR) contribute to the transparency of the information and facilitate national and international reviews;

Accuracy means that emission and removal estimates should be accurate in the sense that they are systematically neither over nor under true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable. Appropriate methodologies should be used, in accordance with the 2006 IPCC Guidelines, to promote accuracy in inventories;

Consistency means that an annual GHG inventory should be internally consistent for all reported years in all its elements across sectors, categories and gases. An inventory is consistent if the same methodologies are used for the base and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. Under certain circumstances referred to in paragraphs 16 to 18 below, an inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;

Comparability means that estimates of emissions and removals reported by Annex I Parties in their inventories should be comparable among Annex I Parties. For that purpose, Annex I Parties should use the methodologies and formats agreed by the COP for making estimations and reporting their inventories. The allocation of different source/sink categories should follow the CRF tables provided in annex II to decision 24/CP.19 at the level of the summary and sectoral tables;

Completeness means that an annual GHG inventory covers at least all sources and sinks, as well as all gases, for which methodologies are provided in the 2006 IPCC Guidelines or for which supplementary methodologies have been agreed by the COP. Completeness also means the full geographical coverage of the sources and sinks of an Annex I Party.

For 2021 submission the QA procedures are implemented by sector experts within the MoEW and experts from the ExEA, who are not directly involved in the preparation of inventory (Order № RD-218/05.03.2010 by the minister) or external reviewers.

The expert peer review present opportunity to uncover technical issues related to the application of methodologies, selection of activity data, or the development and choice of emission factors. The comments received during these processes are reviewed and, as appropriate, incorporated into the National Inventory Report or reflected in the inventory estimates.

The project for "Improvement of National Quality Management System for GHG Inventories" in 2011-2012 can be seen as expert peer review.

Information of the QA/QC activities

According to the 2006 IPCC GL the QA/QC system, that should be implemented for GHG Inventories consists of an inventory agency responsible for coordinating QA/QC activities, a QA/QC plan, general QC procedures (Tier 1), source category-specific QC procedures (Tier 2), QA review procedures and verifications as well as procedures regarding reporting, documentation and archiving.

The QA/QC plan is a basic element of the QA/QC system. The plan outlines QA/QC activities that are implemented and includes the scheduled time frame for inventory preparation from its initial development through the final reporting in any year. It contains an outline of the processes and schedule to review of all source categories.
The QA/QC plan is an internal document to organise, plan and implement QA/QC activities. Once developed for the next submission, it is referenced and used in subsequent inventory preparation, or modified as appropriate.
The main parts of the National QA/QC Plan for emissions inventories are presented in the next table:

Table 4 Comparison of 2006 IPCC GL and ISO 9001

	2006 IPCC GL	ISO 9001
1. Scope	✓	✓
2. Definitions	✓	✓
3. Administrative requirements	✓	✓
4. Organisation and management	✓	✓
5. Quality system	✓	✓
6. Personnel	✓	✓
7. Facilities and equipment	✓	✓
8. Handling of inspection samples and items	✓	✓
9. Records	✓	✓
10. Reports	✓	✓
11. Sub-contracting	✓	✓
12. Complaints and appeals	✓	✓

The cycle of QA/QC activity for inventory consists of the following steps:

The QA/QC Manager prepares a Plan for implementation of QA/QC activities for the current submission. The check list with all specific QA/QC procedures are part of the plan;
The plan for QA/QC is sent to all engaged QC and QA experts for implementation;
In the process of preparation of inventory the QC experts (activity data provider and ExEA's sector experts) apply each of the specific procedures set in the check list for each of the sources categories they are responsible for.
The QA/QC Manager coordinate the exchange of the check lists between the QC experts for correction of the findings with input data for calculation of emissions (activity data and EF).
The QA/QC Manager send to the QA experts the prepared by ExEA's sector expert and/or external consultants CRF tables and respective chapters from NIR;
The QA/QC Manager coordinate the exchange of the check lists between the QA experts and ExEA's sector expert and/or external consultants for correction of the findings with quality of the inventory (CRF and NIR);
The QA/QC Manager prepares a summary of the results from implemented QA/QC checks.
The QA/QC Manager prepares an attendant file for implemented procedures;
The QA/QC Manager prepares a report to the executive director of the ExEA for results of the performed QA/QC procedures and improvement plan for the next reporting round;
The QA/QC Manager is responsible for documentation and archiving of all documents, related to performed QA/QC procedures in the national System for documentation and archiving of inventory in ExEA.

QA/QC activities of data provider

The QA/QC Plan is provided for implementation to all institutions, which are engaged in the process of preparation of emissions inventories under UNFCCC as provision of the relevant activity data.
Based on the National QA/QC Plan each of the institutions has nominated experts, responsible for preparation of the required information as well as for implementation of QA/QC procedures.

The QC experts are all experts from the institutions, who are engaged to participate in the activity of BGNIS and to implement the requirements of National QA/QC Plan

All institutions, engaged in the functioning of BGNIS are responsible for quality of information, which are provided by their competence to the ExEA for preparation of national emission inventories. The institutions are obligated to implement all requirements of the international and national standards for collection, processing and provision of activity data from them competence.

The QC experts fill in a check-list, which is an annex to the National QA/QC plan. The QC experts fill the check-list for the sector they are responsible for and in the part "Review of input data for calculation of emissions", "Activity data" and/or "Method and EF".

The check list contains all general and specific procedures for QC. It consist information for carried out review by the QC experts, including findings and corrections made.

The check lists are filled in by QC experts in accordance with them responsibilities and for each category (CRF).

The check lists are exchange between QC experts for correction of the findings with input data for calculation of emissions in the respective sectors.

Table 5 Responsibilities in the exchange of check lists between QC experts for 2021 submission

Sector CRF	Activity data		Methodology/ emission factors		Emission calculations	
	Check	Correction	Check	Correction	Check	Correction
Energy CRF1	ExEA NSI ME external consultant	NSI ME	ExEA NSI ME	external consultant	ExEA NSI ME	external consultant
Transport CRF1A3	ExEA NSI MI MTITC external consultant	MTITC MI NSI	ExEA NSI MI MTITC	ExEA external consultant	ExEA NSI MI MTITC	Sector expert ExEA and external consultant
Industry processes and product use CRF2	NSI ExEA	NSI ExEA	NSI ExEA	ExEA	NSI ExEA	Sector expert ExEA
Agriculture CRF3	ExEA MAFF	MAFF	ExEA MAFF	ExEA	ExEA MAFF	Sector expert ExEA
LULUCF CRF4	ExEA EAF	EAF	ExEA EAF	ExEA	ExEA EAF	Sector expert ExEA and external consultant
Waste CRF5	NSI ExEA	NSI ExEA	NSI ExEA	ExEA	NSI ExEA	Sector expert ExEA

General (QC) procedures are described in Checklists that is part of QA/QC Plan.

As it is written above for 2021 submission the QA procedures are implemented by sector experts within the MoEW and experts from the ExEA, who are not directly involved in the preparation of inventory (Order № RD-218/05.03.2010 by the minister) or external reviewers

The QA experts fill a check list in the part "Review of reporting tables and National report" in the sector of them competence.

The check list contains all general and specific procedures for QA. It consist information for carried out review by the QA experts, including findings and corrections made.

The check lists are filled out by QA experts in accordance with them responsibilities for each category (CRF).
The check lists are exchanged between QA experts and sector expert in ExEA and/or external consultant for correction of the findings with reporting tables and respective chapters from national reports.

Table 6 Responsibilities in exchange of the check lists between QA experts and sector experts for 2021 submission

Sector - CRF	Reporting Tables - CRF		National Report - NIR	
	Check	**Correction**	**Check**	**Correction**
Energy CRF1	MOEW ExEA	External consultant	MOEW ExEA	External consultant
Industry processes and product use CRF2	MOEW ExEA	Sector expert ExEA	MOEW ExEA	Sector expert ExEA
Agriculture CRF3	MOEW ExEA	Sector expert ExEA	MOEW ExEA	Sector expert ExEA
LULUCF CRF4	MOEW ExEA	External consultant	MOEW ExEA	External consultant
Waste CRF5	MOEW ExEA	Sector expert ExEA	MOEW ExEA	Sector expert ExEA

Quality management of the sources of initial data

Each organization – data source, solves the quality management issues in accordance with its internal rules and provisions. With some of the sources as NSI, MAFF, etc., those rules follow strictly the international practices. For example, quality assessment/quality control procedures with NSI have been harmonized with the relevant instructions and provisions of EUROSTAT. Strict rules on data processing and storage, harmonized with international organizations. Some of the large enterprises – GHG emission sources, have well arranged and effective quality management systems. Most of them have introduced quality management systems on the basis of ISO 9001:2000 standard.

Fulfilment of paragraph 12(e)

Official consideration and approval of the inventory

Bulgaria's reporting obligations to the UNFCCC, UNECE and EC are being administered by the MoEW. All activities on preparation of GHG inventory in Bulgaria are coordinated and managed on the state level by MoEW. The ExEA is the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Kyoto Protocol and designated as single national entity (see Figure 1 Organizational Chart of the Bulgarian National Inventory System).

Quality improvement

Fulfilment of paragraph 13

Since November 2011, a project for **"Improvement of National Quality Management System for GHG Inventories"** had been started together with the Austrian Environmental Agency. The project is funded by the **German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety** and **German Federal Environment Agency** with means of the Advisory Assistance Programme for Environmental Protection in the Countries of Central and Eastern Europe, the Caucasus and Central Asia.
The objectives of the project are:

Third-party audit[24] of the current QMS according to ISO 19011 Guidelines for quality and/or environmental management system auditing (and ISO 17020 General criteria for the operation of various types of bodies performing inspection):

- To analyze/review the current QMS (in accordance with the IPCC GPG)
    1. system audit
    2. procedures audit
- Identification of improvements
    1. QMS Manual
    2. Quality Policy
    3. Roles and responsibilities
    4. QC activities
    5. Quality assurance (QA) activities
    6. Documentation and archiving System within NIS.
    7. Development of Procedures and Checklists
    8. Improvement plan for the QMS and GHG Inventory
- Proposal on implementation of the improvements
- Training of the quality manager and the sectoral experts (within the QMS) according to 2006 IPCC GL Chapter 6 and following the ISO 9000 standards

The outcome of the project is development of an efficient and optimal aligned QMS, that fulfils every quality requirement of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Chap. 6).

WORK PLAN FOR SUBMISSION 2022

Fulfilment of Para 16(a) (b) (c) and 17 Inventory management

The next table presents the responsibilities of all engaged institutions for preparation of GHGs emission inventory for 2022 submission.

Table 7 Preparation of GHGs emission inventory for 2022 submission

Sector CRF	Activity data	Methodology and selection of emission factors	Preparation of Sector inventories
Energy CRF1A1 CRF1A2 CRF1A4	NSI	ExEA, NSI	Sector expert ExEA External consultant

[24] Audits are used to determine the extent to which the quality management system requirements are fulfilled. Audit findings are used to assess the effectiveness of the quality management system and to identify opportunities for improvement.

- First-party audits are conducted by, or on behalf of, the organization itself for internal purposes and can form the basis for an organization's self-declaration of conformity.
- Second-party audits are conducted by customers of the organization or by other persons on behalf of the customer.
- Third-party audits are conducted by external independent organizations.

Such organizations, usually accredited, provide certification or registration of conformity with requirements such as those of ISO 9001.

ISO 19011 provides guidance on auditing.

Sector CRF	Activity data	Methodology and selection of emission factors	Preparation of Sector inventories
Energy/Transport CRF1A3	NSI MI MTITC	ExEA, NSI MI, MTITC	Sector expert ExEA External consultant
Energy CRF1B	NSI MEE	ExEA, NSI, ME	Sector expert ExEA External consultant
Industry processes and product use CRF2	NSI ExEA MOEW ExEA	ExEA, NSI, Installations operators	Sector expert ExEA
Agriculture CRF3	MAF NSPP	ExEA, MAF	Sector expert ExEA
LULUCF CRF4	EAF MAFF	ExEA, EAF	Sector expert ExEA External consultant
Waste CRF5	NSI ExEA	ExEA, NSI	Sector expert ExEA

The Work plan for preparation and submission of National GHGs inventory in 2022 is presented in the next table.

Table 8 Work plan for GHGs inventory preparation and submission 2022

Action	Responsible organization	Initial Deadline	Final Deadline	Comment
Sending of statistic questionnaire to all enterprises in the country	NSI with its regional inspectorates	31.03.21	15.06.21	NSI uses statistical methods and procedures for data collection, summarizing and structuring that are harmonized with EUROSTAT
Sending of letters to the responsible organizations for provision of necessary activity data.	ExEA	31.03.21	15.06.21	
QA/QC Procedures - Implementation of the requirements of National QA/QC Plan.	NSI MAFF, ME, MEW, SFA, RCD	15.06.21	30.09.21	National QA/QC Plan
Provision of all collected activity data by questionnaires and other sources of information to ExEA	NSI MAFF, ME, MEW, EFA, MIA	30.09.21	30.10.21	
QA/QC Procedures - Implementation of the requirements of National	ExEA	30.10.21	15.11.21	QA/QC expert, responsible for implementation of all procedures laid down in the National QA/QC Plan

Action	Responsible organization	Initial Deadline	Final Deadline	Comment
QA/QC Plan				
Provision of annual national energy and material balances to ExEA	NSI		30.11.21	
Preliminary estimation of emissions	ExEA, external consultants		15.12.21	
Provision of corrected activity data as a result of QA/QC procedures to ExEA	NSI MAFF, ME, MEW, EFA, MIA		20.12.21	
Recalculation of emissions, based on the corrected activity data of inventory in the required format for reporting	ExEA and external consultant		31.12.21	
Preparation of Preliminary national inventory report (NIR) to the EC.	ExEA		10.01.22	
Submission of national GHG inventory under the RMM with the short NIR.	ExEA		15.01.22	Delivered to Eionet Central Data Repository
Submission of final national GHG inventory and NIR.	ExEA		15.03.22	Delivered to Eionet Central Data Repository
Submission of the final GHG inventory and NIR after the European Commission comments	MEW ExEA		15.04.22	Official submission to UNFCCC Delivered to Eionet Central Data Repository
Documentation and archiving of inventory. Preparation of inventory management report	ExEA		15.05.22	
Preparation of QA/QC plan for the next inventory.	ExEA		15.06.22	

Fulfilment of Para 14(d) Make a quantitative estimate of inventory uncertainty for each source category and for the inventory in total, following the 2006 IPCC Guidelines

As a whole, the uncertainty assessment of the GHG inventories follows the methodology of the 2006 IPCC Guidelines. The overall uncertainty is closely related to the GHG emission sources data uncertainty (fuels, activities, processes, etc.) and to the emission factor uncertainty.

The uncertainties for all the emission sources (key and non-key) and emission factors are presented in Chapter 1.3.

Fulfilment of Para 15. As part of its inventory preparation, each Party included in Annex I should:

(a) Apply source-category-specific QC procedures (tier 2) for key source categories and for those individual source categories in which significant methodological and/or data revisions have occurred, in accordance with the IPCC good practice guidance;

(b) Provide for a basic review of the inventory by personnel that have not been involved in the inventory development, preferably an independent third party, before the submission of the inventory, in accordance with the planned QA procedures referred to in paragraph 12 (d) above;

(c) Provide for a more extensive review of the inventory for key source categories, as well as source categories where significant changes in methods or data have been made;

(d) Based on the reviews described in paragraph 15 (b) and (c) above and periodic internal evaluations of the inventory preparation process, re-evaluate the inventory planning process in order to meet the established quality objectives referred to in paragraph 12 (d).

VERIFICATION ACTIVITIES

Emission and activity data are verified by comparing them with other available data compiled independently of the GHG inventory system. These include data from research projects and other obligations for other purposes but producing information relevant to the inventory preparation. Verification activities that have been undertaken are described in the category-specific chapters.

TREATMENT OF CONFIDENTIALITY ISSUES

ExEA ensures confidentiality of sensitive information that is data declared as confidential obtained in the course of preparing the national GHG inventory. ExEA is a member of the National Statistics Institute (NSI).
Confidentiality of statistics: The strict confidentiality provisions concerning handling of sensitive data relating to individuals and organisations are regulated by the Statistics Law.
Security of data: Confidentiality of sensitive data used to calculate the emissions is a legal obligation.
Furthermore a checklist with the following items is elaborated:
Outlines what information is to be treated as confidential;
Identify sectoral expert who is dealing with the information;
Identify the use to which the information can be put;
Specify the publishment of confidentiality data on an aggregated level.

1.4 BRIEF GENERAL DESCRIPTION OF METHODOLOGIES (INCLUDING TIERS USED) AND DATA SOURCES USED

Fulfilment of Para 14(b) (c) (e) (f)

The most recent greenhouse gas inventory for the period 1988 to 2019 (NIR 2021) was compiled according to the recommendations for inventories set out in the UNFCCC reporting guidelines according to Decision 24/CP.19, the Common Reporting Format (CRF) and the 2006 IPCC Guidelines.
The GHG inventory represents a process, covering the following main activities:

- Collecting, processing and assessment of input data on used fuels, produced output, materials and other GHG emission sources;
- Selection and application of emission factors for estimating the emissions;
- Determination of the basic (key) GHG emission sources and assessment of the results uncertainty.

Each year during inventory, some changes occur that affect directly the activities above enlisted. Important inventory stage is the process of data transformation into a form, suitable for CRF Tables format. During this process, aggregation of the fuels by type is made (solid, liquid and gaseous), and further data is added, regarding parameters and indices, specifying the systems for transportation and distribution of oil and natural gas, the systems for fertilizer processing, etc. These activities are just a part of additional data, filled in the CRF Tables.

National Inventory Methodology

According to Clean Air Act, article 25 (6) The Minister of Environment and Water in co-ordination with the interested ministers issues an order for the approval of a Methodology for the calculation, with balance methods, of the emissions of harmful substances (pollutants), emitted in the ambient air. The national Methodology (approved with Order RD 77 from 03.02.2006 of MEW) is harmonized with CORINAIR methodology for calculation of the emissions according to the UNECE/LRTAP Convention.
During 2007, MEW/ExEA had a project for development of Common methodology for emissions inventory under UNECE/LRTAP Convention and UNFCCC, i.e. to update the present Methodology under article 25 (6) CAA. (Approved with Order RD 40 from 22.01.2008 of MEW). The aim of the project was harmonization of the national Methodology with IPCC, including the three main greenhouse gases – CO_2, CH_4 and N_2O (plus relevant ODS and SF_6).
The Bulgarian national GHGs inventory and NIR are compiled according to requirements of the following documents:

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC GL)
- EMEP/EEA air pollutant emission inventory guidebook – 2019.

The emission factors are mainly from:

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC GL)
- EMEP/EEA air pollutant emission inventory guidebook – 2019.
- Country-specific

The following tables summarise the 'Applied method' and 'Emission factor' of the inventory 2019, submission 2021.

Table 9 Methods and the emission factors applied (CO_2, CH_4, N_2O)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1. Energy	T1,T2	CR,CS,D	T1,T2	CR,CS,D	T1,T2	CR,D
A. Fuel combustion	T1,T2	CR,CS,D	T1,T2	CR,D	T1,T2	CR,D
1. Energy industries	T1,T2	CS,D	T1	D	T1	D
2. Manufacturing industries and construction	T1,T2	CS,D	T1	D	T1	D
3. Transport	T1,T2	CR,CS,D	T1,T2	CR,D	T1,T2	CR,D
4. Other sectors	T1,T2	CS,D	T1	D	T1	D
5. Other						
B. Fugitive emissions from fuels	T1	D	T1,T2	CS,D	T1	D
1. Solid fuels	T1	D	T1,T2	CS,D		
2. Oil and natural gas	T1	D	T1	D	T1	D
C. CO_2 transport and storage						
2. Industrial Processes	T1,T2	CR,CS,D,PS			T1,T3	CS,D,PS
A. Mineral industry	T1,T2	CS,D,PS				
B. Chemical industry	T2	CS,PS			T3	PS
C. Metal industry	T2	CS,PS				
D. Non-energy products from fuels and solvent use	T1,T2	CR,D				
E. Electronic industry						
F. Product uses as ODS substitutes						
G. Other product manufacture and use	T1,T2	D			T1	CS,D
H. Other						
3. Agriculture	T1	D	D,T1,T2	CS,D	D,T1,T2	D
A. Enteric fermentation			T1,T2	CS,D		
B. Manure management			T1,T2	CS,D	T1,T2	D
C. Rice cultivation			T1	D		
D. Agricultural soils(3)					T1	D
E. Prescribed burning of savannas						
F. Field burning of agricultural residues			D	D	D	D
G. Liming						
H. Urea application	T1	D				
I. Other carbon-containing fertilizers						
J. Other						
4. LULUCF	T1,T2	CS,D	T1	D	T1	D
A. Forest land	T1,T2	CS,D	T1	D	T1	D
B. Cropland	T1,T2	CS,D			T1	D
C. Grassland	T1,T2	CS,D			T1	D
D. Wetlands	T1,T2	CS,D			T1	D
E. Settlements	T1,T2	CS,D			T1	D
F. Other land						
G. Harvested wood products	T2	D				
H. Other						
5. Waste	T1	D	T1,T2	CS,D	T1	D
A. Solid waste disposal			T2	CS,D		
B. Biological treatment of solid waste			T1	D	T1	D
C. Incineration and open burning of waste	T1	D	T1	D	T1	D
D. Waste water treatment and discharge			T2	D	T1	D
E. Other						
7. Other (specified in Summary 1.A)						

Table 10 Methods and the emission factors applied: HFCs, PFCs, SF_6

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFCs		PFCs		SF_6		NF_3	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
2. Industrial processes	NO,T2	D,NO	NO	NO	NO,T2	D,NO	NO	NO
A. Mineral industry								
B. Chemical industry								
C. Metal industry								
D. Non-energy products from fuels and solvent use								
E. Electronic industry	NO	NO	NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes	NO,T2	D,NO	NO,T2	D,NO	NO	NO	NO	NO
G. Other product manufacture and use	NO	NO	NO	NO	NO,T2	D,NO	NO	NO
H. Other								

The following notation keys were used to specify the method applied:		
D (IPCC default)	**T1a, T1b, T1c** (IPCC Tier 1a, Tier 1b and Tier 1c, respectively)	**CR** (CORINAIR)
RA (Reference Approach)	**T2** (IPCC Tier 2)	**CS** (Country Specific)
T1 (IPCC Tier 1)	**T3** (IPCC Tier 3)	**OTH** (Other)
If using more than one method within one source category, list all the relevant methods. Explanations regarding country-specific methods, other methods or any modifications to the default IPCC methods, as well as information regarding the use of different methods per source category where more than one method is indicated, should be provided in the documentation box. Also use the documentation box to explain the use of notation OTH.		
Use the following notation keys to specify the emission factor used:		
D (IPCC default)	**CS** (Country Specific)	**OTH** (Other)
CR (CORINAIR)	**PS** (Plant Specific)	

1.5 BRIEF DESCRIPTION OF KEY CATEGORIES

Fulfilment of paragraph 14(a)

The key category analysis follows the Approach 1 and Approach 2 is performed according to the 2006 IPCC Guidelines (IPCC 2006, chapter 4).
According to method of the Approach 2 assessment of the key sources is made by identifying the uncertainty of each source. The uncertainty is the combined uncertainty of the assessment, which is a mean quadratic assessment of the uncertainty of the data and of the emission factors.
The key source identification of the Bulgarian inventory includes all reported greenhouse gases CO_2, CH_4, N_2O, HFC, PFC, NF_3 and SF_6, and all IPCC source categories, including LULUCF. The key source analysis is performed by the ExEA with data for greenhouse gas emissions of the corresponding current submission and comprises a level assessment for all years between 1988 and the last reported year and trend assessments for the trend of the latest reported years with respect to base year emissions.
Emissions and removals from LULUCF are included in the key category analysis which is performed according to the 2006 IPCC Guidelines.
The key category analysis is used to prioritize improvements that should be taken into account for the next inventory submissions. First of all, it is important that emissions of key categories, being the most significant in terms of absolute weight and/or combined uncertainty, are estimated with a high level of accuracy.

The Key Category analysis Approach 1 and Approach 2 method including and excluding LULUCF is provided in Annex 1.

1.6 GENERAL UNCERTAINTY EVALUATION, INCLUDING DATA ON THE OVERALL UNCERTAINTY FOR THE INVENTORY TOTALS

This section provides an overview of the approach to uncertainty analysis adopted for the Bulgarian inventory. The mandatory, detailed reporting table of the analysis for all the emission sources (key and non-key) and emission factors is provided in as Approach 1 Uncertainty calculation and reporting'.

The present approach consists of two levels: screening and detailed analysis. Screening is done with Approach 1 uncertainty analysis. The key categories are discussed with the sectoral experts during the annual quality meetings.

Separate uncertainty calculation was performed using a spreadsheet prepared specifically according to the Approach 1 (2006 IPCC GL).

GHG INVENTORY

As a whole, the uncertainty assessment of the GHG inventories follows the methodology of the 2006 IPCC GL.

The overall uncertainty is closely related to the GHG emission sources data uncertainty (fuels, activities, processes, etc.) and to the emission factor uncertainty.

The uncertainty of the GHG emission sources can be defined during data collection and processing and it is a part of procedures, applied by the statistical authorities, differences between the production, import, export and consumption of fuels, expert assessment, etc.

The uncertainty of emission factors depends on the origin of the factors applied. In case the emission factors result from direct periodical measurements, the uncertainty is determined by the relevant methodology, related to the measuring methods and apparatuses.

The overall uncertainty of the GHG inventory is determined by combining the emission sources uncertainty and the emission factors uncertainty.

Two rules are applied in this process:

Rule A - combination of the uncertainty by summing;

Rule B - combination of the uncertainty by multiplying.

Since the GHG inventories are sums of the products of emission sources, multiplied by emission factors, the two rules above can be used for determining the overall uncertainty of the inventory.

Rules A and B represent the foundation of the Approach 1 method, recommended in the IPCC Guidance.

The uncertainties for all the emission sources (key and non-key) and emission factors are presented in Table 11.

Combined uncertainty as a part of overall emissions for 2019 for every source has been calculated as following equation:

$$\mathbf{MCUi = (EMi/EMtotal) x\ CUi}$$

where MCUi – measured combined uncertainty,

EM_i - source emissions for 2019,

EM_{total} – total country emissions for 2019,

CN_i – combined uncertainty of the i-th source.

Uncertainty of the overall emissions trend for 2019 for every source has been calculated as HTi – overall emissions trend uncertainty brought in by the i-th source. This uncertainty calculates in column M of Table 3.2 of p.3.31 of the 2006 IPCC GL.

The calculated uncertainties, in %, of the overall national GHG emissions for the year 2019 (row 7, column H in Table 3.2 of the 2006 IPCC GL), and the overall emission trend related to the base inventory year until 2019 (row 7, column M in Table 6.1.) are given in Table 11. The relevant data for the previous inventory for 2018 are given for comparison (NIR 2020 and NIR 2021).

Table 11 Uncertainty in total GHG emissions, %

Uncertainty	Uncertainty NIR 2020	Uncertainty NIR 2021
Uncertainty in total GHG emissions	17.33%	17.33%
Overall uncertainty into the trend in total GHG emissions	2.63	2.63

The respective sectoral uncertainties are documented in detail in the sectoral chapters of this report. The complete uncertainty information and other background information are presented in Annex 2.

1.7 GENERAL ASSESSMENT OF THE COMPLETENESS

GHG INVENTORY

Completeness by source and sink categories and gases

Bulgaria has provided estimates for all significant IPCC source and sink categories according to the detailed CRF classification. Estimates are provided for the following gases: CO_2, N_2O CH_4, F-gases (HFC, PFC, NF_3 and SF_6), NMVOC, NOx, CO and SO_2. In accordance with the IPCC Guidelines, international aviation and marine bunker fuel emissions are not included in national totals. However, CO_2, CH_4 and N_2O emissions from lubricants from International bunkers are included in emissions from feedstock and non-energy use of the fuels. Lubricants are not split between domestic and international, as only information on total sales of lubricants is available in fuel statistics.
CRF - Table 9 (Completeness) has been used to give information regarding completeness. An assessment of completeness for each sector is given in the Sector Overview part of the corresponding subchapters.
All sources and sinks included in the IPCC Guidelines are addressed. No additional sources and sinks specific to Bulgaria have been identified.

Completeness by geographical coverage

The geographic coverage is complete. There is no part of the Bulgarian territory not covered by the national inventory.

Completeness by timely coverage

A complete set of CRF tables are provided for all years and the estimates are calculated in a consistent manner.

Notation keys

The sources and sinks not considered in the inventory but included in the IPCC Guidelines are indicated, the reasons for such exclusion are explained. In addition, the notation keys presented below are used to fill in the blanks in all the tables in the CRF. Notation keys used in the NIR are consistent with those reported in the CRF. Notation keys are used according to the UNFCCC guidelines (UNFCCC 2014).
Allocations to categories may differ from Party to Party. The main reasons for different category allocations are different allocations in national statistics, insufficient information on the national statistics, national methods, and the impossibility to disaggregate emission declarations.

IE (included elsewhere):

"IE" for emissions by sources and removals by sinks of GHGs estimated but included elsewhere in the inventory instead of under the expected source/sink category. Where "IE" is used in an inventory, the Annex I Party should indicate, in the CRF completeness table (Table 9), where in the inventory the emissions or removals for the displaced source/sink category have been included, and the Annex I Party should explain such a deviation from the inclusion under the expected category, especially if it is due to confidentiality.

NE (not estimated):

"NE" for AD and/or emissions by sources and removals by sinks of GHGs which have not been estimated but for which a corresponding activity may occur within a Party. Where "NE" is used in an inventory to report emissions or removals of CO_2, N_2O, CH_4, HFCs, PFCs, SF_6 and NF_3, the Annex I Party shall indicate in both the NIR and the CRF completeness table why such emissions or removals have not been estimated. Furthermore, a Party may consider that a disproportionate amount of effort would be required to collect data for a gas from a specific category that would be insignificant in terms of the overall level and trend in national emissions and in such cases use the notation key "NE". The Party should provide in the NIR justifications for exclusion in terms of the likely level of emissions. An emission should only be considered insignificant if the likely level of emissions is below 0.05 per cent of the national total GHG emissions and does not exceed 500 kt CO_2 eq. The total national aggregate of estimated emissions for all gases and categories considered insignificant shall remain below 0.1 per cent of the national total GHG emissions. Parties should use approximated AD and default IPCC EFs to derive a likely level of emissions for the respective category. Once emissions from a specific category have been reported in a previous submission, emissions from this specific category shall be reported in subsequent GHG inventory submissions.

NA (not applicable):

"NA" for activities under a given source/sink category that do occur within the Party but do not result in emissions or removals of a specific gas. If the cells for categories in the CRF tables for which "NA" is applicable are shaded, they do not need to be filled in.

"NO" (not occurring):

"NO" for categories or processes, including recovery, under a particular source or sink category that do not occur within an Annex I Party;

C (confidential):

"C" is used for emissions which could lead to the disclosure of confidential information if reported at the most disaggregated level. In this case a minimum of aggregation is required to protect business information.

KP-LULUCF INVENTORY

All activities according to Article 3.3 and 3.4 of the Kyoto Protocol are provided in the relevant chapter (see also Chapter 11).

2 TRENDS IN GREENHOUSE GAS EMISSIONS

Description and interpretation of emission trends for aggregated greenhouse gas emissions

In 2019 Bulgaria's greenhouse gas emissions totalled 55 955 Gg CO_2 eq. without reporting of sequestration from LULUCF sector. The emissions decreased by 51.26% compared with the base year. Emissions in 2019 were 2.3% decreased in comparison with the emissions of the previous year.

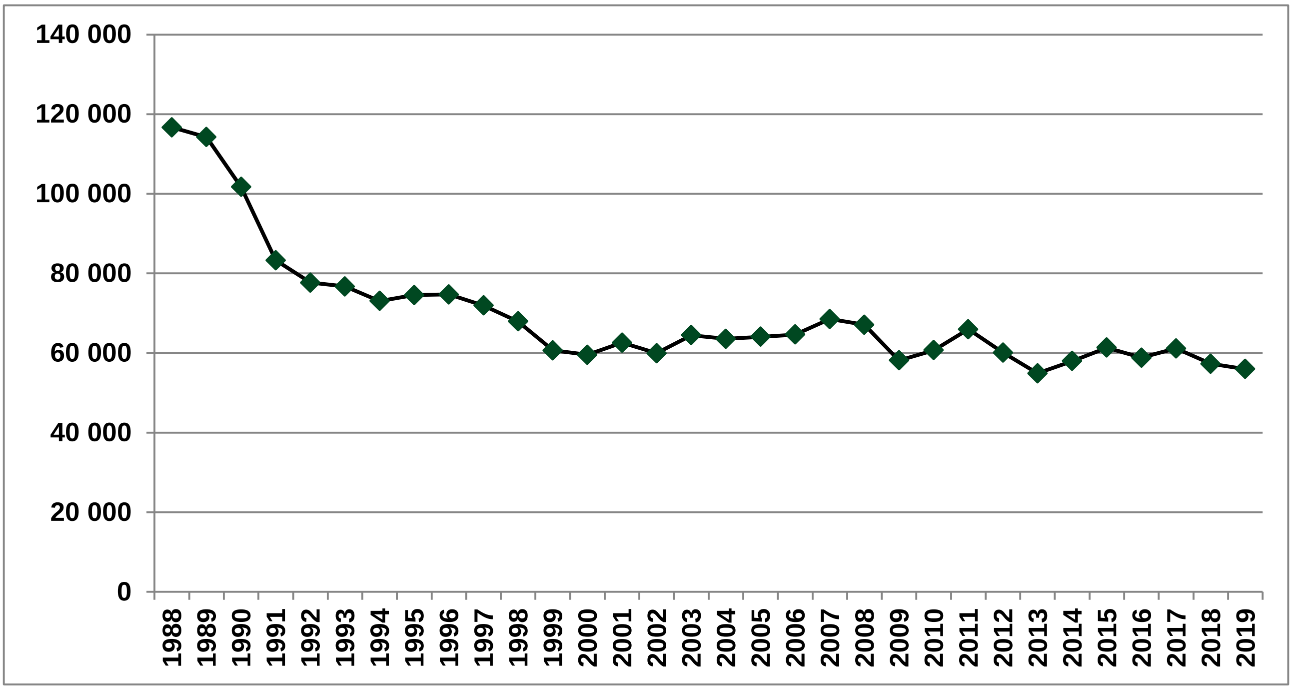

Figure 7 Total GHG emissions (without LULUCF) for 1988 – 2019, Gg CO_2 eq.

The net emissions including reporting of sequestration from LULUCF sector were 46 393 Gg CO_2 eq. The emissions decreased by 51.58% compared with the base year.

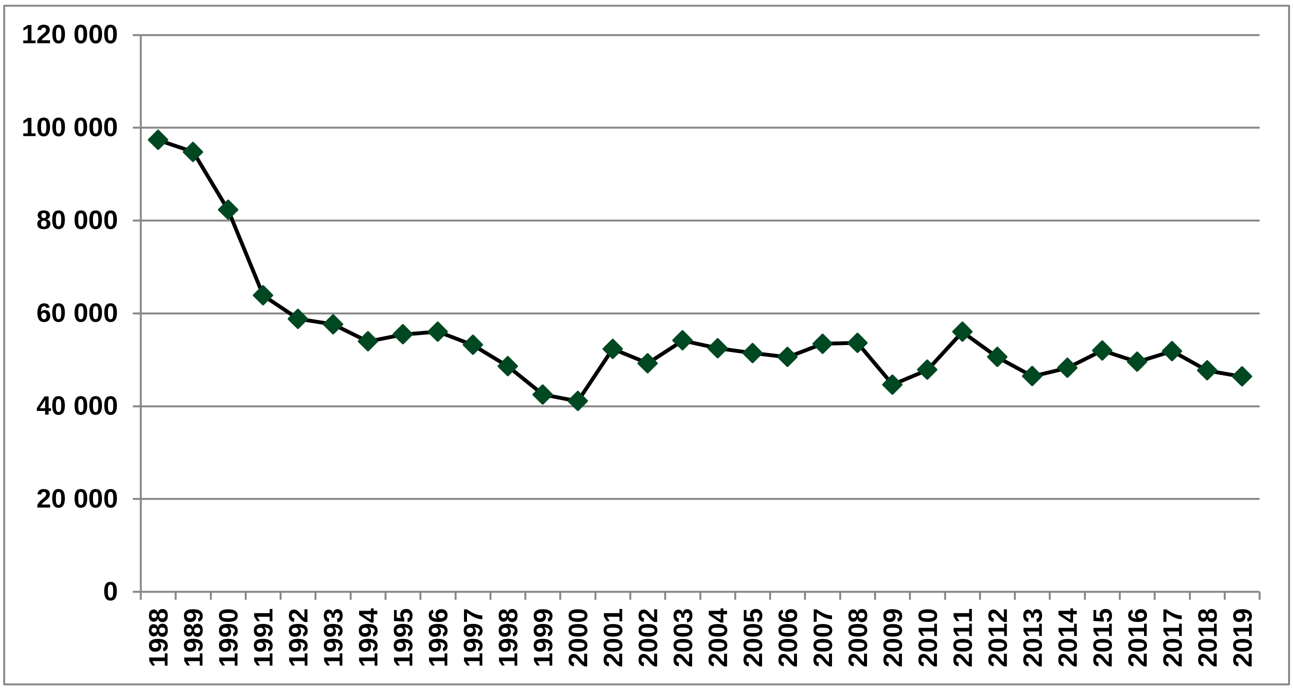

Figure 8 Total GHG emissions (with LULUCF) for 1988 – 2019, Gg CO_2 eq.

The main reasons for the declining GHG emission trend in Bulgaria are the structural economic changes due to the radical transition process from a centrally-planned economy to a market-based economy. This led to a decrease of power production from thermal power stations (and an increase of the shares of hydropower and nuclear power), structural changes in industry (including a decline in production by energy-intensive enterprises and energy - efficiency improvements), introduction of energy efficiency measures in the residential sector and a shift form solid and liquid fuels to natural gas in energy consumption. This also led to a decrease in GHG emissions from the agricultural sector stemming from the decline in the cattle and sheep populations and the use of fertilizers.

Bulgaria experienced a steady declining population trend during the period 1988-2019, which resulted in the reduction of population by 22.6%.

2.1 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS FOR AGGREGATED GHG EMISSIONS

The most important greenhouse gas in Bulgaria is carbon dioxide. The share of CO_2 emissions from the total greenhouse gas emissions varies around 75.5% excluding LULUCF and 69.6% including LULUCF. In absolute terms CO_2 emissions have decreased 51.6% since 1988. Around 71.9% of total CO_2 eq emissions originate from the Energy sector. The amount of energy-related CO_2 emissions has fluctuated much according to the economic trend, the energy supply structure (including electricity exports) and climate conditions.

Methane emissions (CH_4) have decreased by 58.9% from the 1988 level. This is mainly due to the improvements in waste collection and treatment and a reduction in animal husbandry in the Agriculture sector. Correspondingly, emissions of nitrous oxide (N_2O) have also decreased by 43.5% which has been occasioned mostly by the reduced nitrogen fertilisation of agricultural fields, the biggest decline was in the beginning of time series.

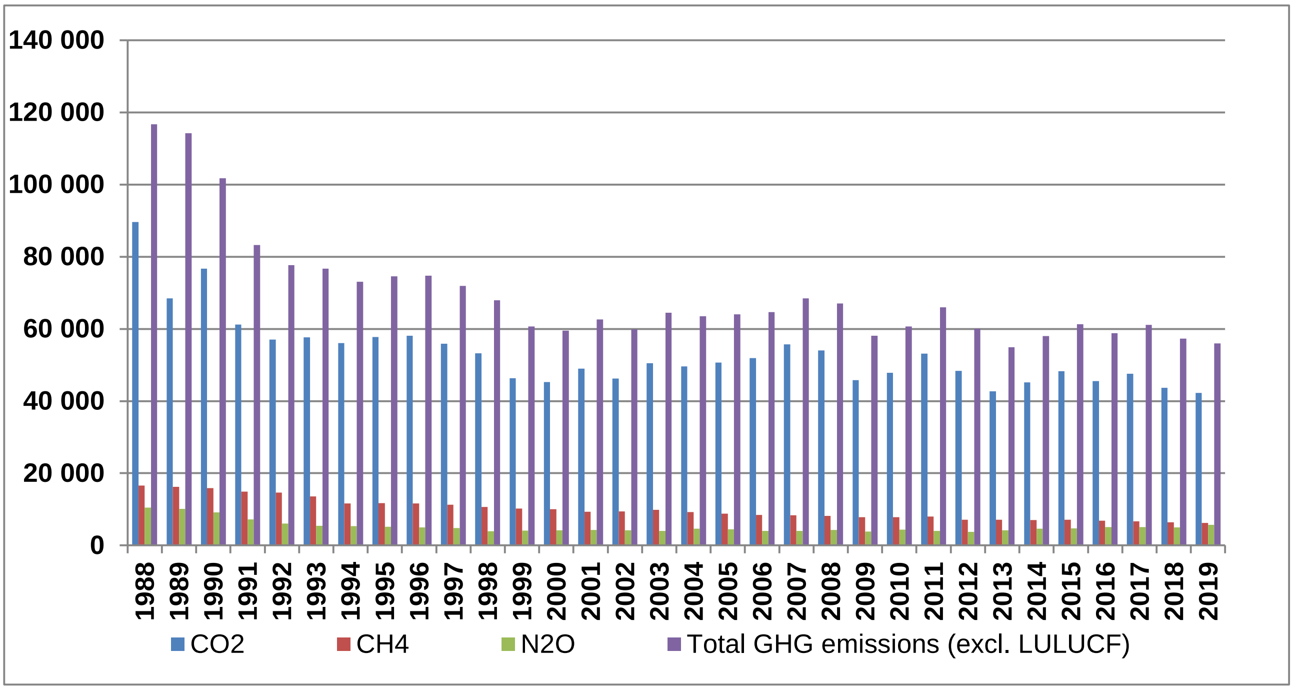

Figure 9 Total GHG emissions in Gg CO_2 eq. for 1988 – 2019

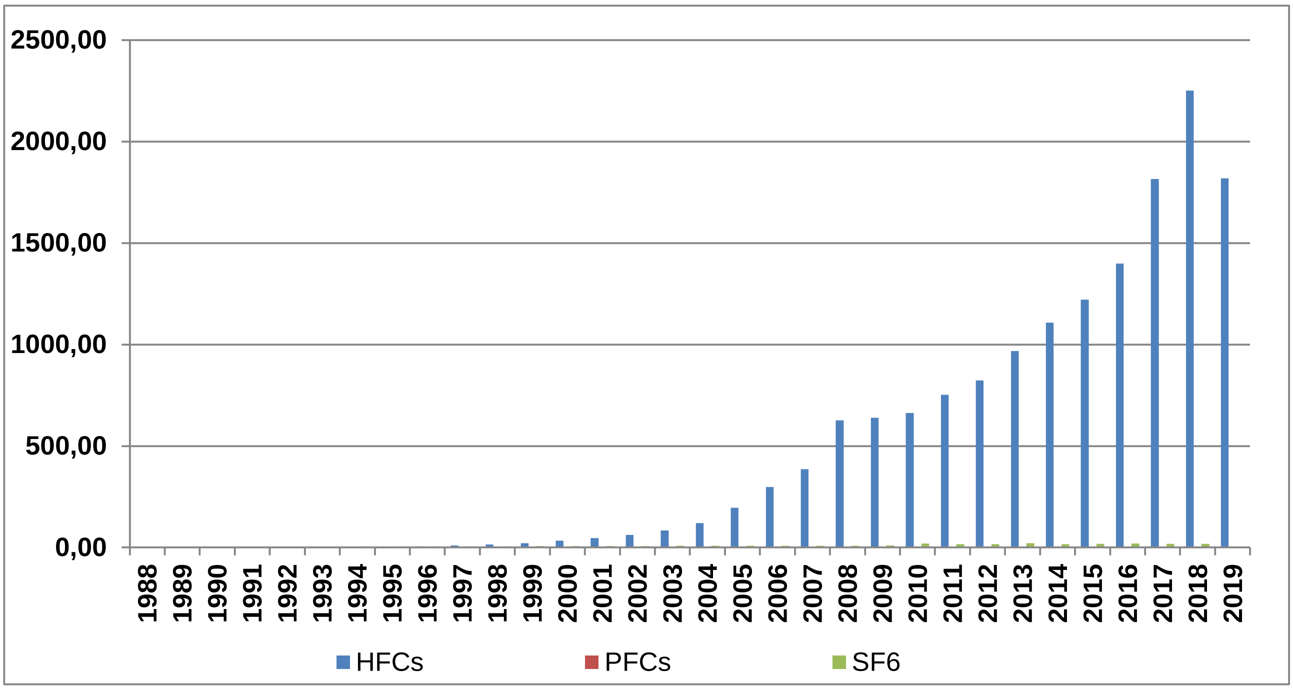

Figure 10 Actual emissions of HFCs, PFCs and SF_6 for 1988 – 2019, Gg CO_2 eq.

The emissions of F-gases have increased over tenfold during 1995-2019. A key driver behind the trend has been the substitution of ozone depleting substances (ODS) by F-gases in many applications. Due to ….the F-gases have decreased in 2019.

2.2 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS BY SECTOR

Figure below shows the GHG aggregated emission trends by IPCC sectors. The Energy sector, where GHG emissions come from fuel combustion, headed the list in 2019 with the biggest share – 71.9%. Sector IPPU ranked the second place with 11.4% and sectors Agriculture ranked the third place with 11.2% and Waste with 5.6%.

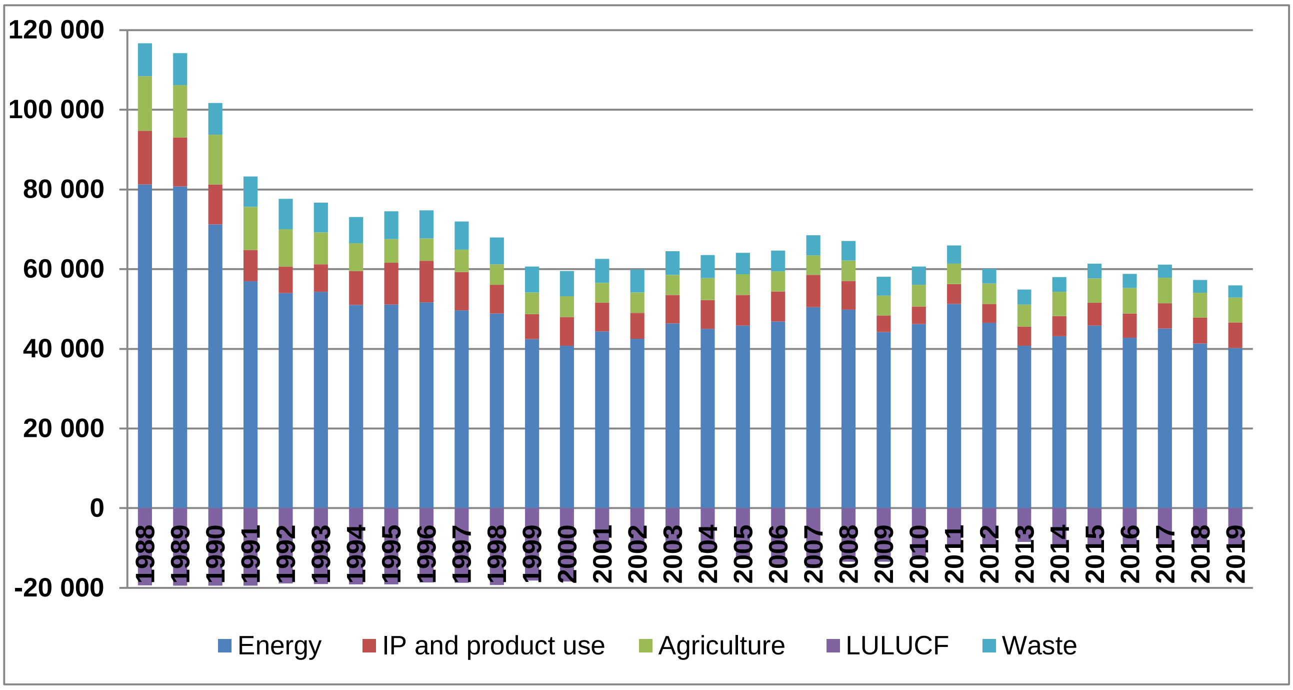

Figure 11 Total greenhouse gas emissions in CO_2-eq. per IPCC sector 1988-2019

Table 12 The reductions of GHG emissions by sectors by base year

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Change from base to latest reported year
1. Energy	-50.5%
2. Industrial Processes and product use	-52.8%
3. Agriculture	-54.1%
4. Land Use, Land-Use Change and Forestry(5)	-49.6%
5. Waste	-51.3%
6. Other	0.00
Total (including LULUCF)	-51.6%

Energy

Emissions from the energy sector in 2019 decreased by 50.5% compared to the base year (40 228 Gg CO2eq in 2019 compared to 81 304 Gg CO2eq in 1988). Compared to previous year, the emissions in 2019 decreased with 2.7% mostly due to the decrease in electricity production from fossil fuels in the energy industries sector.

The main source of emissions in the energy sector is combustion of solid fuels, which is responsible for 53.6% of the emissions from fuel combustion in 2019, followed by liquid fuels with 33.2% and gaseous fuels with 11.6%.

The main reasons for the decrease of the GHG emission trend in energy sector are the transition from a centrally-planned economy to a market-based economy, reconstructing of the economy and subsequent economic slowdown. This led to a sharp drop in demand for electricity production from thermal power production.

The trend of GHG emissions between 1988 and 2019 was defined by a substantial decrease of emissions from fuel combustion in energy industries (44.2%) and energy use in manufacturing industry and construction (75.6%) and in other sectors (commercial, residential, agriculture and forestry) (73.4%), as well as a clear increase in GHG emissions from transport (35.1%).

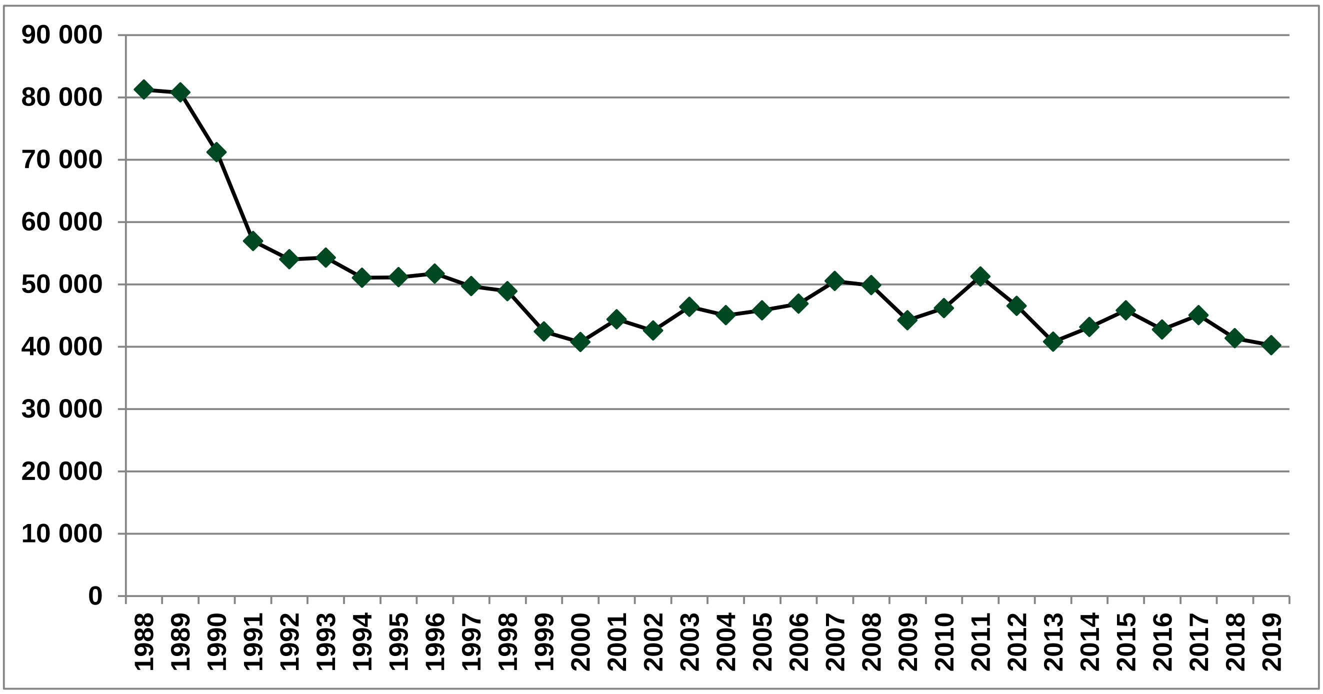

Figure 12 GHG emissions from Energy sector for 1988 – 2019, Gg CO_2 eq.

Chapter 3 of this Report contains a more detailed analysis of GHG emissions in the sector.

Industrial Processes and Product use

A steady trend towards emission reduction in this sector is observed since 1988. The emissions in 2019 decreased with 52.8% compared to the base year.

In the year 2019, 11.4% of national total greenhouse gas emissions (without LULUCF) originated from industrial processes and product use, compared to 11.55% in the base year 1988. In 2019, greenhouse gas emissions from Industrial Processes and Product use are 6 359.9 CO_2 equivalent compared to 13 480.6 Gg CO_2 in the base year.

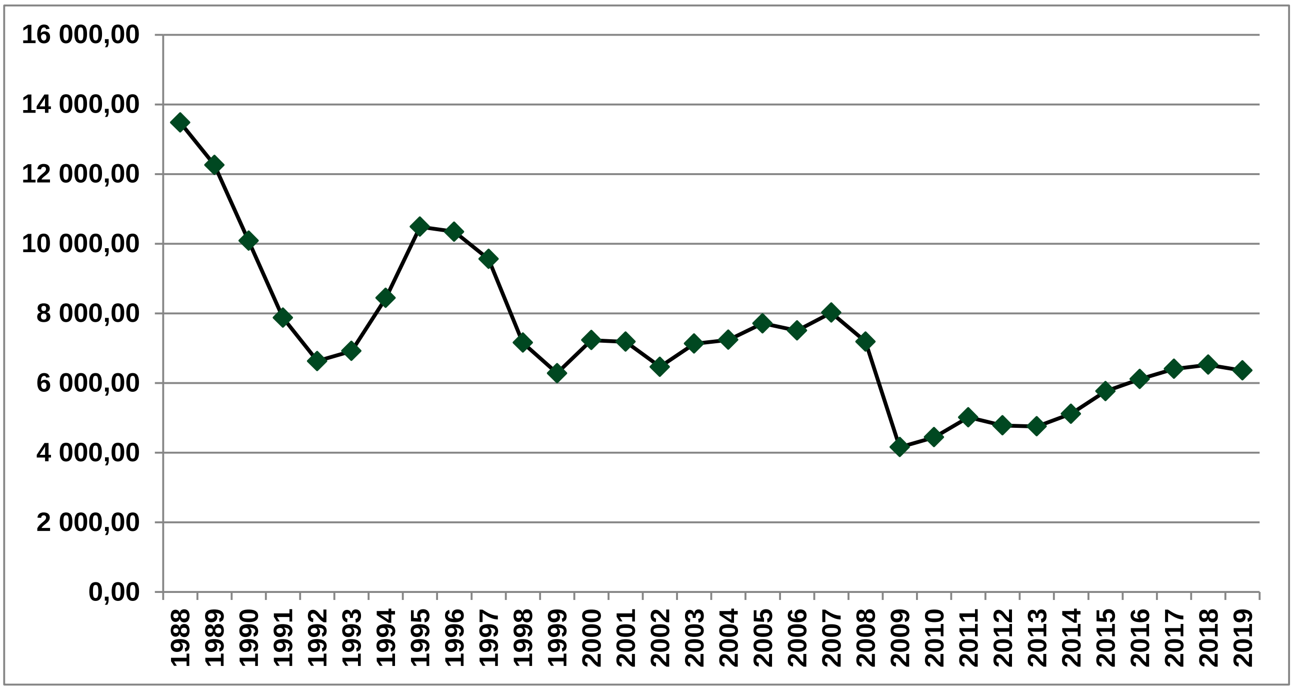

Figure 13 GHG emissions from Industrial processes sector for 1988 – 2019, Gg CO_2 eq.

In 2019 the most important emitting category is Mineral products (mainly production of clinker and quick lime), which share in the total Industrial processes and product use emissions is 37.98%. The second category by share is Product uses as ODS substitutes (Consumption of Halocarbons) with 34.52%, followed by Chemical Industry (ammonia and nitric acid production) with 22.31% share and finally Metal Production (steel) with 2.85%.

Greenhouse gas emissions from the Industrial Processes and product use sector fluctuate during the period and reach a minimum in 2009. The reduction in 2019 for the whole sector is 51.59% while the biggest reduction (compared to the base year) can be seen in Metal Production category – 95.37%.

This is mainly due to economic crisis and in particular the world economic crisis in 2009. The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

The general reduction in the emissions in the later years of the time period is influenced also by the starting introduction of better technologies on plant level.

Agriculture

The overall emission reduction in the sector has amounted to 54.1% since 1988. In the year 2019 the sector agriculture contributed 11.2% to the total of Bulgaria's greenhouse gas emissions (without LULUCF).

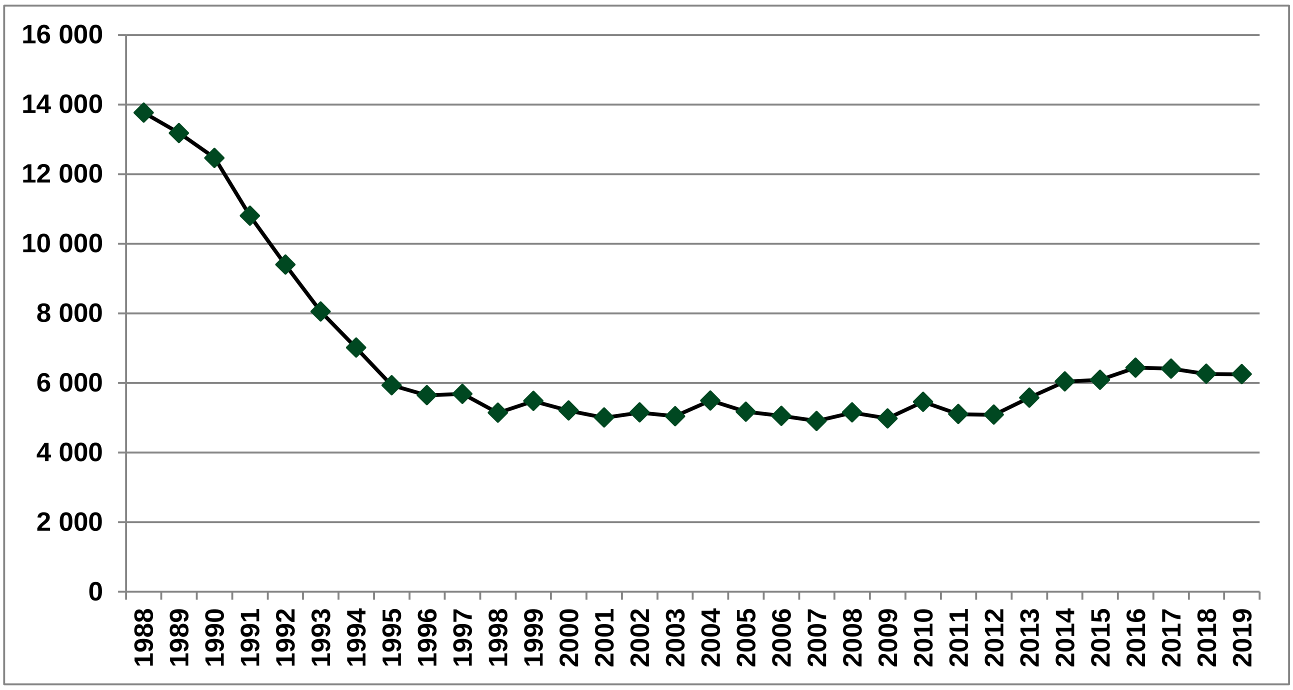

Figure 14 GHG emissions from Agriculture sector for 1988 – 2019, Gg CO_2 eq.

The emission reductions were mainly driven by systematic declines in the agricultural land area due to abandoning of arable lands and reduction in livestock population. Another driver for the emission reduction was the decline in the use of fertilizers.

Chapter 6 of this Report contains a more detailed analysis of GHG emissions in the sector.

Land-Use Change and Forestry

The LULUCF sector is serving as a sink of greenhouse gases for Bulgaria. The two categories – "Forest land" and "Grassland" are removals of CO_2. All other categories are sources of CO_2 emissions. The trend of net CO_2 removals (CO_2 eq) from LULUCF decreases by 49.6% compared to the base year. The main reason for the overall decrease of the uptakes of CO_2 emissions from LULUCF is due to the fall in removals from category Forest land and the slight increase in emissions from CL, WL and SM categories. The key driver for the fall in removals from FL is the observed decline in the rate of forest growth as the average age of the forest stands increases steadily over the reporting period. In spite of the decrease observed, the share of the removals from the total GHG emissions (in CO_2eq) is still remarkable. The reason for this is that the emissions in the other sectors have dropped dramatically. The share of the removals in the base year has the figure of -16.5% from the total GHG emissions in CO_2-eq, while in the inventoried year the share is -14.6%.

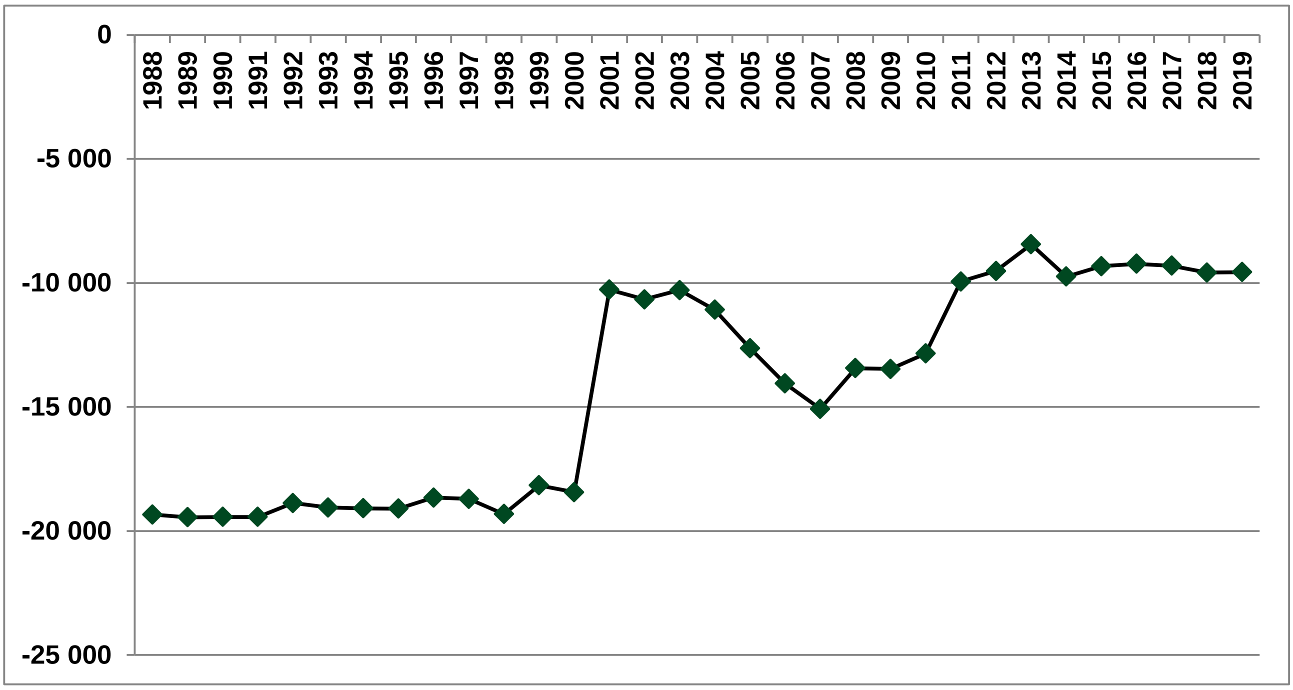

Figure 15 LULUCF emissions and removals for 1988 – 2019 CO2 eq.

Comparing with the base year an increase in the emissions in croplands, settlements and wetlands is observed. The total emissions from croplands fluctuate during the whole time series. The emissions from Settlements increase last couple of years due to changes from other land uses to Settlements according to the risen infrastructural activities since Bulgaria's joined the EU.
Chapter 7 of this Report contains a more detailed analysis of GHG emissions in the sector.

Waste

The total sector emission reduction from the base year is 51.3 %. The decline was mainly driven by a steady population decline over the past 10-15 years.

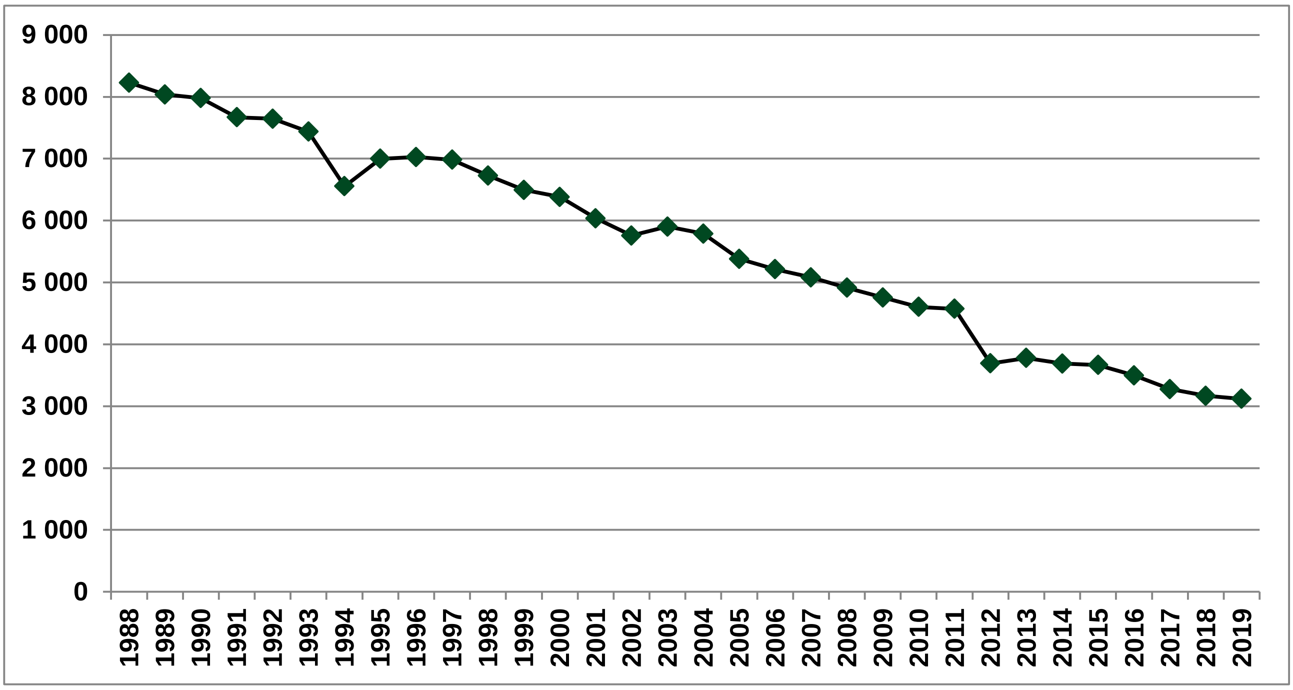

Figure 16 GHG emissions from Waste sector for 1988 – 2019, Gg CO2 eq.

Chapter 8 of this Report contains a more detailed analysis of GHG emissions in the sector.

2.3 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS FOR INDIRECT GREENHOUSE GASES AND SULPHUR OXIDES

Compared to the base year the emissions of non-GHGs emissions decreased as follows:

- NO_x with 56.2%
- CO with 87.5%
- SO_x with 43,3%
- NMVOC with 58.7%

2.4 DESCRIPTION AND INTERPRETATION OF EMISSIONS AND REMOVALS FROM KP-LUCUCF INVENTORY

Emissions and removals from KP-LULUCF activities are described in Chapter 11.

3 ENERGY (CRF CATEGORY 1)

3.1 OVERVIEW OF SECTOR

The Energy sector accounts for all GHG emissions originating from stationary fuel combustion activities in the energy and manufacturing industries, commercial, agricultural and residential sectors, mobile fuel combustion activities resulting from aviation, road transportation, railways and navigation (CRF category 1A), as well as fugitive emissions from fuels (CRF category 1B).
According to the IPCC guidelines, the Energy sector consists of the following categories:

- 1.A.1. Energy Industries
- 1.A.2. Manufacturing Industries and Construction
- 1.A.3. Transport
- 1.A.4. Other Sectors
- 1.A.5. Other
- 1.B. Fugitive Emissions from Fuels

Emissions from the energy sector are the main source of GHGs in Bulgaria: in 2019 the sector is responsible for 71.9% of national total GHG emissions (40 228 Gg CO2e from sector 1A of the total 55 955 Gg CO2e excl. LULUCF).

3.2 EMISSION TREND

Emissions from the energy sector in 2019 decreased by 50.5% compared to the base year (40 228 Gg CO2eq in 2019 compared to 81 304 Gg CO2e in 1988). Compared to the year before, emissions in 2019 decreased by 2.7% mostly due to the decrease of electricity production from fossil fuels in the energy industries sector.

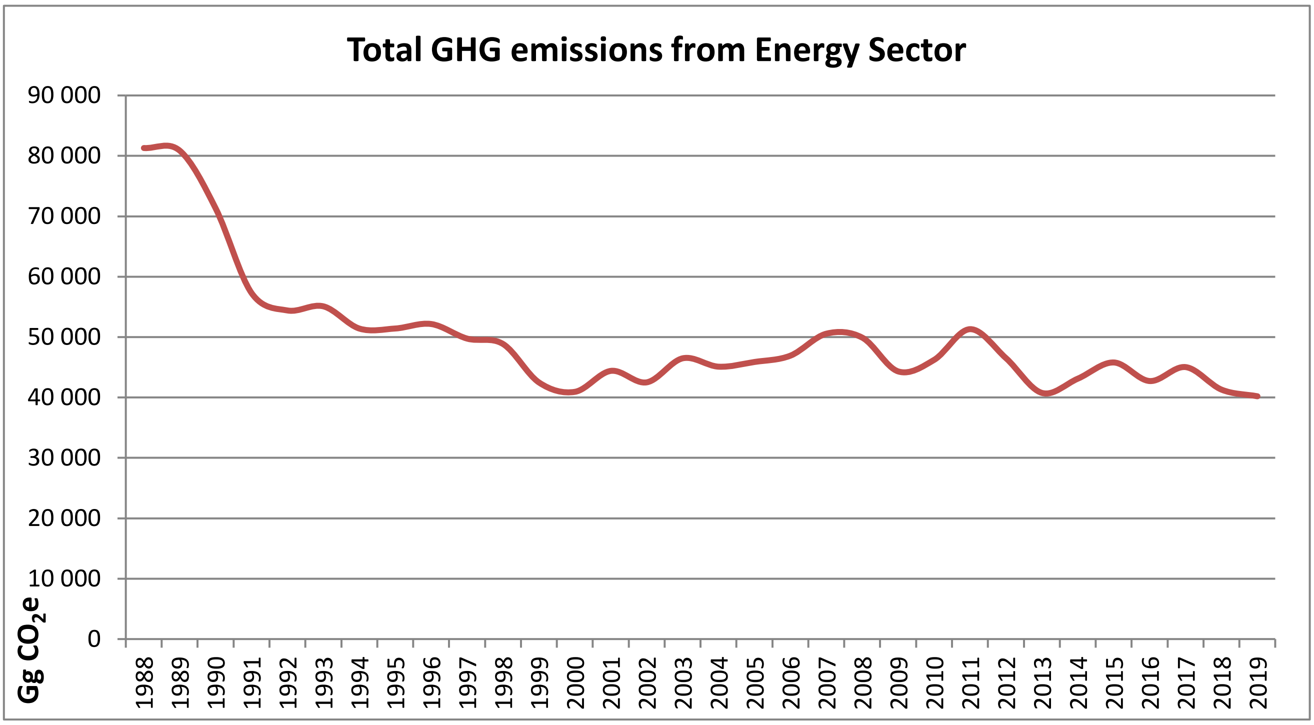

Figure 17 Total GHG emissions from Energy Sector

The main source of emissions in the energy sector is combustion of solid fuels, which is responsible for 53.6% of the emissions from fuel combustion in 2019, followed by liquid fuels with 33.2% and gaseous fuels with 11.6%.

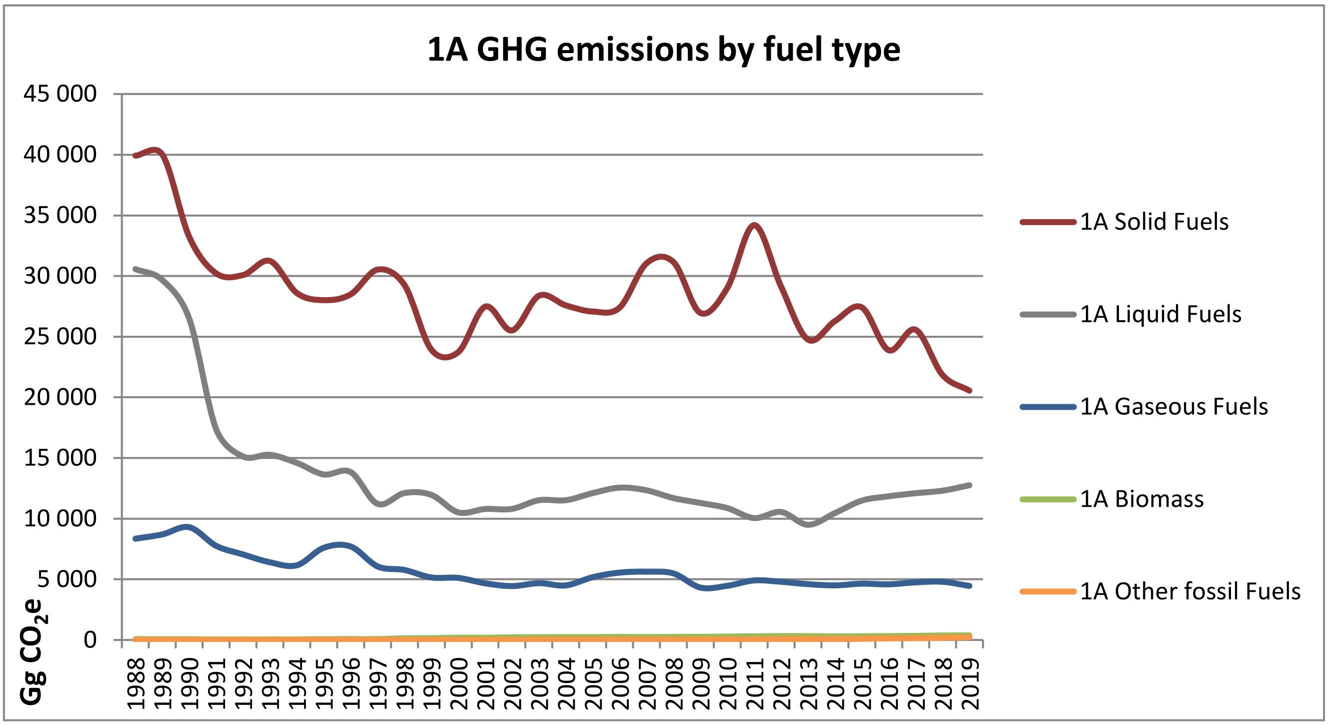

Figure 18 GHG emissions from fuel combustions by fuel type

On a subcategory level, the energy industries sector is the major source of emissions, responsible for 58.7% of the emissions from fuel combustion, followed by transport with 26.0% and manufacturing industries and construction with 10.7%.

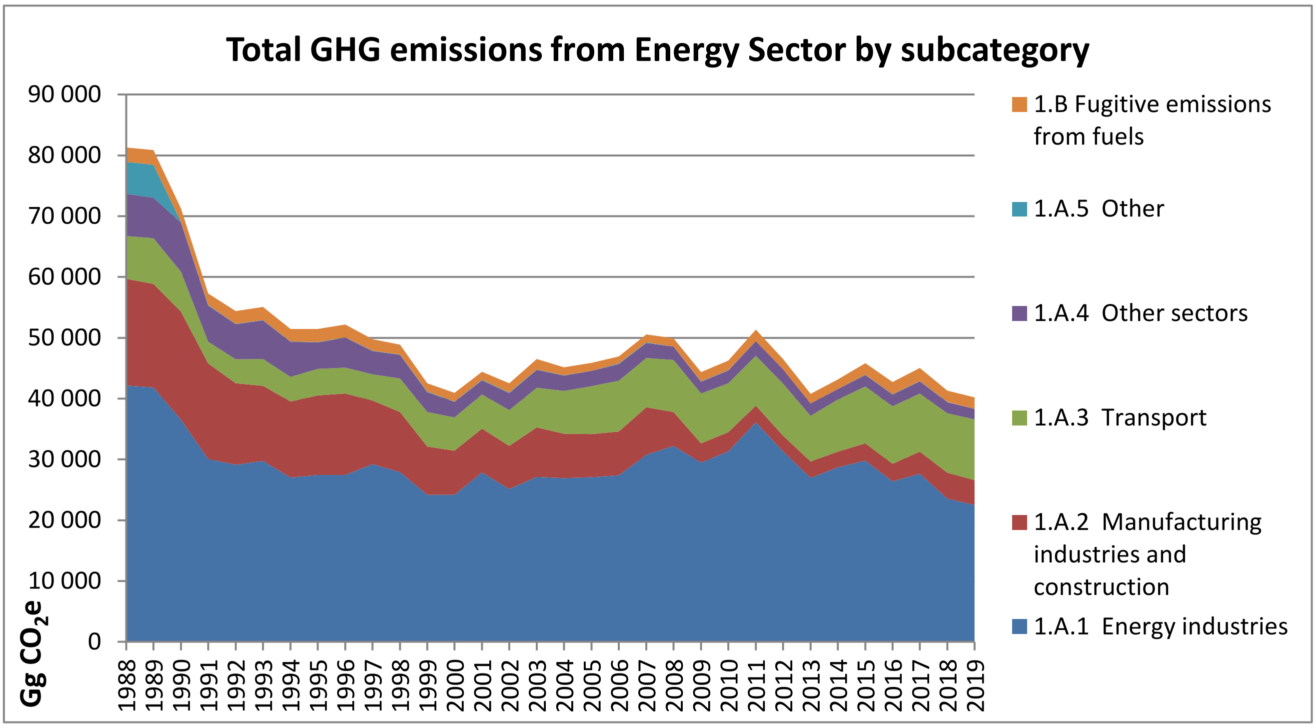

Figure 19 Total GHG emissions from Energy Sector by subcategory

Total emissions from the energy sector mainly consist of CO_2; with a total amount of 38 452 Gg for 2019, followed by CH_4 and N_2O, which only make up about 56.24 Gg and 1.24 Gg, respectively.

Table 13 Emissions of GHG and their trends for the years 1988 – 2019

Year	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1988	78 065.07	107.48	1.85	81 304.06
1990	68 272.94	99.71	1.76	71 288.99

Year	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1995	48 868.97	89.73	1.10	51 440.99
2000	39 052.19	63.40	1.10	40 966.04
2005	44 014.32	60.56	1.27	45 905.47
2010	44 355.89	62.53	1.14	46 257.66
2011	49 145.22	72.89	1.22	51 331.73
2012	44 502.30	67.06	1.18	46 529.64
2013	38 976.31	59.64	1.07	40 785.48
2014	41 324.18	59.40	1.12	43 143.70
2015	43 850.50	64.49	1.20	45 819.91
2016	40 884.76	61.05	1.14	42 750.21
2017	43 065.95	65.67	1.17	45 056.97
2018	39 469.12	59.78	1.22	41 327.37
2019	38 451.60	56.24	1.24	40 228.06

3.3 FUEL COMBUSTION (CRF 1.A)

3.3.1 COMPARISON OF SECTORAL AND REFERENCE APPROACHES

Following the IPCC guidelines, two separate approaches are applied in order to estimate the emissions from fuel combustions activities: Reference approach (RA) and Sectoral approach (SA).
The Reference approach is a method for estimating CO_2 combustion emissions by a simplified top-down methodology, which considers reported quantities of primary and secondary fuels from the national energy balance, taking into account the non-energy use of fuels. For the purposes of the RA, the apparent consumption of each fuel is calculated on the basis of reported quantities for production, import, export, stock changes and international bunkers.
The Sectoral Approach (SA) is a more detailed bottom-up methodology, which considers fuel consumption in each of the following subcategories:

- Energy Industries, including Public Electricity and Heat Production, Petroleum Refining and Manufacture of Solid Fuels and Other Energy Industries;
- Manufacturing Industries and Construction, including Iron and Steel, Non-Ferrous Metals, Chemicals, Pulp, Paper and Print, Food Processing, Beverages and Tobacco, Non-metallic minerals and Other
- Transport, including Civil Aviation, Road Transportation, Railways, Navigation and Other Transportation
- Other Sectors, including Commercial/Institutional, Residential, Agriculture/Forestry/Fisheries
- Other Stationary and Mobile sources

3.3.1.1 Methodology

Default methodologies are applied based on the fuel type and according to 2006 IPCC Guidelines, Ch. 6, Equations 6.1 and 6.2.

3.3.1.2 Results of the reference approach

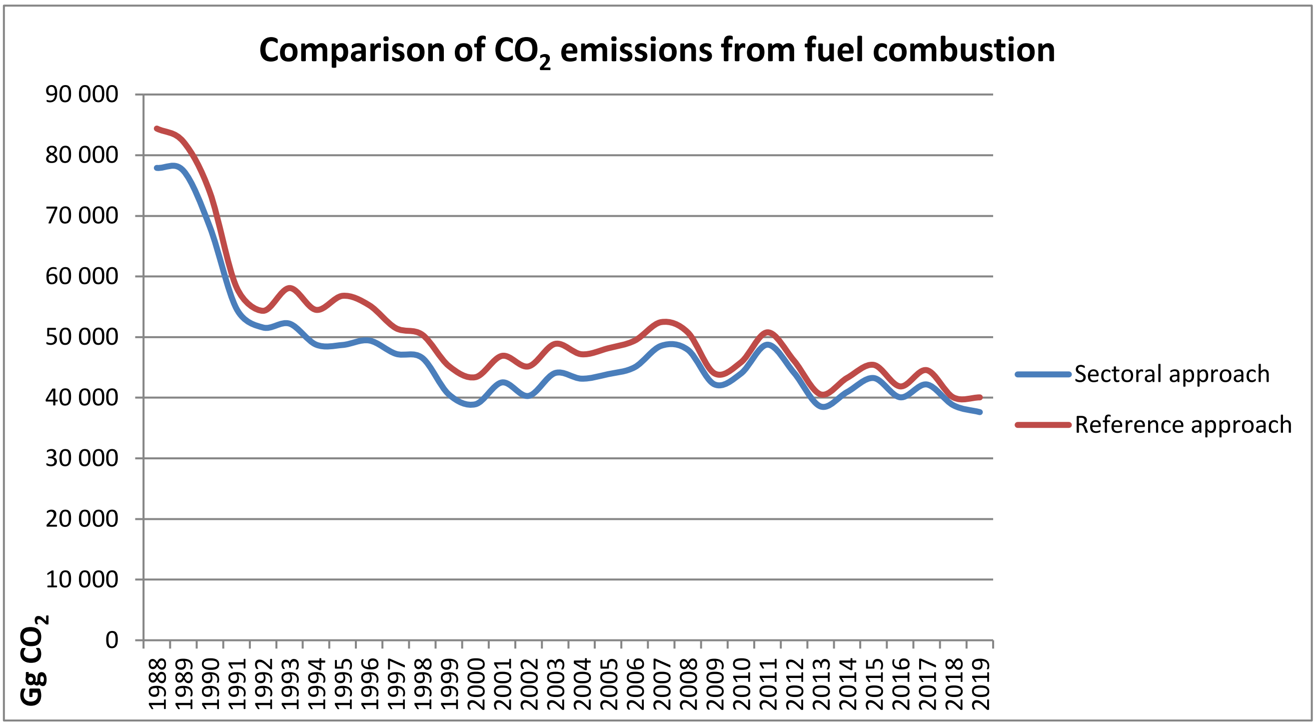

Figure 20 Comparison of the sectoral approach with the reference approach

The following tables compare the energy consumption and the emissions according to both approaches by fuel type.

Table 14 Comparison of the sectoral approach with the reference approach (all fuels)

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1988	1 011.05	945.25	6.96%	84 385.33	77 901.95	8.32%
1990	894.21	848.17	5.43%	73 857.04	68 148.36	8.38%
1995	679.03	596.09	13.91%	56 803.49	48 702.06	16.63%
2000	502.90	467.82	7.50%	43 387.51	38 927.75	11.46%
2005	558.01	519.77	7.36%	48 156.13	43 890.19	9.72%
2010	518.26	506.59	2.30%	45 824.64	43 981.52	4.19%
2011	567.70	554.32	2.41%	50 782.46	48 750.74	4.17%
2012	523.19	508.45	2.90%	46 098.80	44 119.28	4.49%
2013	465.78	449.57	3.61%	40 555.27	38 564.30	5.16%
2014	493.76	475.24	3.90%	43 268.22	40 940.21	5.69%
2015	518.32	501.62	3.33%	45 415.43	43 250.13	5.01%
2016	483.98	471.60	2.63%	41 867.15	40 071.85	4.48%
2017	513.24	495.68	3.54%	44 546.28	42 188.48	5.59%
2018	485.77	468.00	3.80%	40 905.97	38 757.67	5.54%
2019	458.61	451.34	1.61%	40 055.49	37 624.69	6.46%

Table 15 Comparison of the sectoral approach with the reference approach (liquid fuels)

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1988	459.41	402.65	14.10%	34 107.23	30 098.27	13.32%
1990	362.76	352.96	2.78%	26 775.59	26 010.68	2.94%
1995	222.87	182.87	21.87%	16 429.52	13 382.50	22.77%
2000	145.58	142.44	2.20%	10 640.67	10 272.75	3.58%
2005	177.02	160.82	10.07%	13 024.11	11 846.25	9.94%

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
2010	152.70	144.57	5.63%	11 267.48	10 679.33	5.51%
2011	143.87	135.23	6.39%	10 492.38	9 859.39	6.42%
2012	150.97	141.29	6.85%	11 069.93	10 360.55	6.85%
2013	138.15	126.61	9.11%	10 148.66	9 325.99	8.82%
2014	150.64	139.04	8.34%	11 048.57	10 277.93	7.50%
2015	163.99	153.30	6.98%	12 006.36	11 295.02	6.30%
2016	168.23	158.09	6.41%	12 415.00	11 657.08	6.50%
2017	174.94	161.38	8.40%	13 026.77	11 912.25	9.36%
2018	173.79	163.45	6.32%	12 869.50	12 113.51	6.24%
2019	178.54	170.41	4.77%	13 370.92	12 558.09	6.47%

Table 16 Comparison of the sectoral approach with the reference approach (solid fuels)

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1988	400.64	391.60	2.31%	41 941.99	39 467.58	6.27%
1990	361.45	327.08	10.51%	37 697.17	32 856.19	14.73%
1995	313.87	275.77	13.82%	32 518.96	27 731.81	17.26%
2000	263.17	232.90	13.00%	27 549.11	23 549.84	16.98%
2005	284.71	265.41	7.27%	29 815.96	26 878.52	10.93%
2010	283.47	281.20	0.81%	30 016.45	28 827.99	4.12%
2011	333.58	330.31	0.99%	35 293.13	33 972.88	3.89%
2012	284.18	239.48	18.67%	25 675.72	24 589.36	4.42%
2013	242.55	239.48	1.28%	25 675.72	24 589.36	4.42%
2014	260.77	254.75	2.36%	27 635.80	26 123.38	5.79%
2015	269.24	264.36	1.85%	28 652.54	27 254.76	5.13%
2016	230.67	229.91	0.33%	24 690.48	23 729.49	4.05%
2017	249.79	247.29	1.01%	26 581.28	25 414.03	4.59%
2018	222.16	216.38	2.67%	23 017.11	21 709.66	6.02%
2019	198.29	198.44	-0.07%	21 906.74	20 425.25	7.25%

Table 17 Comparison of the sectoral approach with the reference approach (gaseous fuels)

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1988	151.00	151.00	0.00%	8 336.10	8 336.10	0.00%
1990	169.99	168.13	1.11%	9 384.27	9 281.48	1.11%
1995	142.29	137.45	3.52%	7 855.01	7 587.76	3.52%
2000	94.15	92.48	1.81%	5 197.73	5 105.16	1.81%
2005	96.25	93.50	2.94%	5 313.25	5 162.62	2.92%
2010	81.74	80.44	1.63%	4 515.66	4 445.63	1.58%
2011	89.94	88.44	1.70%	4 970.53	4 889.51	1.66%
2012	87.57	86.46	1.28%	4 833.59	4 774.46	1.24%
2013	84.52	82.66	2.24%	4 679.32	4 578.78	2.20%
2014	81.80	80.69	1.37%	4 534.42	4 475.36	1.32%
2015	84.28	82.92	1.64%	4 688.23	4 614.34	1.60%
2016	83.73	81.97	2.15%	4 658.41	4 561.65	2.12%
2017	86.88	85.07	2.12%	4 820.15	4 721.65	2.09%
2018	87.81	85.85	2.27%	4 876.63	4 769.84	2.24%
2019	79.18	79.58	-0.51%	4 582.96	4 423.92	3.60%

3.3.1.3 Explanation of differences

A comparison between the Reference Approach (RA) and the Sectoral Approach (RA) indicates a difference of 1.61% in terms of energy consumption and 6.46% in terms of CO2 emissions for 2019.
The main reason why these two approaches do not match most likely has to do with the significant statistical differences reported for some of the years in the national energy balances. The most notable differences are observed in the period 1993-1996, and particularly 1995. Analysis reveals that these differences in liquid fuels consumption are caused by significant amounts of refinery losses reported, e.g. 9.5% of total refinery intake in 1995 was reported as refinery losses, with an average of 4.1% for the period 1990-2019 and 5.5% for 2019 alone.
Another reason for potential discrepancies is the difference between the net calorific values of primary and secondary fuels in fuel transformation processes. This is especially valid for liquid fuels – the Reference approach calculation is based on the energy content of refined crude oil, whereas the Sectoral approach uses the energy content of produced secondary fuels. For solid fuels, the Reference approach is based on the net calorific value of lignite coal, used in BKB plants, whereas the Sectoral approach disregards the initial amount of lignite reported for transformation in BKB plants, instead using the net calorific value of the BKB fuel itself. The same note is also applicable to coking coal used for the production of coke oven coke and coke oven gas, even though this activity has not taken place since 2009.
In short, discrepancies in the emission estimates between the reference and the sectoral approach occur due to the fact, that the Energy balance is mass-balanced, but not energy-balanced, i.e. there are some differences in the energy content of the primary fuels and the secondary fuels produced.
A special case for solid fuels used in blast furnaces in the Iron & Steel subcategory is an additional reason for differences between RA and SA for the period before 2008. In order to avoid double counting between Energy and Industrial Processes categories (2C Metal production), part of the solid fuels reported in the Energy balance are not accounted in the Sectoral approach (details regarding exact fuel allocation are given in Annex III). This is the reason why the difference between RA and SA for solid fuels was minimized immediately after the closure of the largest I&S plant in Bulgaria in 2008.
For liquid fuels (diesel fuel and gasoline) there is an additional reason for differences associated with the blending of biofuels. While in the SA the CO2 emissions from the biofuels component are accounted under biomass, in the RA all liquid fuel consumption is accounted as fossil. Similarly, the use of alternative fuels, which is accounted in the SA, is not accounted in the RA.

3.3.1.4 Quantification of differences

For 2019 the difference due to statistical differences and distribution losses for gaseous fuels is equal to 2 886 TJ, which is 2.9% of the total consumption of gaseous fuels. In terms of emissions, this is equivalent to 167.1 Gg CO2. For liquid fuels, in 2019 the refinery losses are 5.5% of the refinery intake, which is equal to 16 127 TJ or 1182.1 Gg CO2.
If all those quantified differences are accounted, the remaining difference between the reference and the sectoral approaches for 2019 is equal to 2.6% in terms of energy consumption and 2.9% in terms of emissions.

3.3.2 INTERNATIONAL BUNKER FUELS

The International Bunkers represent the fuels and the emissions resulting from international air and marine transport of passengers and cargo. These GHG emissions are also subject to the inventory and they have to be reported. However, they are not included in the total sum of the emissions of the country. The Energy balance provides a split between domestic and international fuel consumption.

Table 18 GHG Emissions from International bunker fuels

Year	Total [Gg CO_2e]	Aviation [Gg CO_2e]	Navigation [Gg CO_2e]
1988	2 071.36	1 112.46	958.90
1990	903.84	719.35	184.48
1995	1 774.90	912.48	862.41
2000	444.54	241.85	202.69
2005	917.38	569.01	348.37

Year	Total [Gg CO_2e]	Aviation [Gg CO_2e]	Navigation [Gg CO_2e]
2010	813.93	505.41	308.52
2011	751.14	511.61	239.53
2012	694.93	493.01	201.93
2013	766.33	480.60	285.72
2014	769.22	511.61	257.61
2015	806.69	533.31	273.38
2016	886.79	641.84	244.95
2017	971.23	718.43	252.80
2018	1 032.56	773.05	259.50
2019	970.64	734.08	236.56

3.3.3 FEEDSTOCKS AND NON-ENERGY USE OF FUELS

Non-energy use of fuels is reported for the following fuels:

- Anthracite
- Coke Oven Coke
- Other bituminous coal
- Lubricants
- Bitumen
- Naphtha
- Paraffin waxes
- White spirit
- Residual Fuel Oil
- Other Oil Products
- Petroleum Coke
- Natural Gas as Feedstock

The amounts of fuels used for non-energy purposes are available in the energy balance by activity category and type of fuel. These amounts were used in the calculations for the reference approach, applying a value of 1 for the fraction of carbon stored.

There are some fluctuations in reported consumption for some of the fuels during the examined time series. These fluctuations are due to changes in industrial production, e.g. differences in production volume, decommissioning of installations or shift from one fuel type to another. In addition, the Energy balance incorporates certain discrepancies concerning the quantities of fuels reported as non-energy use, as some industrial plants fail to report their non-energy use of fuels properly.

In order to improve reporting consistency, additional data was collected from several chemical plants regarding the annual production of ammonia, soda ash and calcium carbide. The amounts of energy and non-energy use of natural gas, anthracite, other bituminous coal and coke oven coke were reallocated according to the quantities of fuels considered as emission sources in the Industrial Processes sector.

The non-energy use of fuels is on average 8.3% of the total apparent energy consumption during the period 1988-2019 and 7.1% for 2019. The apparent consumption is calculated according to Equation 6.2 in Vol. 2, Ch. 6 of the 2006 IPCC Guidelines.

Table 19 Non-energy use of fuels compared to total apparent energy consumption

Year	Non-energy use, PJ	Apparent energy consumption incl. non-energy use, PJ	%
1988	93.53	1108.57	8.4%
1990	92.88	987.09	9.4%
1995	82.82	763.05	10.9%
2000	60.60	563.50	10.8%
2005	48.49	606.48	8.0%
2010	26.90	545.16	4.9%
2011	34.29	601.99	5.7%

Year	Non-energy use, PJ	Apparent energy consumption incl. non-energy use, PJ	%
2012	30.48	553.67	5.5%
2013	29.76	495.50	6.0%
2014	33.21	526.91	6.3%
2015	42.29	560.57	7.5%
2016	41.47	525.40	7.9%
2017	40.93	554.17	7.4%
2018	37.38	523.15	7.1%
2019	36.21	507.32	7.1%

The most significant fuels used as feedstock are bitumen, anthracite and natural gas. The non-energy use of naphtha has been discontinued since 2010.

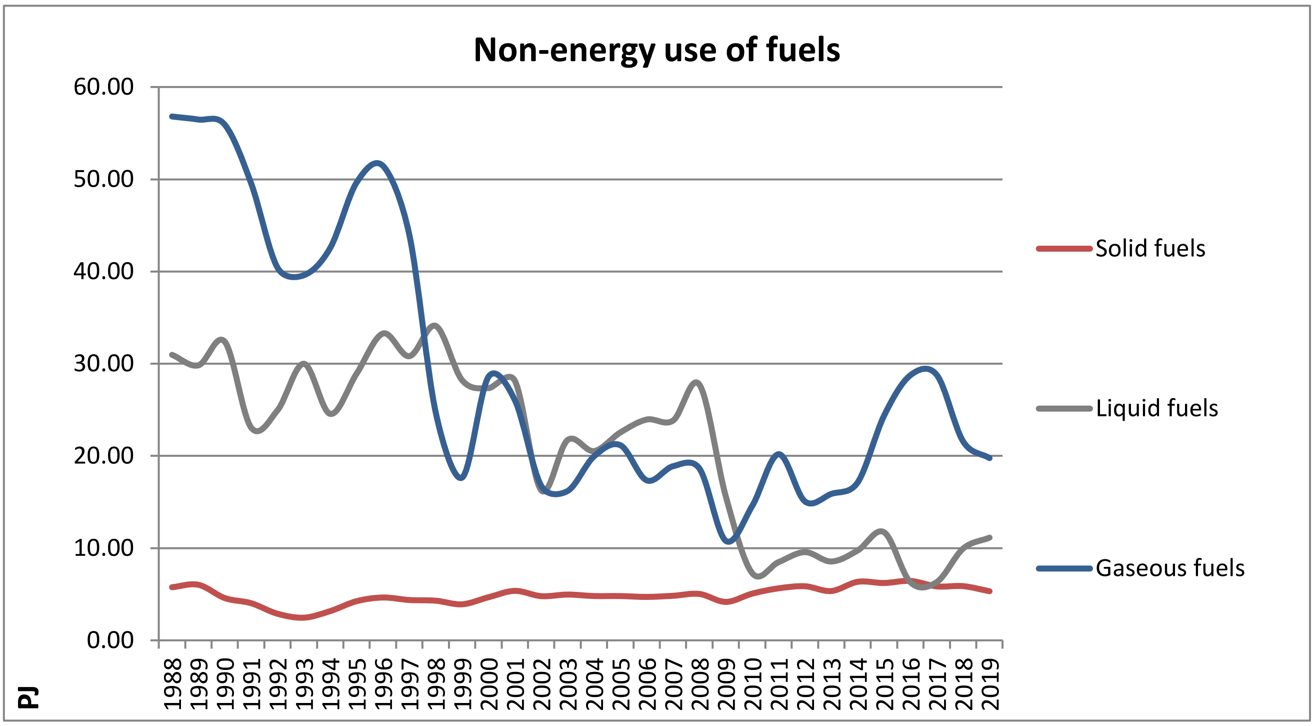

Figure 21 Non-energy use of fuels

The amounts of fuels used for non-energy purposes are available in the energy balance by activity category and type of fuel. These amounts were used in the calculations for the reference approach. As per ERT recommendation FCCC/ARR/2016/BGR E.6 in this case there is no need to use fractions of carbon stored for the non-energy use of fuels.

In general, most of the non-energy use of fuels is attributed to the industrial sector (lubricants, paraffin wax), chemical and petrochemical industry (anthracite, natural gas, naphtha, white spirit and other petroleum products) and construction (bitumen). All sources of emissions due to non-energy use of fuels (natural gas) are reported under category 2B Chemical Industry. Currently, this includes also emissions from lubricants used in 2-stroke engines, which are also reported under the IPPU sector (CRF 2.D.1), as they are less than 2% from the emissions from all lubricants. The quantities of waste oils, which are used with energy recovery in the non-metallic minerals and other industrial plants, are reported as other fuels under category 1.A.2.g Other industries.

Table 20 Apparent consumption of non-energy fuels

PJ	Solid fuels	Liquid fuels	Gaseous fuels
1988	5.76	30.96	56.80
1990	4.58	32.38	55.91
1995	4.25	28.93	49.65
2000	4.67	27.35	28.58
2005	4.80	22.54	21.15

PJ	Solid fuels	Liquid fuels	Gaseous fuels
2010	5.07	7.27	14.57
2011	5.64	8.47	20.18
2012	5.87	9.55	15.06
2013	5.35	8.54	15.87
2014	6.35	9.73	17.12
2015	6.22	11.71	24.36
2016	6.45	6.28	28.75
2017	5.85	6.31	28.77
2018	5.88	9.94	21.56
2019	5.33	11.12	19.75

3.3.4 CO_2 CAPTURE FROM FLUE GASES AND SUBSEQUENT CO_2 STORAGE

CO_2 capture from flue gases and CO_2 storage is not occurring in Bulgaria.

3.3.5 COUNTRY-SPECIFIC ISSUES

Due to country specificities regarding national statistics, two independent sources of information were used for various periods. The Eurostat energy balances prepared by the National Statistics Institute were the most relevant source of information and they were used for estimating the emissions for the years 1990-2019. However, since the National statistics have not issued official balances in the Eurostat format for the years before 1990, the IEA Energy balances were used for the years 1988 and 1989. It is worth mentioning that for 1988 and 1989 the fuel allocation by category is different and significant quantities are allocated to sector 'Other'.

3.3.6 KEY CATEGORIES

The methodology and results of key category analyses are presented in Annex I. Table 21 presents the key source categories of 1 A Fuel Combustion Activities.

Table 21 Key subcategories in sector 1.A. Fuel combustion

Category	Classification	Gas	Key Category Assessment*
1.A.1 - Energy Industries	Gaseous fuels	CO_2	LA, TA
1.A.1 - Energy Industries	Liquid fuels	CO_2	LA, TA
1.A.1 - Energy Industries	Solid fuels	CO_2	LA, TA
1.A.2 - Manufacturing Industries and Construction	Gaseous fuels	CO_2	LA, TA
1.A.2 - Manufacturing Industries and Construction	Liquid fuels	CO_2	LA, TA
1.A.2 - Manufacturing Industries and Construction	Solid fuels	CO_2	LA, TA
1.A.3.b - Road Transportation	Liquid fuels	CO_2	LA, TA
1.A.3.b - Road Transportation	Gaseous fuels	CO_2	LA, TA
1.A.3.e - Other Transportation	Gaseous fuels	CO_2	LA, TA
1.A.4 - Other Sectors	Gaseous fuels	CO_2	LA, TA
1.A.4 - Other Sectors	Liquid fuels	CO_2	LA, TA
1.A.4 - Other Sectors	Solid fuels	CO_2	LA, TA
1.A.5 – Other Stationary	Fossil fuels	CO_2	LA, TA

*LA = Level Assessment w/o LULUCF; TA = Trend Assessment w/o LULUCF

3.3.7 COMPLETENESS

All occurring sources of emissions from 1.A Fuel combustion are estimated for solid, liquid, gaseous fuels, biomass and other fuels (industrial waste). All emissions from CO_2, CH_4 and N_2O have been accounted.

3.3.8 METHODOLOGICAL ISSUES

3.3.8.1 Choice of Method

Tier 1 Methodology

Equation 2.1 from Vol. 2, Chapter 2 of the 2006 IPCC Guidelines is used to estimate the CO_2, CH_4 and N_2O emissions from stationary fuel combustion in CRF subcategories 1.A.1, 1.A.2., 1.A.4 and 1.A.5. The formula used in the calculations is the following:

Emissions $_{GHG}$ ***= Fuel Consumption • Emission Factor*** $_{GHG}$

where:

Emissions $_{GHG}$ = emissions of a given GHG by type of fuel (kg GHG)

Fuel Consumption = amount of fuel combusted (TJ)

Emission Factor $_{GHG}$ = default emission factor of a given GHG by type of fuel (t gas/TJ).

Tier 2 Methodology

The same equation is used for the CO_2 emission calculations using the Tier 2 approach in CRF subcategories 1.A.1, 1.A.2., 1.A.4 and 1.A.5, with the difference that the emission factor takes into account country-specific data for carbon contents of the fuels used and carbon oxidation factors.

3.3.8.2 Choice of emission factor

3.3.8.2.1 Choice of emission factors for stationary sources

Default emission factors according to 2006 IPCC Guidelines (Vol. 2, Ch. 2, Table 2.2-2.5) are applied to all fuels for which no country-specific CO_2 emission factors are available. The 2006 IPCC default emission factors for CRF subcategories 1.A.1, 1.A.2., 1.A.4 and 1.A.5 are used for CH_4 and N_2O emissions. The country-specific carbon content of fuels was calculated based on the country-specific CO_2 emission factors using the following equation:

C = Emission Factor **/ (44/12)**

where:

C = carbon content of fuel in t/TJ

Emission Factor = emission factor for CO_2 by type of fuel (t/TJ)

Unlike the 1996 IPCC guidelines, Tier 1 default emission factors in the 2006 IPCC Guidelines reflect a fuel's full carbon content, including any non-oxidized fraction of carbon retained in the ash, particulates or soot, i.e. a complete oxidation of the carbon contained in the fuel is assumed (carbon oxidation factor equal to 1). Further, the 2006 IPCC guidelines do not provide default oxidation factors, so it is not possible to derive different emission factors (including and excluding the oxidation factor). As a result, the use of default 2006 IPCC emission factors leads to an increase in emission estimates of 0.5 to 2% depending on the fuel type, compared to default emission factors from the 1996 IPCC Guidelines.

Table 22 Default Emission factors for CO_2 for different fuels

Fuel	EF C t/TJ	EF CO2 t/TJ (excl. oxidation factor)
LIQUID FOSSIL		
Primary fuels		
Crude Oil	20.0	73.3
Orimulsion	21.0	77.0
Natural Gas Liquids	17.5	64.2
Secondary fuels/products		
Motor Gasoline	18.9	69.3
Aviation Gasoline	19.1	70.0
Jet Gasoline	19.1	70.0
Jet Kerosene	19.5	71.5
Other Kerosene	19.6	71.9
Shale Oil	20.0	73.3
Gas / Diesel Oil	20.2	74.1
Residual Fuel Oil	21.1	77.4
Liquefied Petroleum Gases	17.2	63.1

Fuel	EF C t/TJ	EF CO2 t/TJ (excl. oxidation factor)
Ethane	16.8	61.6
Naphtha	20.0	73.3
Bitumen	22.0	80.7
Lubricants	20.0	73.3
Petroleum Coke*	26.6	97.5
Refinery Feedstocks	20.0	73.3
Refinery Gas	15.7	57.6
Paraffin Waxes	20.0	73.3
White Spirit and SBP	20.0	73.3
Other Petroleum Products	20.0	73.3
SOLID FOSSIL		
Primary Fuels		
Anthracite*	26.8	98.3
Coking Coal	25.8	94.6
Other Bituminous Coal*	25.8	94.6
Sub-Bituminous Coal	26.2	96.1
Lignite*	27.5	101.0
Oil Shale and Tar Sands	29.2	107.0
Secondary fuels/products		
Brown Coal Briquettes	26.6	97.5
Patent Fuel	26.6	97.5
Coke - Gas Coke	29.2	107.0
Coal Tar	22.0	80.7
Gas Works Gas	12.1	44.4
Coke Oven Gas	12.1	44.4
Blast Furnace Gas	70.9	260.0
Oxygen Steel Furnace Gas	49.6	182.0
GASEOUS FOSSIL		
Natural Gas*	15.3	56.1
OTHER FOSSIL		
Municipal Wastes (non-biomass fraction)	25.0	91.7
Industrial Wastes	39.0	143.0
Waste Oils	20.0	73.3
Peat	28.9	106.0
SOLID BIOMASS		
Wood / Wood Waste	30.5	112.0
Sulphite lyes (Black Liquor)	26.0	95.3
Other Primary Solid Biomass	27.3	100.0
Charcoal	30.5	112.0
LIQUID BIOMASS		
Biogasoline	19.3	70.8
Biodiesels	19.3	70.8
Other Liquid Biofuels	21.7	79.6
GASEOUS BIOMASS		
Landfill Gas	14.9	54.6
Sludge Gas	14.9	54.6
Other Biogas	14.9	54.6
OTHER BIOMASS		
Municipal Wastes (biomass fraction)	27.3	100.0

The above-stated default EFs were used for the calculations, except for the following fuels, for which country-specific EFs were derived:

- Anthracite
- Other bituminous coal (Black coal)

- Lignite
- Petroleum coke
- Natural gas

The country-specific emission factors are listed in Table 24 and Table 25.

3.3.8.2.2 Country specific emission factors for CO_2 for solid fuels

Emission data reported under the European Emission Trading Scheme

A total of 175 operators have provided their verified CO_2 emission reports required under the EU ETS for the years 2007-2019. These emissions have been incorporated in the inventory to the best extent possible (see respective subchapters for more information). Furthermore, the background data for the emission calculations under the EU ETS has been used for further QA/QC checks.

Data from the verified ETS reports has been analysed in order to apply a Tier 2 methodology for the national emission calculations. Out of all operators reporting in 2019, only the 20 largest industrial plants used plant specific methodologies. That made it possible to derive country-specific EFs for the major solid fuels. There were no plants, which applied plant-specific EFs for liquid or gaseous fuels. The country-specific emission factors were derived from the verified ETS reports as a weighted average from all operators, which declared that they had used plant-specific emission factors (Tier 3 according to Commission Regulation 601/2012 on the monitoring and reporting of greenhouse gas emissions). The EFs including oxidation factor are calculated as the total sum of the verified CO_2 emissions divided by the total amount of the respective fuel as reported by the operators. For the years 2007 to 2019 the respective annual emission factors were applied, whereas for the years 1988 to 2006 an EF calculated as a weighted average was applied. A subset of all operators reported plant-specific oxidation factors, based on which country-specific EFs excluding oxidation factor were calculated, by using the country-specific EFs including oxidation factor.

The following country-specific carbon contents were calculated:

Table 23 Country-specific carbon content for solid fuels [t/TJ]

Fuel	Anthracite	Lignite	Other Bituminous Coal	Petroleum Coke
1988-2006	28.1856	29.5664	26.7573	25.7857
2007	27.4792	29.3911	27.3114	26.1149
2008	28.8427	29.8238	26.9270	25.9131
2009	28.6586	29.5021	26.7776	25.3961
2010	27.9950	29.5215	26.3476	25.6574
2011	27.7125	29.3377	26.5553	25.1971
2012	27.2728	29.3820	26.8637	25.5126
2013	27.2555	29.3129	26.5746	25.6736
2014	27.4779	29.3766	26.1637	25.8451
2015	27.5376	29.3360	25.9361	25.7868
2016	29.3428	29.4636	26.0945	25.9060
2017	29.5507	29.2726	25.4187	25.7673
2018	29.9937	28.4366	24.9509	25.6125
2019	**29.0681**	**29.1563**	**24.9035**	**25.5480**

The following emission factors excluding oxidation factor were calculated:

Table 24 Country-specific EFs excl. oxidation factor for CO_2 for solid fuels [t/TJ]

Fuel	Anthracite	Lignite	Other Bituminous Coal	Petroleum Coke
1988-2006	103.3470	108.4102	98.1099	94.5477
2007	100.7572	107.7673	100.1419	95.7545
2008	105.7566	109.3540	98.7324	95.0147
2009	105.0817	108.1742	98.1845	93.1192
2010	102.6484	108.2456	96.6078	94.0772
2011	101.6126	107.5715	97.3695	92.3894
2012	100.0003	107.7340	98.5004	93.5463
2013	99.9368	107.4805	97.4401	94.1364
2014	100.7522	107.7140	95.9336	94.7654
2015	100.9712	107.5652	95.0989	94.5517

Fuel	Anthracite	Lignite	Other Bituminous Coal	Petroleum Coke
2016	107.5904	108.0331	95.6798	94.9888
2017	108.3525	107.3327	93.2018	94.4801
2018	109.9769	104.2675	91.4866	93.9125
2019	**106.5831**	**106.9063**	**91.3130**	**93.6759**

The following country-specific emission factors including oxidation factor were used for the calculations of the emissions for all years and subcategories in CRF 1.A.

Table 25 Country-specific EFs incl. oxidation factor for CO_2 for solid fuels [t/TJ]

Fuel	Anthracite	Lignite	Other Bituminous Coal	Petroleum Coke
1988-2006	98.4802	105.8747	95.6910	94.5161
2007	97.5236	104.9506	98.3294	95.7225
2008	100.7763	106.8890	96.2981	94.9830
2009	99.6547	105.5404	95.1683	93.0881
2010	97.3953	105.8315	93.4475	94.0458
2011	96.6057	105.1891	95.0759	92.3586
2012	96.3049	105.3618	96.4435	93.5150
2013	95.8515	104.8037	95.3831	94.1049
2014	96.6008	104.6660	94.1733	94.7434
2015	98.2139	104.3856	93.4664	94.5258
2016	104.9487	104.5859	93.8423	94.9704
2017	105.5266	104.0991	90.1683	94.4578
2018	105.1822	101.3470	88.5682	93.8869
2019	**102.9444**	**104.1995**	**88.1773**	**93.6478**

The national emission estimates were prepared using country-specific emission factors, including oxidation factor for anthracite, lignite, other bituminous coke and petroleum coke. For all other solid fuels, default emission factors were used and an oxidation factor of 1 was applied.
For the purposes of annual reports under Regulation 601/2012 on the monitoring and reporting of greenhouse gas emissions, plant operators should use either plant-specific emission factors, the country-specific emission factors excluding oxidation factor (Table 24) or the default emission factors (Table 22). Plant operators should apply either a plant-specific oxidation factor or an oxidation factor of 1, since the IPCC Guidelines do not provide default oxidation factors. Although the calculated weighted-average country-specific oxidation factors for solid fuels are representative on a national level, they cannot be applied on a plant level due to significant technological differences among various installations.

3.3.8.2.3 Country specific emission factors for CO_2 for gaseous fuels

As CO_2 emissions from natural gas are a key category in several subcategories and following previous ARR (CC/ERT/ARR/2010/37, §82) recommendations, an improved calculation for a country-specific emission factor for natural gas was executed. To this end, additional data from relevant companies was collected:

- Bulgargaz EAD, the sole public supplier of natural gas for the territory of the Republic of Bulgaria for the period 2007-2019
- Petroceltic Bulgaria EOOD and Oil and Gas Exploration and Production AD - the companies licensed for oil and gas extraction for the period 2004-2019 and 1999-2019 respectively

The companies provided the following parameters of the natural gas they supplied or extracted over the above-stated periods:

- the percentages of methane, ethane, propane, i-butane, n-butane, i-pentane, n-pentane, neo-pentane, i-hexane, N_2 and CO_2 as molar percentage;
- density, NCV/GCV and quantities supplied or extracted at a temperature of 20°C (293.15 K) and an absolute pressure of 101.325 kPa (760 mm Hg)

Using stoichiometric calculations and the above data it was possible to calculate a country specific emission factor for natural gas for each year and also as a weighted average for the period 2007-2010.

The calculation showed that the average country-specific emission factor for natural gas is about 1.6% lower than the default emission factor, which was previously used.

Table 26 Country-specific carbon contents and EFs for CO_2 for gaseous fuels [t/TJ]

Natural gas	Carbon content	EF excl. oxidation factor
1988-2006	15.0557	55.2044
2007	15.0501	55.1839
2008	15.0479	55.1758
2009	15.0647	55.2371
2010	15.0658	55.2413
2011	15.0717	55.2628
2012	15.0542	55.1987
2013	15.0999	55.3662
2014	15.1186	55.4349
2015	15.1711	55.6275
2016	15.1734	55.6359
2017	15.1317	55.4829
2018	15.1470	55.5390
2019	**15.1539**	**55.5644**

As there is no country-specific oxidation factor for natural gas, the default value of 1 was used for the emission estimates.
Since all gas companies report and account the quantities of natural gas at a temperature of 20°C (293.15 K) and an absolute pressure of 101.325 kPa, all calculations were performed considering those conditions. However, since 2012, the National Statistics has started to report to Eurostat the used quantities of natural gas in cubic meters and at a temperature of 15°C. In order to convert the reported values a conversion factor of 1.017 is used (i.e. $Q_{15} = Q_{20} / 1.017$ and $NCV_{15} = NCV_{20} * 1.017$).
For CH_4 emission estimates the default emission factors referenced in IPCC 2006 guidelines, Vol. II, Ch. 2, Table 2-2, Table 2-3, Table 2-4, Table 2-5 are applied.

Table 27 Emission factors for CH_4 for different fuels [kg/TJ]

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
LIQUID FOSSIL				
Primary fuels				
Crude Oil	3	3	10	10
Orimulsion	3	3	10	10
Natural Gas Liquids	3	3	10	10
Secondary fuels/products				
Motor Gasoline	3	3	10	10
Aviation Gasoline	3	3	10	10
Jet Gasoline	3	3	10	10
Jet Kerosene	3	3	10	10
Other Kerosene	3	3	10	10
Shale Oil	3	3	10	10
Gas / Diesel Oil	3	3	10	10
Residual Fuel Oil	3	3	10	10
Liquefied Petroleum Gases	1	1	5	5
Ethane	1	1	5	5
Naphtha	3	3	10	10
Bitumen	3	3	10	10
Lubricants	3	3	10	10
Petroleum Coke	3	3	10	10
Refinery Feedstocks	3	3	10	10
Refinery Gas	1	1	5	5

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
Paraffin Waxes	3	3	10	10
White Spirit and SBP	3	3	10	10
Other Petroleum Products	3	3	10	10
SOLID FOSSIL				
Primary Fuels				
Anthracite	1	10	10	300
Coking Coal	1	10	10	300
Other Bituminous Coal	1	10	10	300
Sub-Bituminous Coal	1	10	10	300
Lignite	1	10	10	300
Oil Shale and Tar Sands	1	10	10	300
Secondary fuels/products				
Brown Coal Briquettes	1	10	10	300
Patent Fuel	1	10	10	300
Coke - Gas Coke	1	10	10	300
Coal Tar	1	1	5	5
Gas Works Gas	1	10	10	300
Coke Oven Gas	1	1	5	5
Blast Furnace Gas	1	1	5	5
Oxygen Steel Furnace Gas	1	1	5	5
GASEOUS FOSSIL				
Natural Gas	1	1	5	5
OTHER FOSSIL				
Municipal Wastes (non-biomass fraction)	30	30	300	300
Industrial Wastes	30	30	300	300
Waste Oils	30	30	300	300
Peat	1	2	10	300
SOLID BIOMASS				
Wood / Wood Waste	30	30	300	300
Sulphite lyes (Black Liquor)	3	3	3	3
Other Primary Solid Biomass	30	30	300	300
Charcoal	200	200	200	200
LIQUID BIOMASS				
Biogasoline	3	3	10	10
Biodiesels	3	3	10	10
Other Liquid Biofuels	3	3	10	10
GASEOUS BIOMASS				
Landfill Gas	1	1	5	5
Sludge Gas	1	1	5	5
Other Biogas	1	1	5	5
OTHER BIOMASS				
Municipal Wastes (biomass fraction)	30	30	300	300

For N_2O the default emission factors referenced in the IPCC 2006 Guidelines, Vol. II, Ch. 2, Table 2-2, Table 2-3, Table 2-4, Table 2-5 are applied.

Table 28 Emission factors for N_2O for different fuels [kg/TJ]

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
LIQUID FOSSIL				
Primary fuels				
Crude Oil	0.6	0.6	0.6	0.6
Orimulsion	0.6	0.6	0.6	0.6
Natural Gas Liquids	0.6	0.6	0.6	0.6
Secondary fuels/products				
Motor Gasoline	0.6	0.6	0.6	0.6
Aviation Gasoline	0.6	0.6	0.6	0.6
Jet Gasoline	0.6	0.6	0.6	0.6
Jet Kerosene	0.6	0.6	0.6	0.6
Other Kerosene	0.6	0.6	0.6	0.6
Shale Oil	0.6	0.6	0.6	0.6
Gas / Diesel Oil	0.6	0.6	0.6	0.6
Residual Fuel Oil	0.6	0.6	0.6	0.6
Liquefied Petroleum Gases	0.1	0.1	0.1	0.1
Ethane	0.1	0.1	0.1	0.1
Naphtha	0.6	0.6	0.6	0.6
Bitumen	0.6	0.6	0.6	0.6
Lubricants	0.6	0.6	0.6	0.6
Petroleum Coke	0.6	0.6	0.6	0.6
Refinery Feedstocks	0.6	0.6	0.6	0.6
Refinery Gas	0.1	0.1	0.1	0.1
Paraffin Waxes	0.6	0.6	0.6	0.6
White Spirit and SBP	0.6	0.6	0.6	0.6
Other Petroleum Products	0.6	0.6	0.6	0.6
SOLID FOSSIL				
Primary Fuels				
Anthracite	1.5	1.5	1.5	1.5
Coking Coal	1.5	1.5	1.5	1.5
Other Bituminous Coal	1.5	1.5	1.5	1.5
Sub-Bituminous Coal	1.5	1.5	1.5	1.5
Lignite	1.5	1.5	1.5	1.5
Oil Shale and Tar Sands	1.5	1.5	1.5	1.5
Secondary fuels/products				
Brown Coal Briquettes	1.5	1.5	1.5	1.5
Patent Fuel	1.5	1.5	1.5	1.5
Coke - Gas Coke	1.5	1.5	1.5	1.5
Coal Tar	0.1	0.1	0.1	0.1
Gas Works Gas	1.5	1.5	1.5	1.5
Coke Oven Gas	0.1	0.1	0.1	0.1
Blast Furnace Gas	0.1	0.1	0.1	0.1
Oxygen Steel Furnace Gas	0.1	0.1	0.1	0.1
GASEOUS FOSSIL				
Natural Gas	0.1	0.1	0.1	0.1
OTHER FOSSIL				
Municipal Wastes (non-biomass fraction)	4	4	4	4
Industrial Wastes	4	4	4	4
Waste Oils	4	4	4	4
Peat	1.5	1.5	1.4	1.4
SOLID BIOMASS				
Wood / Wood Waste	4	4	4	4

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
Sulphite lyes (Black Liquor)	2	2	2	2
Other Primary Solid Biomass	4	4	4	4
Charcoal	4	4	1	1
LIQUID BIOMASS				
Biogasoline	0.6	0.6	0.6	0.6
Biodiesels	0.6	0.6	0.6	0.6
Other Liquid Biofuels	0.6	0.6	0.6	0.6
GASEOUS BIOMASS				
Landfill Gas	0.1	0.1	0.1	0.1
Sludge Gas	0.1	0.1	0.1	0.1
Other Biogas	0.1	0.1	0.1	0.1
OTHER BIOMASS				
Municipal Wastes (biomass fraction)	4	4	4	4

3.3.8.2.4 Choice of emission factors for mobile sources

The emission factors for mobile sources are presented in Chapter 3.3.12.3.5.

3.3.8.3 Choice of activity data for stationary sources

The activity data required for the calculation of emissions from stationary combustion is based on the National Energy Balances, which provide information about indigenous production, imports, exports and inland consumption, by subcategory, of all types of fuels.
The balances provide the consumption of fuels in natural units (mass or volume units – thousands of tons/Gg for solid and liquid fuels, cubic meters for gaseous fuels) and the net calorific values for each fuel per subcategory.
Following the recommendations, the energy balances prepared by the National Statistics Institute in the Eurostat format were used for estimating the emissions for the years 1990-2019. As the National statistics have not prepared balances in the Eurostat format for the years before 1990, the IEA Energy balances were used for the years 1988 and 1989.
Additionally, it was established that the use of alternative fuels (industrial waste) is not reported in the energy balances for the entire time series. As a result, the reports provided by plants operating according to Bulgarian waste legislation and ETS reports were used in order to calculate the GHG emissions from waste incineration in cement and other plants.
According to the sectoral approach methodology for stationary combustion, only the fuel quantities that are combusted are relevant and thus considered for the emission calculations. Reported quantities of fuels for non-energy use and feedstock use, international bunker fuels, transformation and distribution losses, transformations of fuels to other fuels and internal refinery processes which have been reported in the transformation sector of the energy balances were not considered.
The correspondence between the energy balance categories and CRF categories can be reviewed in detail in Annex III.
The national energy balance is provided by NSI. The energy balance also presents the net calorific values (NCVs) used for converting mass or volume units of the fuel quantities into energy units [TJ].

3.3.8.3.1 Choice of NCV

The corresponding Net Calorific Values (NCVs) for each category from the Energy balances were used in order to convert the fuel consumption reported in natural units to energy units. For solid fuels there is more than one NCV provided in the Energy balance. Details about the correspondence between each type of NCV and each category are presented in Annex III.
For the reference approach for solid fuels the weighted average NCV from the NCVs of production, imports and exports was calculated. The calculated NCVs used for the reference approach can be found in Annex IV.
For liquid fuels the balances provide average NCVs, which were used in all calculations.

For gaseous fuels the amount in TJ as reported by the energy balances was used directly. Since the reported values are Gross Calorific Values, all numbers were multiplied by 90% in order to calculate the NCV. (IEA Energy Statistics Manual, p. 183, Table A3.12)

Table 29 Selected Net Calorific Values for 2019

Fuel	Public electricity and heat production [TJ/Gg]	Industry [TJ/Gg]
Liquid fuels		
Crude oil	42.538	
Gasoline	42.320	
Jet Kerosene	43.120	
Gas/Diesel Oil	41.998	
Residual Fuel Oil	40.000	
LPG	46.000	
Naphtha	43.691	
Bitumen	40.449	
Lubricants	40.200	
Petroleum Coke	32.590	
Refinery Feedstocks	41.849	
Refinery Gas	47.385	
White Spirit SBP	40.200	
Paraffin Wax	40.200	
Other Petroleum Products	40.200	
Solid fuels		
Anthracite	-	29.871
Coking Coal	-	-
Other Bituminous Coal	11.257	25.421
Lignite and Sub-bituminous Coal	6.952	8.318
BKB & Patent Fuel	10.598	18.000
Coke Oven / Gas Coke	-	28.500
Gaseous fuels		
Natural Gas, 20°C [TJ/1000 m3]	0.034306	
Natural Gas, 15°C [TJ/1000 m3]	0.034889	

For all NCVs please consult Annex IV.

3.3.8.4 Biomass

A wide range of biomass sources can be used to produce bioenergy in a variety of forms. Solid biofuels include the following:

- wood and wood waste combusted directly for energy purposes and biomass used for charcoal production
- black liquor - concentrated residue from the pulp and paper industry
- other primary solid biomass - plant residues not included in the above-stated black liquor and wood and wood waste categories
- charcoal - a product from destructive distillation and pyrolysis of wood and other vegetal material
- Liquid biofuels as biogasoline, biodiesel and other bioliquids are mainly used for transportation. This is further explained in the transport sector section.

Landfill, sludge and other biogas is generated by the anaerobic fermentation of biomass and solid wastes in landfills, from sludge and animal slurries and other sources, respectively. In addition to biogas, a solid biomass fraction is present in municipal waste. All these types of biomass are combusted to produce heat and/or power. However, CO_2 emissions released from these processes are reported as an information item, as the released CO_2 is considered naturally absorbed. Yet, this is not applicable for the methane and N_2O emissions that are reported and accounted in the total inventory emissions.

In Bulgaria all types of biomass – solid, liquid and gaseous – are used as an energy source. Biomass is primarily used for the production of heat in the transformation sector (autoproducer heat and CHP; main activity producer heat plants), industry, residential, commercial and public services sector, agriculture and other sectors.
Over the course of the examined time series, solid biomass has primarily been combusted for the following activities:

- Energy industries (main activity producer heat plants, own use in electricity, CHP and heat plants)
- Manufacturing Industries and construction (iron and steel, chemical and petrochemical, non-ferrous metals, non-metallic minerals, transport equipment, machinery, mining and quarrying, food and tobacco, paper, pulp and print, wood and wood products, construction, textile and leather and non-specified (industry); autoproducer CHP plants and autoproducer heat plants
- Other sectors (residential, commercial/institutional, agriculture/forestry/fishing, non-specified other)
- Regarding liquid and gaseous types, only limited amounts of biodiesel, biogasoline and sludge gas has been utilized. Liquid biofuels have been consumed in road transport sector, while gaseous fuels have been consumed in agriculture, commercial and public services and electricity and heat plants. Data for liquid biofuels is reported for 2006-2019 and for gaseous biofuels is reported for 2008-2019.

For the estimate of the CH_4 and N_2O emissions the EFs from 2006 IPCC Guidelines, Vol. 2, Ch. 2, Table 2.2-2.5 were applied.

3.3.8.5 Other fossil fuels

There is a specific case to develop a separate calculation model for alternative fuels used in the industry. Due to the fact that all cement plants participate in the ETS, their verified reports were used in order to calculate the country-specific EFs for the following fuels:

- SRF/RDF
- Waste oils
- Tyres
- Filters
- Biomass

Data from the reports of all industrial plants, submitted according to Bulgarian waste legislation, was used in order to calculate the emissions based on specific waste type.
According to this model the emissions from biomass fraction and non-biogenic fraction are accounted separately, as CO_2 emissions from biomass fraction must not be included in the national totals.

3.3.8.6 Uncertainties in CRF 1.A

<u>**STATIONARY COMBUSTION**</u>

3.3.8.6.1 Uncertainty of AD

Solid fuels
About 95% of solid fuels consumption is derived from national lignite production, whereas less than 5% of solid fuels (anthracite and bituminous coal) are imported, predominantly from Russia and Ukraine. Except for electricity production, solid fuels are used in the chemical industry, as well as in the non-metallic minerals and iron and steel industry. The Eurostat format energy balances, which are prepared by NSI, are based on bottom-up and top-down approach.
For the early years of the time series, the allocation between 'Transformation sector', 'Energy sector' and 'Total Final Consumption' and among the subcategories isn't always consistent; in general, consumption tends to be allocated to 'Other' categories (1.A.2.g and 1.A.5). Varying coal properties (ash, moisture, sulphur, and calorific value) – even from the same mines – are another reason for uncertainties. Ultimately, coal is quantified on a mass basis and therefore associated conversion factors may cause uncertainties. Broadly speaking, solid fuels utilized in the ETS participating plants

have a considerably lower uncertainty compared to solid fuels which are used small combustion plants.
Based on the above background information, the uncertainties are estimated as following:
- For CRF categories 1.A.1 and 1.A.2: 1%
- For CRF category 1.A.4 and 1.A.5: 2%

Natural gas
According to the Energy Act, the supply, transmission and storage of natural gas are licensed to Bulgargaz and Bulgartransgaz. The gas transmission network consists of gas pipelines with high-pressure branches, compressor stations, gas pressure-reduction stations and gas measuring stations. The gas transmission network for natural gas transit is not connected to the national gas transmission network. Furthermore, underground gas storage and a related compressor stations exist. Losses are mainly due to leakages, maintenance, old pipes, and varying pressure. Whereas the uncertainty of natural gas supplied to the industry can be assessed as low, the uncertainty for natural gas consumed by households is higher due to the large number of licensed providers and network complexity. Another reason for uncertainty is related to GCV and the conversion factor m^3 to TJ.
Based on the above background information, the uncertainties are estimated to be:
- For CRF categories 1.A.1 and 1.A.2: 1%
- For CRF category 1.A.4 and 1.A.5: 5%

Liquid fuels
Five main importers and distributors of petrol oil are operating more than 3000 petrol stations In Bulgaria. Crude oil is more or less exclusively imported from Russia, Ukraine and other former Russian republics. Liquid fuels are either refined in the LUKOIL Neftochim refinery in Burgas or imported. Due to recent regulations the amounts of gasoline and diesel fuel, sold at petrol stations, have been monitored in real-time since January 2011, which leads to low uncertainty. Nevertheless, before 2011, there were occasional reports for small distributors not declaring the liquid fuels they have sold in order to avoid taxes. For some of the years, the allocation of various liquid fuels to the subcategories is not clear. Therefore, a higher uncertainty is estimated for small combustion plants and engines.
Based on the above background information, the uncertainties are estimated as following:
- For CRF categories 1.A.1 and 1.A.2: 3%
- For CRF category 1.A.4 and 1.A.5: 5%

3.3.8.6.2 Uncertainty for EF

Since for some of the fuels the default EFs from the 2006 IPCC GL were used, the data on default uncertainties presented in "Table A1-1 Uncertainties due to emission factors and activity data" (1996 IPCC GL, p. D 1.4) is applicable (referenced by the 2006 IPCC GL). For the energy sector the uncertainty for emission factor and activity data is 7%.
For the country-specific EFs for solid fuels, the ETS verified reports were used, which involves much lower uncertainty. Nevertheless, the conditions in which solid fuels are combusted are very different. Therefore, higher uncertainty can especially be caused by oxidation factors for solid fuels in households.
Based on the above background information, the uncertainties are estimated as follows:
- For solid fuels in CRF categories 1.A.1 and 1.A.2: 2%
- For solid fuels in CRF category 1.A.4 and 1.A.5: 5%
- For liquid fuels: 7%
- For gaseous fuels: 2%

Quantitative uncertainty estimates are provided in Annex II.

3.3.8.7 Source-specific QA/QC and verification

For the calculation of the emissions from CRF category 1A, an Excel based spreadsheet model was developed, which was linked directly to the Eurostat format energy balances provided by the NSI.
Wherever possible, automated data validation was implemented within the model, yet a number of manual checks were performed, as well.

Following recommendation FCCC/ARR/2011/BGR, §65 the possibility of obtaining a correlation between the carbon content and the NCV of each fuel, reported by selected facilities which have used higher tier methods under the EU ETS, was investigated. To this end, recent scientific literature was consulted (Fott, 1999; Mazumdar, 2000; Mesroghli et al., 2009). Due to the fact that the number of samples is relatively low and coal in Bulgaria is locally produced and imported in a varying proportion, it was established that there is a very limited correlation between the NCV and the CO_2 emission factors for all types of coal (Anthracite, Other Bituminous Coal, Sub-Bituminous Coal, Lignite). This is mostly due to the fact that the NCV is also dependent on other parameters like hydrogen, oxygen and sulphur contents, also ash and water contents.

3.3.8.7.1 Activity data checks

Trend analysis was performed regarding activity data for all subcategories and individual fuels. In order to provide an explanation for variations, the most notable data peaks/drops were discussed with NSI. Since the methodologies used by the National statistics have changed several times over the years, there are several sectors with significant differences in fuel consumption over various time periods. These differences are a result of reallocation of the consumption in different subcategories. An attempt to compare the reallocated quantities was made. To be specific, if a significant decrease in the consumption is noticed in a subcategory, it is considered if an equal drop is noticeable in another subcategory in which case the consumption was reallocated in the following years.

Some changes in the activity data were necessary, because NCVs are not provided for some of the years for some fuels (most notably solid fuels for 1990-91 and 1998) by the NSI. All changes on the activity data were discussed with and approved by the data provider.

For some subcategories the activity data regarding the energy consumption and the data for the production were checked for correlation.

Activity data peaks/drops were discussed with industrial process experts in order to identify sectoral restructuring (closing or opening of plants) or technological changes within specific plants, which result in fuel mix or energy consumption changes.

3.3.8.7.2 Calculations checks

Manual data checks are performed in order to prevent calculation errors:

- Unit conversion checks – activity data units are checked in order to verify that the proper unit conversions are applied.
- Calculation formulas checks – cell formulas are manually checked in order to ensure consistency.

In order to assure integrity of the calculations and to prevent possible errors due to incomplete activity data, the automatic data validation checks were implemented in the Excel model. Each cell with a validation rule is coloured red in case there is a logical problem with the calculations:

- Conversion from natural units to energy units – ensure all non-negative values reported in natural units are properly converted to energy units.
- Calculation of the emissions – ensure the corresponding emissions are calculated from all non-zero values in energy units.
- Emission factors validation – ensure chosen emission factors are within the 2006 GL ranges
- The model itself and the calculations were validated by international experts, and by national experts as part of the QA procedures implemented.

Currently the data from the calculation models is transferred manually to the CRF reporter import templates. In order to ensure that there are no differences due to technical errors, additional comparisons are made between the data in the calculation models and the CRF tables generated by the CRF Reporter software.

3.3.8.8 Source-specific recalculations, including changes made in response to the review process

Following a recommendation of a previous ARR (CC/ERT/ARR/2010/37, §72), a change in the calculation model was introduced. Up until the year 2003, the National statistics provides only aggregated information regarding the consumption of anthracite coal and other bituminous coal – they

are reported as other bituminous coal. Notably, EF for anthracite coal is about 2% higher than EF for other bituminous coal. Thus, in order to avoid underestimation of the emissions it was decided to use the EF for anthracite coal to calculate the emissions from other bituminous coal.
Following another ARR recommendation (CC/ERT/ARR/2010/37, §66), the calculation models were improved, so they could be directly linked to the activity data.
Up to the 2011 submission, the country-specific emission factors were calculated as a weighted average from the available ETS reports and applied to all the years in the time series, which was leading to an annual recalculation of the entire time series. From the 2012 submission on, the country specific emission factors are calculated as a weighted average from all reports for 2007, 2008, 2009 and 2010 and applied for the period 1988-2006, whereas for the years after 2007 the respective annual EF is used. The differences in country-specific emission factors can be found in Table 23.
Following the ERT recommendations from the 2016 review cycle, several methodological changes were adopted, leading to recalculations of the inventory. The consumption of anthracite and other bituminous coal in the National Energy Balance was aggregated for the period 1988-2003. The quantities were disaggregated based on the shares of the consumption for the period 2004-2014 and the NCVs were recalculated, which led to recalculations in all subcategories. Additionally, a new methodology for allocation of energy and non-energy use of coke oven coke in the non-ferrous sector was adopted, resulting in reallocation of a significant part of previously reported emissions to subcategory 2C.
For the 2020 submission were made some revisions of the National Energy Balances, which were reflected in the GHG inventory. In addition, a review of the calculation files revealed a technical error related to calculation of GHG emissions from industrial waste combustion, which has been corrected.

3.3.8.9 Source-specific planned improvements, including those in response to the review process

No specific improvements for this subcategory are planned.

3.3.9 EMISSION TREND

The fuel consumption in the following subcategories is included in this category:

- 1.A.1. Energy Industries
- 1.A.2. Manufacturing Industries and Construction
- 1.A.3. Transport
- 1.A.4. Other Sectors
- 1.A.5. Other

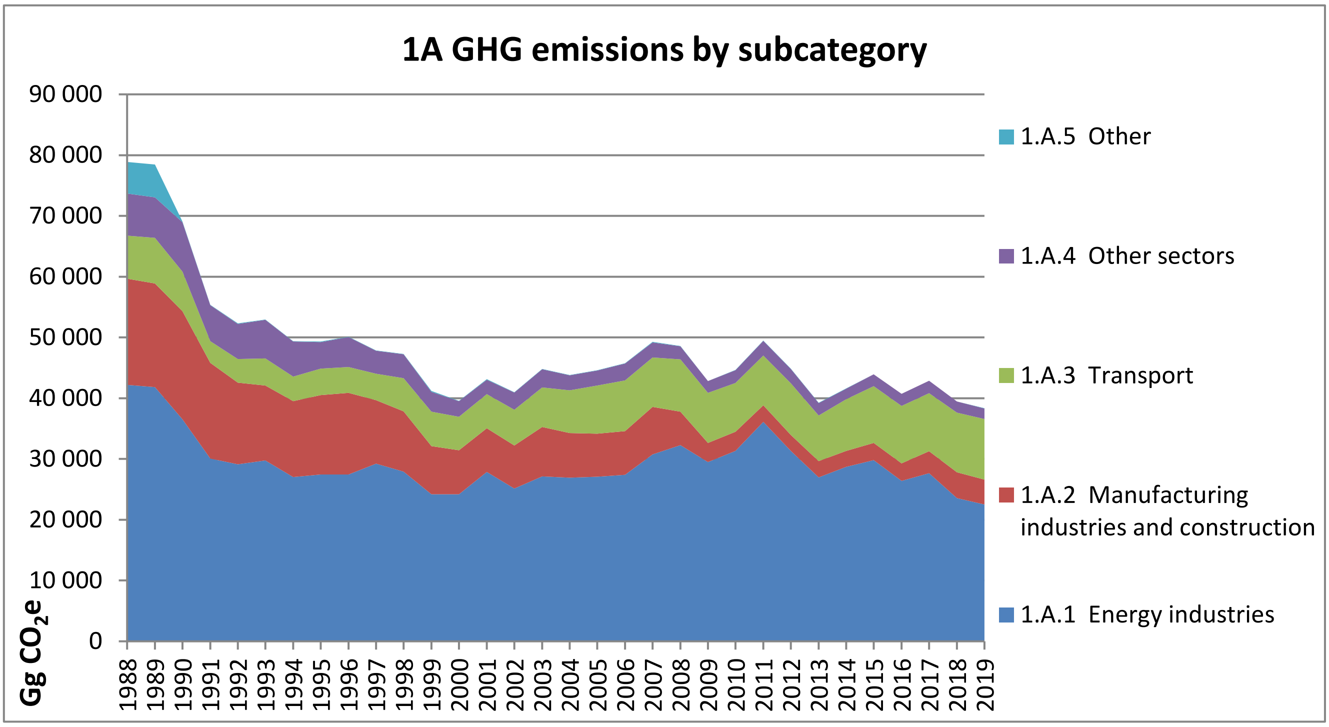

Figure 22 Total GHG emissions from Fuel combustion by subcategory

Energy Industries are the main source of GHG emissions from fuel combustion with 58.7% of the sector emissions for 2019. Transport is the second most important source with 26.0% of the sector emissions, followed by Manufacturing industries and construction with 10.7%.

The general trend shows a sharp drop in country emissions after 1990-1991 due to Bulgaria's transition from planned to market economy. The decrease of the GHG emissions continued until 1999, followed by a slow increase after 2000, when the national economy started to grow. In 2008-2009, due to the economic crisis, the emissions decreased again, approaching the 2000 levels. In 2010 and 2011 there was an increasing trend of the emissions, which was mostly due to the increase in fossil fuel energy production. In 2012 and 2013 there was a drop in country emissions, mostly due to decrease of fossil fuels used for electricity generation and an increase in renewable energy sources. The drop was partially compensated in 2014 and 2015 due to the increase of electricity exports and fuel consumption in Transport sector. In 2019 there is a decrease of the emissions from fuel combustion of 2.9% compared to 2018 which is due to the decrease of electricity production from fossil fuels.

Manufacturing industry and construction is the sector, which changed drastically – compared to 1988 the emissions decreased by 76.6% in 2019. The significant decrease of the emissions after 2008 is mostly due to the restructuring of the Iron and steel industry in Bulgaria. The closure of Bulgaria's biggest I&S plant, which was the only plant in the country operating coke ovens and blast furnaces, decreased significantly the emissions from solid fuels and the emissions from the industry subcategory in general, even though since 2015 the emissions from gaseous fuels started to increase. In 2018 there was a significant increase in the consumption of liquid and solid fuels in the chemical industry.

The trend for solid fuels was reversed in 2011 mostly due to the opening of a new coal power plant and the general increase of electricity production from lignite coal in the country. However, the reduced electricity exports and the increased renewable energy production (solar, wind and biomass) in 2012 and 2013 have led to a significant decrease of solid fuels usage and emissions, which was only partially compensated in the following years. In 2019 there was a significant increase of biomass used for electricity generation.

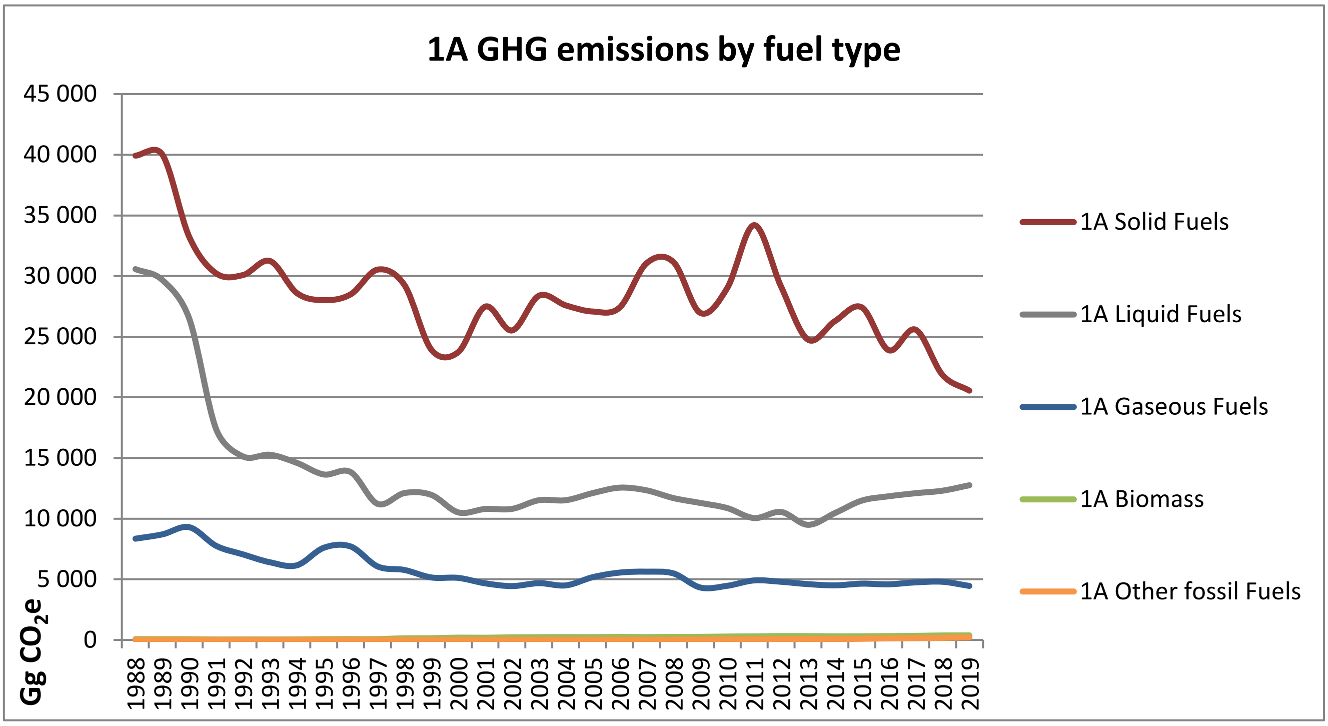

Figure 23 Total GHG emissions from Fuel combustion by fuel type

In 2019, 53.6% of the emissions from fuel combustion were from solid fuels, 33.2% were from liquid fuels, and 11.6% were from gaseous fuels.
The general trend shows a decrease in the share of solid fuels, mostly due to the energy industries reduced exports, increase in liquid and gaseous fuels due to the increase of transport and industry sectors, including of the on-going gasification of industrial plants, residential sector and transport.

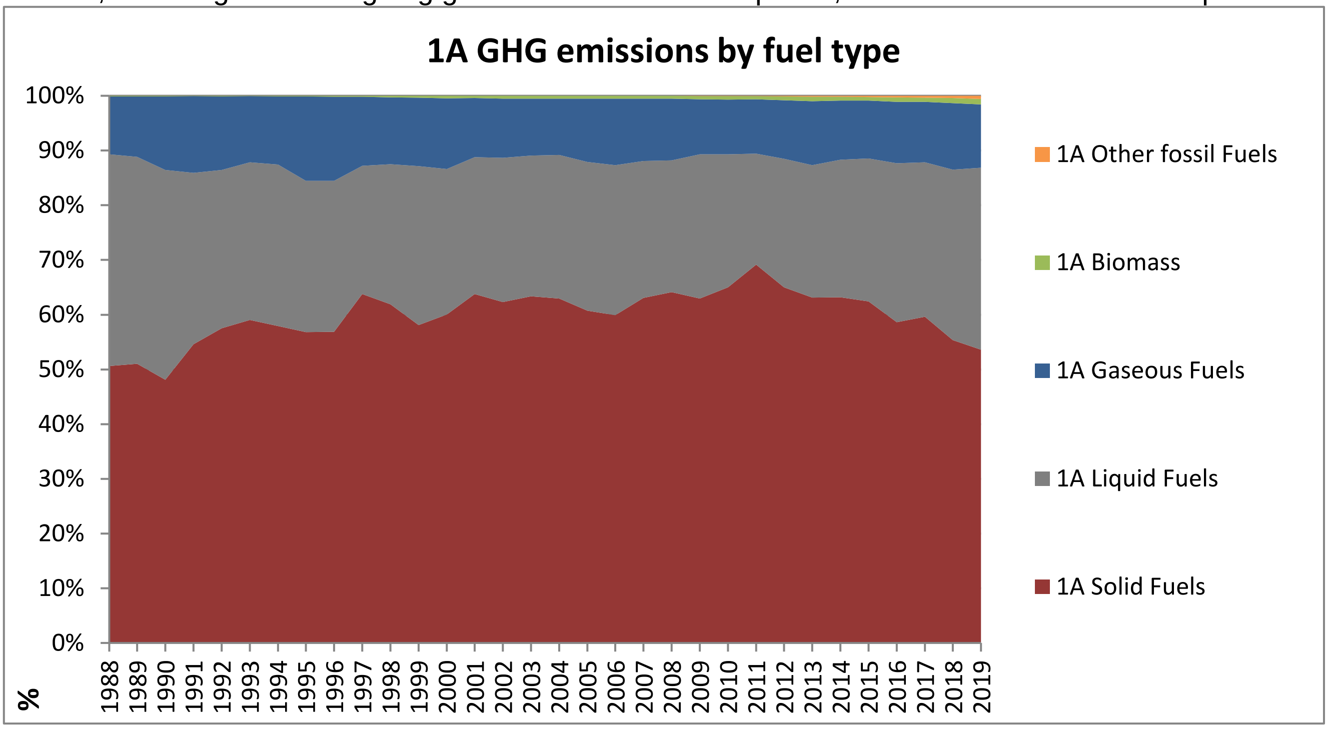

Figure 24 Total GHG emissions from Fuel combustion by fuel type

Table 30 CO_2 emissions in 1.A. Fuel Combustion

CO_2 (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	77 901.95	30 098.27	39 467.58	8 336.10	889.3920	NO
1990	68 148.36	26 010.68	32 856.19	9 281.48	808.7520	NO
1995	48 702.06	13 382.50	27 731.81	7 587.76	945.9520	NO

CO_2 (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2000	38 927.75	10 272.75	23 549.84	5 105.16	2 580.2560	NO
2005	43 890.19	11 846.25	26 878.52	5 162.62	3 262.2153	2.8073
2010	43 981.52	10 679.33	28 827.99	4 445.63	4 279.5976	28.5713
2011	48 750.74	9 859.39	33 972.88	4 889.51	4 542.2728	28.9598
2012	44 119.28	10 360.55	28 930.94	4 774.46	5 101.2902	53.3336
2013	38 564.30	9 325.99	24 589.36	4 578.78	5 285.1778	70.1757
2014	40 940.21	10 277.93	26 123.38	4 475.36	5 040.0624	63.5395
2015	43 250.13	11 295.02	27 254.76	4 614.34	5 395.9973	86.0053
2016	40 071.85	11 657.08	23 729.49	4 561.65	5 713.8040	123.6271
2017	42 188.48	11 912.25	25 414.03	4 721.65	5 794.3118	140.5558
2018	38 757.67	12 113.51	21 709.66	4 769.84	7 572.4857	164.6498
2019	37 624.69	12 558.09	20 425.25	4 423.92	8 135.1734	217.4251
Decrease 1988-2019	51.7%	58.3%	48.2%	46.9%	-814.7%	-
Decrease 1990-2019	44.8%	51.7%	37.8%	52.3%	-905.9%	-
Decrease 2018-2019	2.9%	-3.7%	5.9%	7.3%	-7.4%	-32.1%

Table 31 CH_4 emissions in 1.A. Fuel Combustion

CH_4 (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	18.3838	3.8112	12.0393	0.1510	2.3823	NO
1990	15.5278	3.8024	9.3878	0.1712	2.1663	NO
1995	11.4978	2.4389	6.7247	0.1408	2.1933	NO
2000	11.6059	1.6472	3.3707	0.0967	6.4913	NO
2005	12.8764	1.4410	3.4212	0.1463	7.8668	0.0010
2010	13.4746	1.1462	2.7783	0.2246	9.3149	0.0105
2011	14.4997	1.0352	3.4149	0.2380	9.8024	0.0093
2012	15.0200	1.0158	3.2582	0.2483	10.4829	0.0147
2013	14.0543	0.8788	2.7207	0.2616	10.1750	0.0181
2014	12.9661	0.9471	2.0056	0.2866	9.7088	0.0180
2015	13.0697	0.9702	2.0552	0.2903	9.7285	0.0255
2016	13.5502	0.9133	2.2399	0.2689	10.0861	0.0419
2017	14.2881	0.8416	2.3960	0.2682	10.7320	0.0504
2018	14.3096	0.7807	1.8221	0.2745	11.3707	0.0616
2019	14.1371	0.7598	1.6522	0.2791	11.3669	0.0790
Decrease 1988-2019	22.6%	80.0%	84.9%	-82.0%	-376.8%	-
Decrease 1990-2019	8.5%	79.9%	80.6%	-60.5%	-424.3%	-
Decrease 2018-2019	-0.1%	7.2%	24.0%	-2.4%	-5.8%	-18.0%

Table 32 N_2O emissions in 1.A. Fuel Combustion

N_2O (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1.8512	1.2306	0.5737	0.0151	0.0318	NO
1990	1.7549	1.2327	0.4765	0.0168	0.0289	NO
1995	1.1022	0.6541	0.4005	0.0137	0.0338	NO
2000	1.1033	0.6633	0.3386	0.0092	0.0922	NO
2005	1.2653	0.7440	0.3909	0.0137	0.1165	0.0001
2010	1.1342	0.5337	0.4218	0.0241	0.1530	0.0015

N_2O (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2011	1.2204	0.5339	0.4955	0.0275	0.1622	0.0013
2012	1.1750	0.5373	0.4201	0.0312	0.1839	0.0025
2013	1.0651	0.4749	0.3592	0.0360	0.1919	0.0031
2014	1.1200	0.5093	0.3821	0.0429	0.1827	0.0029
2015	1.1957	0.5517	0.3965	0.0454	0.1978	0.0041
2016	1.1351	0.5342	0.3449	0.0428	0.2067	0.0065
2017	1.1687	0.5348	0.3709	0.0450	0.2103	0.0077
2018	1.2177	0.5609	0.3246	0.0490	0.2741	0.0092
2019	1.2400	0.5806	0.2977	0.0544	0.2959	0.0113
Decrease 1988-2019	33.0%	52.8%	48.1%	-260.5%	-831.7%	-
Decrease 1990-2019	29.3%	52.9%	37.5%	-223.8%	-924.6%	-
Decrease 2018-2019	-1.8%	-3.5%	8.3%	-11.2%	-8.0%	-22.5%

Table 33 GHG emissions in 1.A. Fuel Combustion

GHG (Gg)	TJ	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	953 191.40	78 913.20	30 560.28	39 939.52	8 344.38	69.0232	NO
1990	853 611.67	69 059.52	26 473.10	33 232.88	9 290.77	62.7649	NO
1995	604 494.43	49 317.96	13 638.40	28 019.29	7 595.37	64.9009	NO
2000	490 854.61	39 546.68	10 511.60	23 735.00	5 110.34	189.7433	NO
2005	548 894.18	44 589.14	12 103.98	27 080.54	5 170.36	231.3895	2.8728
2010	545 121.31	44 656.37	10 867.04	29 023.14	4 458.42	278.4787	29.2919
2011	595 153.79	49 476.92	10 044.36	34 205.91	4 903.67	293.4069	29.5881
2012	555 094.15	44 844.92	10 546.08	29 137.57	4 789.97	316.8671	54.4356
2013	498 508.97	39 233.05	9 489.46	24 764.42	4 596.06	311.5513	71.5533
2014	521 910.56	41 598.12	10 453.37	26 287.39	4 495.32	297.1681	64.8667
2015	552 310.64	43 933.18	11 483.70	27 424.31	4 635.14	302.1530	87.8737
2016	526 208.69	40 748.87	11 839.12	23 888.25	4 581.15	313.7535	126.5995
2017	550 786.85	42 893.97	12 092.67	25 584.47	4 741.77	330.9576	144.1065
2018	539 103.95	39 478.28	12 300.17	21 851.94	4 791.30	365.9435	168.9361
2019	527 621.83	38 347.62	12 750.12	20 555.26	4 447.12	372.3630	222.7632
Decrease 1988-2019	44.7%	51.4%	58.3%	48.5%	46.7%	-439.5%	-
Decrease 1990-2019	38.2%	44.5%	51.8%	38.1%	52.1%	-493.3%	-
Decrease 2018-2019	2.2%	2.9%	-3.7%	5.9%	7.2%	-1.8%	-31.9%

3.3.10 ENERGY INDUSTRIES (CRF 1.A.1)

The fuel consumption in the following subcategories is included in this category:

- Conventional electricity, CHP and heat plants (public and autoproducers),
- Petroleum refining plants,
- Solid fuel transformation plants,
- Oil and gas extraction and coal mining,
- Own consumption of the energy sector.

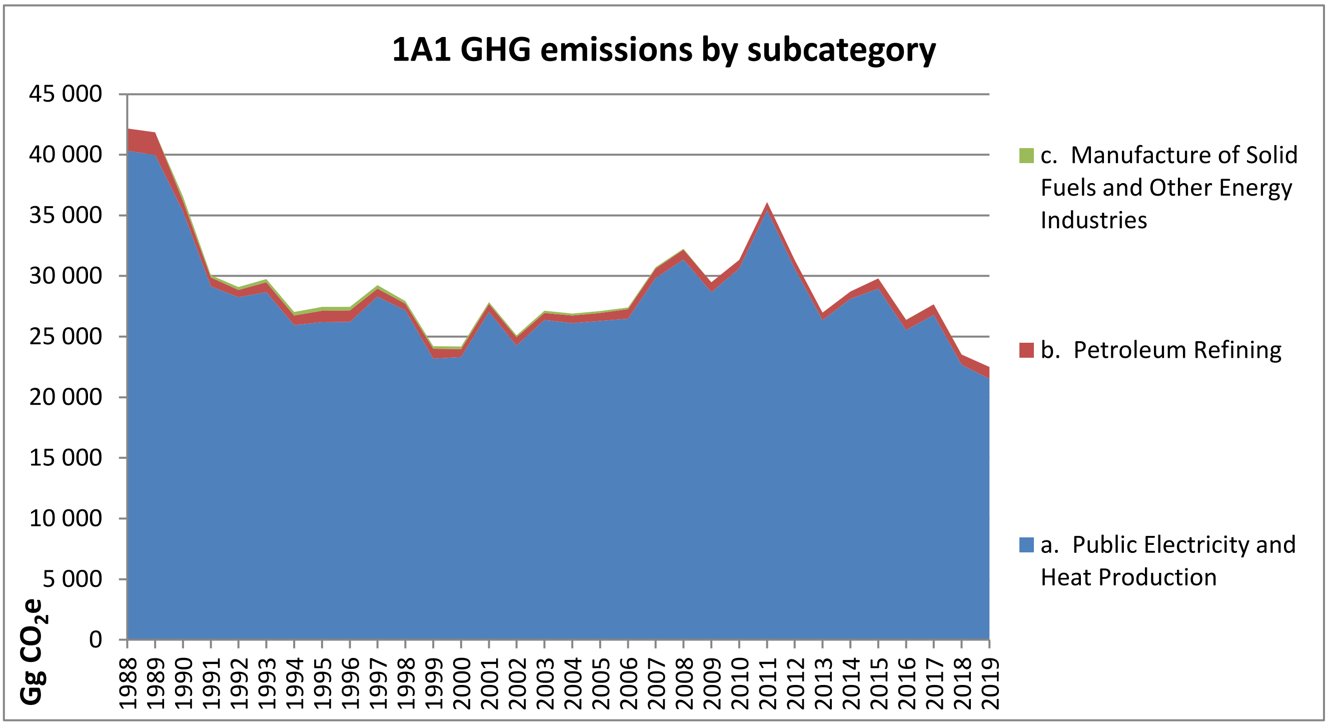

Figure 25 Total GHG emissions from 1.A.1 Energy industries by subcategory

For 2019 the general trend in CRF category 1.A.1 is a decrease in the emissions of 46.6% compared to base year and a decrease of 4.4% compared to last year.

3.3.10.1 Public Electricity and Heat Production (CRF 1.A.1.a)

Category 1.A.1.a Public Electricity and Heat Production covers emissions from fuel combustion in public power and heat plants.

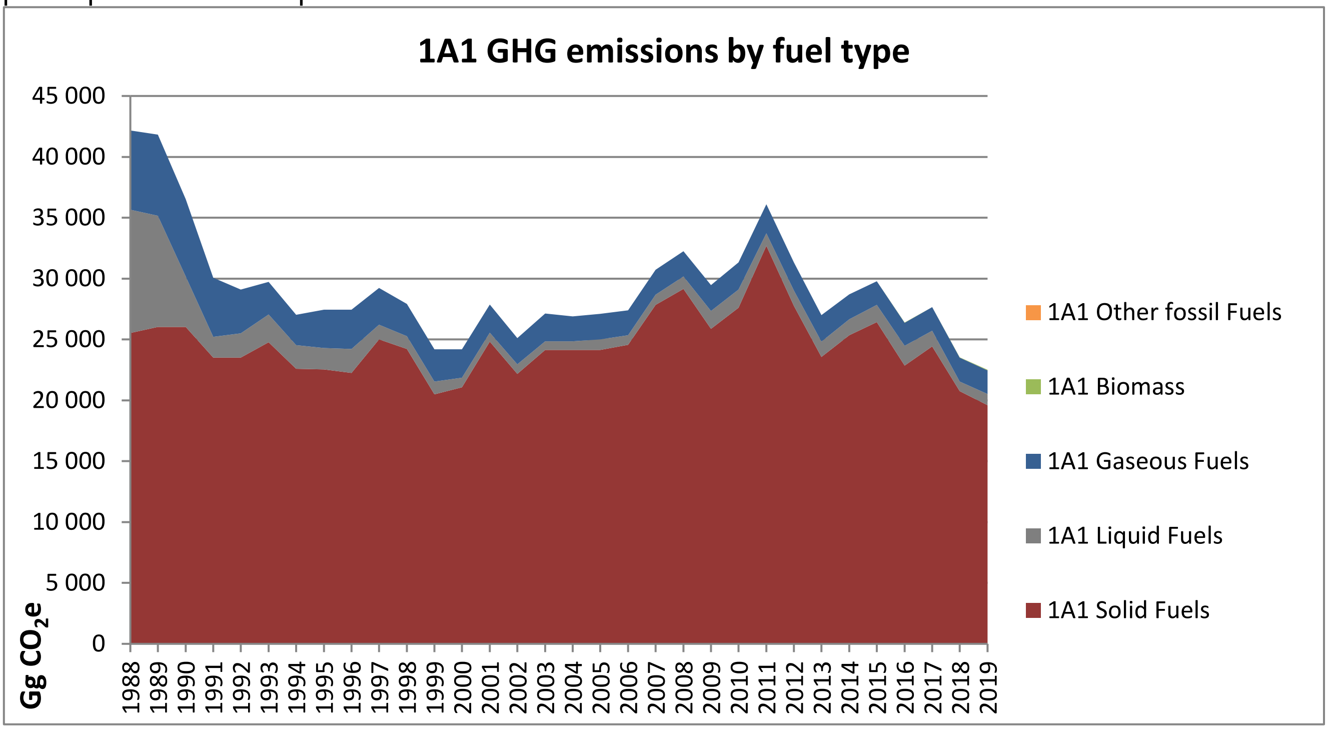

Figure 26 GHG emissions from 1.A.1.a Public Electricity and Heat Production

The share of CRF category 1.A.1.a from the total GHG emissions is 38.5% for the year 2019. The share of this subcategory from CRF category 1.A Fuel combustion is 56.1% for the year 2019. The decrease of the emissions from this subcategory is due to the decrease of electricity and heat production from combustible fuels caused by the reduction of electricity exports.

The consumption of liquid fuels in this subcategory results in a rather peculiar case study. Due to the relatively large past share of petroleum coke used in main activity producers of electricity, CHP and heat plants (in 2017 used petroleum coke was 145 Gg out of 167 Gg of total liquid fuels), the resulting implied emission factor for this subcategory seems higher than what is expected for liquid fuels. The country-specific CO_2 EF for petroleum coke varies in the range of 92-96 t/TJ, which is significantly higher than the average EF of liquid fuels (usually around 74-77 t/TJ). After 2017 petroleum coke consumption in main activity plants has decreased significantly, shifting mostly to autoproducer plants.

Table 34 CO_2 emissions in 1.A.1.a. Public Electricity and Heat Production

CO_2 (Gg)	CRF 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	40 166.76	8 241.55	25 416.61	6 508.60	NO	NO
1990	35 178.69	3 245.34	25 637.89	6 295.45	NO	NO
1995	26 070.04	901.28	22 197.91	2 970.85	0.1120	NO
2000	23 228.36	291.18	20 772.70	2 164.48	NO	NO
2005	26 174.65	335.05	23 885.03	1 954.57	NO	NO
2010	30 479.81	839.68	27 482.65	2 157.47	9.0720	NO
2011	35 265.22	423.28	32 557.09	2 284.85	30.4640	NO
2012	30 482.23	625.97	27 634.52	2 221.74	17.6960	NO
2013	26 226.64	668.32	23 449.64	2 108.69	19.0036	NO
2014	27 990.64	742.67	25 233.10	2 014.87	80.5434	NO
2015	28 834.16	663.76	26 313.81	1 856.60	84.4060	NO
2016	25 423.31	837.12	22 762.15	1 824.04	244.6836	NO
2017	26 677.87	498.46	24 314.03	1 865.38	175.8910	NO
2018	22 564.42	59.70	20 658.12	1 846.59	1 845.4130	NO
2019	21 392.89	48.72	19 504.59	1 839.57	2 295.7260	NO
Decrease 1988-2019	46.7%	99.4%	23.3%	71.7%	-	-
Decrease 1990-2019	39.2%	98.5%	23.9%	70.8%	-	-
Decrease 2018-2019	5.2%	18.4%	5.6%	0.4%	-24.4%	-

Table 35 CH_4 emissions in CRF 1.A.1.a. Public Electricity and Heat Production

CH_4 (Gg)	CRF 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.6820	0.3194	0.2446	0.1179	NO	NO
1990	0.4901	0.1259	0.2501	0.1140	NO	NO
1995	0.3038	0.0350	0.2149	0.0538	0.0000	NO
2000	0.2507	0.0113	0.2002	0.0392	NO	NO
2005	0.2794	0.0121	0.2319	0.0354	NO	NO
2010	0.3365	0.0278	0.2671	0.0391	0.0024	NO
2011	0.3792	0.0141	0.3156	0.0413	0.0082	NO
2012	0.3318	0.0200	0.2668	0.0402	0.0047	NO
2013	0.2917	0.0212	0.2277	0.0381	0.0047	NO
2014	0.3233	0.0236	0.2455	0.0363	0.0179	NO
2015	0.3260	0.0214	0.2545	0.0334	0.0168	NO
2016	0.3283	0.0269	0.2198	0.0328	0.0488	NO
2017	0.3166	0.0163	0.2354	0.0336	0.0312	NO
2018	0.7154	0.0023	0.2048	0.0332	0.4750	NO
2019	0.8178	0.0019	0.1884	0.0331	0.5944	NO
Decrease 1988-2019	-19.9%	99.4%	23.0%	71.9%	-	-
Decrease 1990-2019	-66.9%	98.5%	24.7%	71.0%	-	-
Decrease 2018-2019	-14.3%	18.5%	8.0%	0.4%	-25.1%	-

Table 36 N_2O emissions in 1.A.1.a. Public Electricity and Heat Production

N_2O (Gg)	CRF 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.4426	0.0639	0.3669	0.0118	NO	NO
1990	0.4118	0.0252	0.3752	0.0114	NO	NO
1995	0.3348	0.0070	0.3224	0.0054	0.0000	NO
2000	0.3065	0.0023	0.3003	0.0039	NO	NO
2005	0.3538	0.0024	0.3479	0.0035	NO	NO
2010	0.4104	0.0055	0.4007	0.0039	0.0003	NO
2011	0.4815	0.0028	0.4735	0.0041	0.0011	NO
2012	0.4087	0.0039	0.4002	0.0040	0.0006	NO
2013	0.3502	0.0042	0.3416	0.0038	0.0006	NO
2014	0.3790	0.0047	0.3683	0.0036	0.0024	NO
2015	0.3916	0.0043	0.3818	0.0033	0.0022	NO
2016	0.3449	0.0054	0.3297	0.0033	0.0065	NO
2017	0.3639	0.0033	0.3531	0.0034	0.0041	NO
2018	0.3743	0.0005	0.3073	0.0033	0.0633	NO
2019	0.3655	0.0004	0.2826	0.0033	0.0792	NO
Decrease 1988-2019	17.4%	99.4%	23.0%	71.9%	-	-
Decrease 1990-2019	11.2%	98.5%	24.7%	71.0%	-	-
Decrease 2018-2019	2.4%	18.5%	8.0%	0.4%	-25.2%	-

Table 37 GHG emissions in 1.A.1.a. Public Electricity and Heat Production

GHG (Gg)	TJ	CRF 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	469 001.13	40 315.71	8 268.58	25 532.07	6 515.06	NO	NO
1990	406 137.77	35 313.65	3 255.99	25 755.96	6 301.70	NO	NO
1995	280 421.90	26 177.41	904.24	22 299.36	2 973.80	0.0019	NO
2000	243 184.91	23 325.96	292.13	20 867.19	2 166.63	NO	NO
2005	271 362.80	26 287.08	336.08	23 994.50	1 956.51	NO	NO
2010	315 983.41	30 610.53	842.02	27 608.74	2 159.61	0.1573	NO
2011	362 152.24	35 418.18	424.46	32 706.07	2 287.11	0.5282	NO
2012	314 348.18	30 612.33	627.64	27 760.44	2 223.94	0.3068	NO
2013	273 486.45	26 338.29	670.09	23 557.11	2 110.78	0.3063	NO
2014	290 806.57	28 111.65	744.66	25 348.98	2 016.86	1.1566	NO
2015	296 000.38	28 959.02	665.57	26 433.94	1 858.43	1.0800	NO
2016	264 378.22	25 534.29	839.40	22 865.91	1 825.83	3.1491	NO
2017	276 636.17	26 794.22	499.84	24 425.15	1 867.22	2.0103	NO
2018	256 075.21	22 693.86	59.90	20 754.81	1 848.42	30.7334	NO
2019	243 305.23	21 522.25	48.88	19 593.52	1 841.39	38.4622	NO
Decrease 1988-2019	48.1%	46.6%	99.4%	23.3%	71.7%	-	-
Decrease 1990-2019	40.1%	39.1%	98.5%	23.9%	70.8%	-	-
Decrease 2018-2019	5.0%	5.2%	18.4%	5.6%	0.4%	-25.1%	-

3.3.10.2 Petroleum refining (CRF 1.A.1.b)

Category 1.A.1.b Petroleum refining covers emissions from fuel combustion in petroleum refineries, excluding the emissions from hydrogen production, which are reported as fugitive emissions.

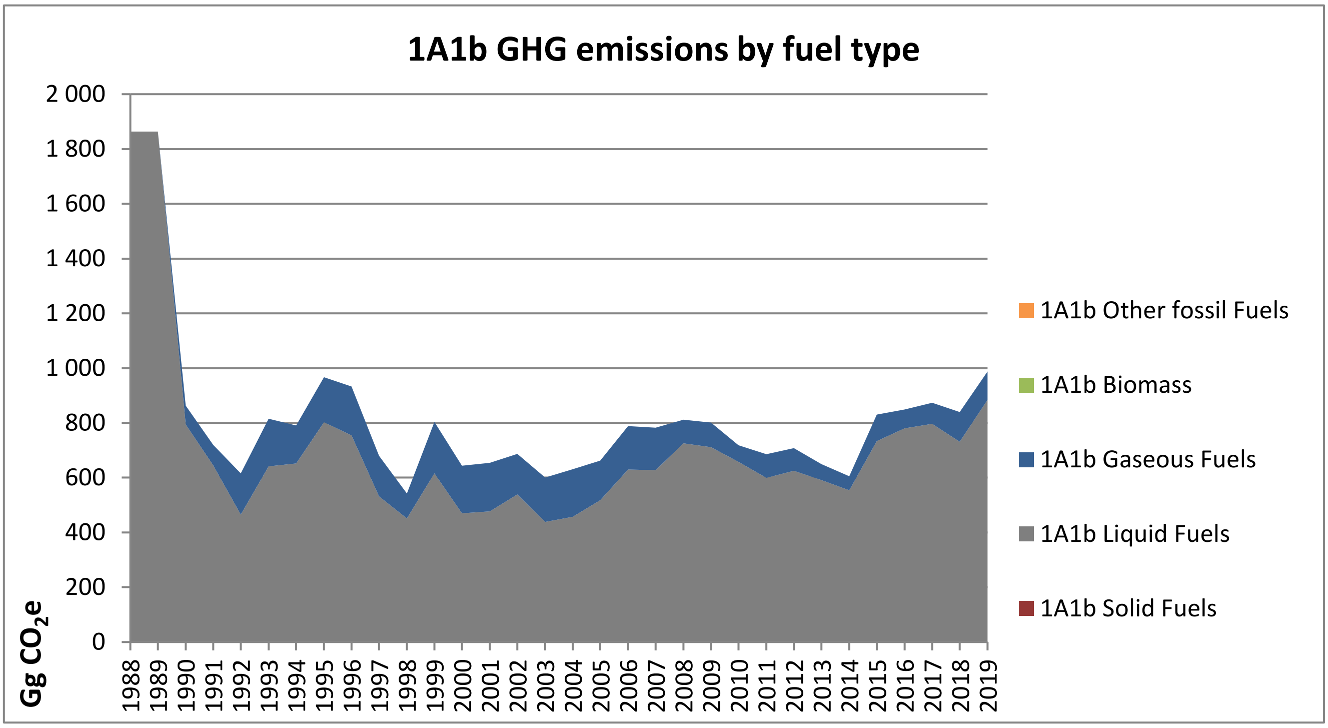

Figure 27 GHG emissions from CRF 1.A.1.b Petroleum refining

For the year 2019 the share of this subcategory from sector 1A Fuel Combustion is 2.6%, which is equivalent to 1.8% out of the total GHG emissions. Since 2015 there is a significant increase in the consumption of natural gas in this subcategory, which is reported as transformation activity in the energy balance. The increase is due to the recent opening of a new complex to process heavy residues at the biggest Bulgarian oil refinery, consisting of a main unit for hydrocracking of vacuum residue and a number of auxiliary units. The increase of emissions from liquid fuels in 2019 is due mostly to the increased use of refinery gas as refinery fuel.

Table 38 CO_2 emissions in CRF 1.A.1.b Petroleum refining

CO_2 (Gg)	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1 857.60	1 857.60	NO	NO	NO	NO
1990	861.38	792.72	NO	68.66	NO	NO
1995	964.41	800.35	NO	164.06	NO	NO
2000	642.16	469.01	NO	173.15	NO	NO
2005	661.60	517.07	NO	144.53	NO	NO
2010	716.93	657.07	NO	59.86	NO	NO
2011	684.45	598.75	NO	85.70	NO	NO
2012	706.79	624.67	NO	82.12	NO	NO
2013	648.63	590.72	NO	57.90	NO	NO
2014	604.76	553.42	NO	51.34	NO	NO
2015	829.49	732.41	NO	97.08	NO	NO
2016	848.53	778.83	NO	69.70	NO	NO
2017	872.87	795.80	NO	77.06	NO	NO
2018	839.13	729.83	NO	109.29	NO	NO
2019	986.68	883.69	NO	102.99	NO	NO
Decrease 1988-2019	46.9%	52.4%	-	-	-	-
Decrease 1990-2019	-14.5%	-11.5%	-	-50.0%	-	-
Decrease 2018-2019	-17.6%	-21.1%	-	5.8%	-	-

Table 39 CH_4 emissions in CRF 1.A.1.b Petroleum refining

CH_4 (Gg)	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0720	0.0720	NO	NO	NO	NO
1990	0.0223	0.0211	NO	0.0012	NO	NO
1995	0.0256	0.0226	NO	0.0030	NO	NO
2000	0.0164	0.0133	NO	0.0031	NO	NO
2005	0.0174	0.0148	NO	0.0026	NO	NO
2010	0.0152	0.0141	NO	0.0011	NO	NO
2011	0.0140	0.0124	NO	0.0016	NO	NO
2012	0.0145	0.0130	NO	0.0015	NO	NO
2013	0.0130	0.0119	NO	0.0010	NO	NO
2014	0.0117	0.0108	NO	0.0009	NO	NO
2015	0.0162	0.0145	NO	0.0017	NO	NO
2016	0.0165	0.0152	NO	0.0013	NO	NO
2017	0.0171	0.0157	NO	0.0014	NO	NO
2018	0.0159	0.0139	NO	0.0020	NO	NO
2019	0.0174	0.0155	NO	0.0019	NO	NO
Decrease 1988-2019	75.8%	78.4%	-	-	-	-
Decrease 1990-2019	21.9%	26.1%	-	-49.0%	-	-
Decrease 2018-2019	-9.6%	-11.8%	-	5.8%	-	-

Table 40 N_2O emissions in CRF 1.A.1.b Petroleum refining

N_2O (Gg)	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0144	0.0144	NO	NO	NO	NO
1990	0.0035	0.0034	NO	0.0001	NO	NO
1995	0.0041	0.0038	NO	0.0003	NO	NO
2000	0.0026	0.0023	NO	0.0003	NO	NO
2005	0.0027	0.0025	NO	0.0003	NO	NO
2010	0.0020	0.0019	NO	0.0001	NO	NO
2011	0.0017	0.0016	NO	0.0002	NO	NO
2012	0.0018	0.0017	NO	0.0001	NO	NO
2013	0.0016	0.0015	NO	0.0001	NO	NO
2014	0.0014	0.0013	NO	0.0001	NO	NO
2015	0.0019	0.0018	NO	0.0002	NO	NO
2016	0.0020	0.0018	NO	0.0001	NO	NO
2017	0.0021	0.0019	NO	0.0001	NO	NO
2018	0.0018	0.0016	NO	0.0002	NO	NO
2019	0.0018	0.0016	NO	0.0002	NO	NO
Decrease 1988-2019	87.7%	89.0%	-	-	-	-
Decrease 1990-2019	50.0%	53.6%	-	-49.0%	-	-
Decrease 2018-2019	1.9%	1.4%	-	5.8%	-	-

Table 41 GHG emissions in CRF 1.A.1.b Petroleum refining

GHG (Gg)	TJ	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	24 000.00	1 863.69	1 863.69	NO	NO	NO	NO
1990	13 493.80	863.00	794.27	NO	68.73	NO	NO
1995	15 051.80	966.28	802.06	NO	164.22	NO	NO
2000	10 206.50	643.34	470.02	NO	173.32	NO	NO

GHG (Gg)	TJ	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2005	10 679.95	662.85	518.18	NO	144.67	NO	NO
2010	12 061.03	717.90	657.98	NO	59.92	NO	NO
2011	11 623.22	685.32	599.53	NO	85.78	NO	NO
2012	11 922.62	707.70	625.50	NO	82.20	NO	NO
2013	10 957.69	649.43	591.47	NO	57.96	NO	NO
2014	10 286.56	605.46	554.07	NO	51.39	NO	NO
2015	14 089.36	830.48	733.30	NO	97.17	NO	NO
2016	14 416.58	849.52	779.75	NO	69.77	NO	NO
2017	14 807.18	873.91	796.77	NO	77.14	NO	NO
2018	14 382.69	840.06	730.66	NO	109.40	NO	NO
2019	17 159.19	987.64	884.56	NO	103.09	NO	NO
Decrease 1988-2019	28.5%	47.0%	52.5%	-	-	-	-
Decrease 1990-2019	-27.2%	-14.4%	-11.4%	-	-50.0%	-	-
Decrease 2018-2019	-19.3%	-17.6%	-21.1%	-	5.8%	-	-

3.3.10.2.1 Source-specific recalculations, including changes made in response to the review process

Following recommendations FCCC/ARR/2016/BGR E.8 and FCCC/ARR/2016/BGR E.9 were introduced several changes in the 2019 submission. As petroleum coke is combusted in order to restore the catalyst's activity and not for energy purposes, all GHG emissions from petroleum coke, which were previously reported under CRF subcategory 1.A.1.b were reallocated under CRF subcategory 1.B.2.a.4. Similarly, the GHG emissions from hydrogen production, which were previously reported under CRF subcategory 1.A.1.b were reallocated under CRF subcategory 1.B.2.c.2.i.

3.3.10.3 Manufacture of Solid Fuels and Other Energy Industries (CRF 1.A.1.c.)

Category 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries covers emissions from fuel combustion in Coal Mines, Patent Fuel Plants (Energy), Coke Ovens (Energy) and BKB Plants (Energy).

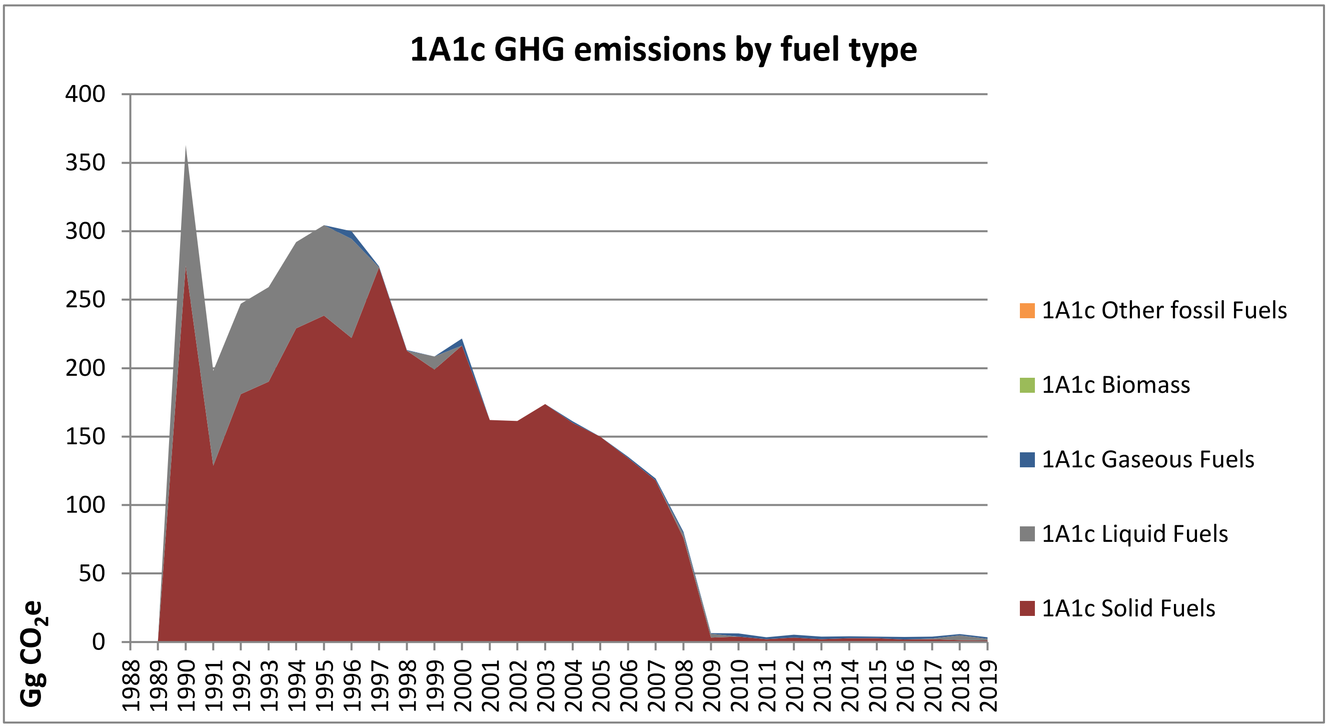

Figure 28 GHG emissions from 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

This sector has shrunk drastically due to the closure of the only I&S plant in Bulgaria, which was operating coke ovens. The category is currently responsible for 0.01% of the emissions from fuel combustion. The closure resulted also in a change in the fuel mix used in this category – from mostly coke oven gas used in coke ovens in the past years, it has now shifted to small quantities of natural gas.

Table 42 CO_2 emissions in CRF 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

CO_2 (Gg)	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1990	362.22	87.76	274.45	NO	NO	NO
1995	303.77	65.82	237.95	NO	NO	NO
2000	221.32	NO	216.06	5.27	NO	NO
2005	149.79	NO	149.79	NO	0.1120	NO
2010	6.11	NO	3.97	2.14	NO	NO
2011	3.35	NO	2.01	1.34	NO	NO
2012	5.26	NO	3.17	2.09	NO	NO
2013	3.93	NO	1.98	1.94	NO	NO
2014	4.07	NO	2.62	1.45	NO	NO
2015	3.93	NO	2.73	1.20	NO	NO
2016	3.70	NO	1.85	1.85	NO	NO
2017	3.85	0.59	1.95	1.31	NO	NO
2018	5.69	3.37	1.39	0.94	NO	NO
2019	3.51	1.16	1.09	1.25	NO	NO
Decrease 1988-2019	-	-	-	-	-	-
Decrease 1990-2019	99.0%	98.7%	99.6%	-	-	-
Decrease 2018-2019	38.4%	65.4%	21.4%	-33.6%	-	-

Table 43 CH_4 emissions in CRF 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

CH_4 (Gg)	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1990	0.0094	0.0036	0.0058	NO	NO	NO
1995	0.0077	0.0027	0.0050	NO	NO	NO
2000	0.0045	NO	0.0045	0.0001	NO	NO
2005	0.0033	NO	0.0033	NO	0.0000	NO
2010	0.0001	NO	0.0000	0.0000	NO	NO
2011	0.0000	NO	0.0000	0.0000	NO	NO
2012	0.0001	NO	0.0000	0.0000	NO	NO
2013	0.0001	NO	0.0000	0.0000	NO	NO
2014	0.0001	NO	0.0000	0.0000	NO	NO
2015	0.0000	NO	0.0000	0.0000	NO	NO
2016	0.0001	NO	0.0000	0.0000	NO	NO
2017	0.0001	0.0000	0.0000	0.0000	NO	NO
2018	0.0002	0.0001	0.0000	0.0000	NO	NO
2019	0.0001	0.0000	0.0000	0.0000	NO	NO
Decrease 1988-2019	-	-	-	-	-	-
Decrease 1990-2019	99.3%	99.0%	99.8%	-	-	-
Decrease 2018-2019	56.3%	72.2%	22.8%	-33.5%	-	-

Table 44 N_2O emissions in CRF 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

N_2O (Gg)	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1990	0.0017	0.0007	0.0010	NO	NO	NO
1995	0.0014	0.0005	0.0009	NO	NO	NO
2000	0.0009	NO	0.0009	0.0000	NO	NO
2005	0.0004	NO	0.0004	NO	0.0000	NO
2010	0.0001	NO	0.0001	0.0000	NO	NO
2011	0.0000	NO	0.0000	0.0000	NO	NO
2012	0.0001	NO	0.0000	0.0000	NO	NO
2013	0.0000	NO	0.0000	0.0000	NO	NO
2014	0.0000	NO	0.0000	0.0000	NO	NO
2015	0.0000	NO	0.0000	0.0000	NO	NO
2016	0.0000	NO	0.0000	0.0000	NO	NO
2017	0.0000	0.0000	0.0000	0.0000	NO	NO
2018	0.0000	0.0000	0.0000	0.0000	NO	NO
2019	0.0000	0.0000	0.0000	0.0000	NO	NO
Decrease 1988-2019	-	-	-	-	-	-
Decrease 1990-2019	98.5%	99.1%	98.3%	-	-	-
Decrease 2018-2019	47.6%	74.7%	22.8%	-33.5%	-	-

Table 45 GHG emissions in 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

GHG (Gg)	TJ	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO	NO
1990	6 985.19	362.95	88.06	274.89	NO	NO	NO
1995	5 928.39	304.38	66.05	238.34	NO	NO	NO
2000	4 549.15	221.70	NO	216.43	5.27	NO	NO
2005	3 269.80	150.00	NO	150.00	NO	0.0019	NO
2010	78.26	6.13	NO	3.99	2.14	NO	NO
2011	44.36	3.36	NO	2.02	1.34	NO	NO
2012	69.77	5.28	NO	3.19	2.09	NO	NO
2013	55.45	3.94	NO	1.99	1.95	NO	NO
2014	51.97	4.08	NO	2.63	1.45	NO	NO
2015	48.65	3.95	NO	2.74	1.20	NO	NO
2016	51.75	3.71	NO	1.86	1.85	NO	NO
2017	51.78	3.86	0.59	1.96	1.31	NO	NO
2018	77.38	5.71	3.38	1.40	0.94	NO	NO
2019	50.23	3.52	1.17	1.10	1.25	NO	NO
Decrease 1988-2019	-	-	-	-	-	-	-
Decrease 1990-2019	99.3%	99.0%	98.7%	99.6%	-	-	-
Decrease 2018-2019	35.1%	38.4%	65.4%	21.4%	-33.6%	-	-

3.3.11 MANUFACTURING INDUSTRIES AND CONSTRUCTION (1.A.2)

Sub-sector Manufacturing Industries and Construction includes the following groups:

- Iron and steel (CRF 1.A.2.a);
- Non-ferrous metals (CRF 1.A.2.b);
- Chemicals (CRF 1.A.2.c);
- Pulp, paper and print (CRF 1.A.2.d);
- Food processing, beverages and tobacco (CRF 1.A.2.e);
- Non-metallic minerals (CRF 1.A.2.f);
- Other (CRF 1.A.2.g).

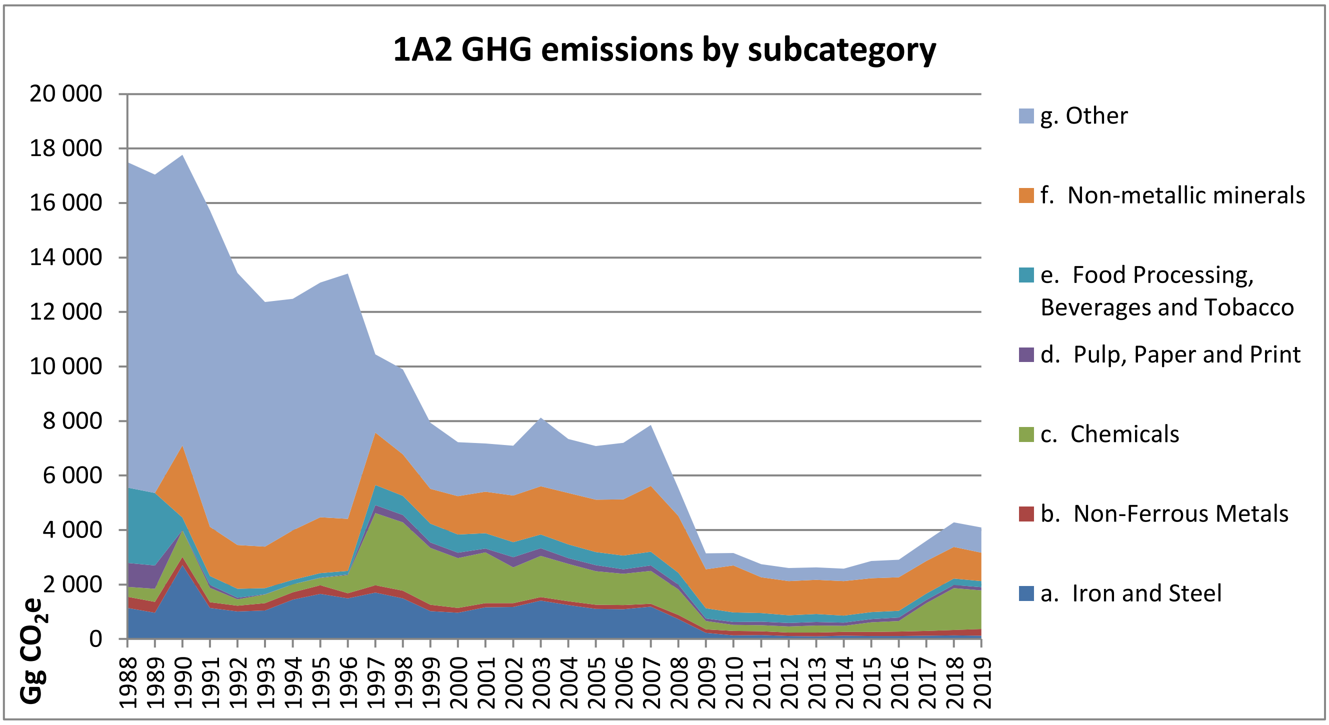

Figure 29 Total GHG emissions from 1.A.2 Manufacturing Industries and Construction by subcategory

Following the restructuring of the industry sector of the country, the general trend in CRF category 1.A.2 shows an emission decrease of 76.6% compared to base year and an increase of 4.2% compared to last year. Almost all subcategories within the industry sector are decreasing steadily until 2009, maintaining the same level afterwards, with the exception of the chemical industry, which is steadily increasing between 2015 and 2018, and decreasing since last year.

3.3.11.1 Iron and Steel (CRF 1.A.2.a.)

Category 1.A.2.a. Iron and Steel covers emissions from fuel combustion in Iron and steel industry.

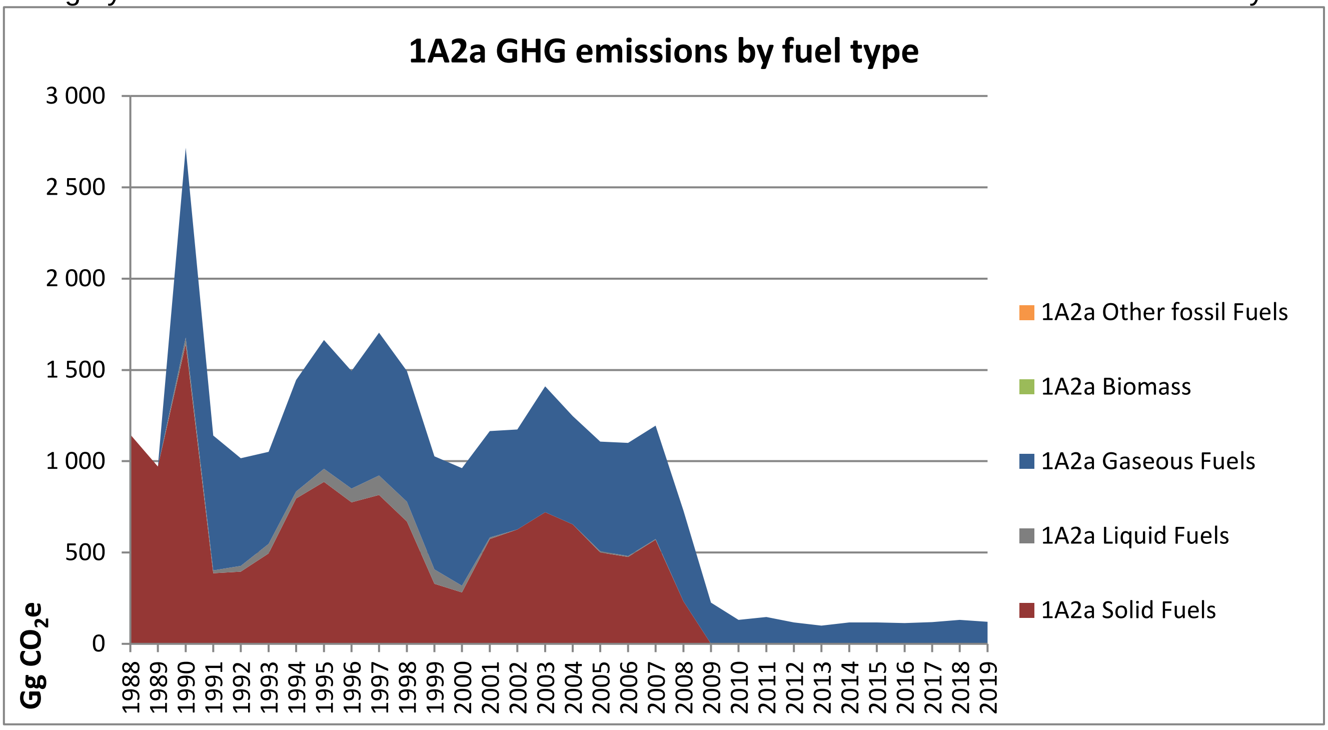

Figure 30 GHG emissions from 1.A.2.a. Iron and Steel

For the year 2019 the share of this subcategory from sector 1A Fuel Combustion is 0.3%, which is equivalent to 0.2% out of the total GHG emissions. The drastic decrease in the emissions since 2009 in this subcategory is due to the closure of the biggest iron and steel plant in Bulgaria at the end of 2008.

Table 46 CO_2 emissions in CRF 1.A.2.a. Iron and Steel

CO_2 (Gg)	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1 141.10	NO	1 141.10	NO	NO	NO
1990	2 705.22	37.34	1 630.87	1 037.00	NO	NO
1995	1 656.97	71.55	881.59	703.82	0.3360	NO
2000	959.19	37.19	279.04	642.96	0.3360	NO
2005	1 103.07	6.24	496.80	600.03	0.5600	NO
2010	130.95	NO	NO	130.95	0.2240	NO
2011	146.08	NO	NO	146.08	0.2240	NO
2012	116.25	NO	NO	116.25	NO	NO
2013	99.01	NO	NO	99.01	0.1120	NO
2014	117.39	NO	NO	117.39	NO	NO
2015	115.80	NO	NO	115.80	NO	NO
2016	113.61	NO	NO	113.61	0.2240	NO
2017	118.61	0.79	0.24	117.58	0.1718	NO
2018	129.70	0.65	0.09	128.95	0.0887	NO
2019	120.87	0.56	0.09	120.21	0.1449	NO
Decrease 1988-2019	89.4%	-	100.0%	-	-	-
Decrease 1990-2019	95.5%	98.5%	100.0%	88.4%	-	-
Decrease 2018-2019	6.8%	13.7%	6.5%	6.8%	-63.4%	-

Table 47 CH_4 emissions in CRF 1.A.2.a. Iron and Steel

CH_4 (Gg)	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0758	NO	0.0758	NO	NO	NO
1990	0.1680	0.0015	0.1477	0.0188	NO	NO
1995	0.0919	0.0028	0.0762	0.0127	0.0001	NO
2000	0.0332	0.0014	0.0200	0.0116	0.0001	NO
2005	0.0553	0.0003	0.0440	0.0109	0.0002	NO
2010	0.0024	NO	NO	0.0024	0.0001	NO
2011	0.0027	NO	NO	0.0026	0.0001	NO
2012	0.0021	NO	NO	0.0021	NO	NO
2013	0.0018	NO	NO	0.0018	0.0000	NO
2014	0.0021	NO	NO	0.0021	NO	NO
2015	0.0021	NO	NO	0.0021	NO	NO
2016	0.0021	NO	NO	0.0020	0.0001	NO
2017	0.0022	0.0000	0.0000	0.0021	0.0000	NO
2018	0.0024	0.0000	0.0000	0.0023	0.0000	NO
2019	0.0022	0.0000	0.0000	0.0022	0.0000	NO
Decrease 1988-2019	97.1%	-	100.0%	-	-	-
Decrease 1990-2019	98.7%	99.2%	100.0%	88.5%	-	-
Decrease 2018-2019	6.2%	23.3%	6.5%	6.8%	-63.4%	-

Table 48 N_2O emissions in CRF 1.A.2.a. Iron and Steel

N_2O (Gg)	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0109	NO	0.0109	NO	NO	NO
1990	0.0242	0.0003	0.0221	0.0019	NO	NO
1995	0.0132	0.0006	0.0113	0.0013	0.0000	NO
2000	0.0043	0.0003	0.0029	0.0012	0.0000	NO
2005	0.0077	0.0001	0.0065	0.0011	0.0000	NO
2010	0.0002	NO	NO	0.0002	0.0000	NO
2011	0.0003	NO	NO	0.0003	0.0000	NO
2012	0.0002	NO	NO	0.0002	NO	NO
2013	0.0002	NO	NO	0.0002	0.0000	NO
2014	0.0002	NO	NO	0.0002	NO	NO
2015	0.0002	NO	NO	0.0002	NO	NO
2016	0.0002	NO	NO	0.0002	0.0000	NO
2017	0.0002	0.0000	0.0000	0.0002	0.0000	NO
2018	0.0002	0.0000	0.0000	0.0002	0.0000	NO
2019	0.0002	0.0000	0.0000	0.0002	0.0000	NO
Decrease 1988-2019	97.9%	-	100.0%	-	-	-
Decrease 1990-2019	99.1%	99.5%	100.0%	88.5%	-	-
Decrease 2018-2019	6.1%	30.8%	6.5%	6.8%	-63.4%	-

Table 49 GHG emissions in CRF 1.A.2.a. Iron and Steel

GHG (Gg)	TJ	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	16 396.80	1 146.24	NO	1 146.24	NO	NO	NO
1990	35 474.30	2 716.64	37.47	1 641.14	1 038.03	NO	NO
1995	23 228.68	1 663.19	71.79	886.87	704.52	0.0058	NO
2000	16 535.12	961.32	37.31	280.40	643.60	0.0058	NO
2005	16 753.11	1 106.74	6.26	499.85	600.63	0.0097	NO
2010	2 372.60	131.09	NO	NO	131.08	0.0039	NO
2011	2 645.30	146.22	NO	NO	146.22	0.0039	NO
2012	2 106.00	116.36	NO	NO	116.36	NO	NO
2013	1 789.30	99.11	NO	NO	99.11	0.0019	NO
2014	2 117.70	117.51	NO	NO	117.51	NO	NO
2015	2 081.70	115.91	NO	NO	115.91	NO	NO
2016	2 044.10	113.73	NO	NO	113.73	0.0039	NO
2017	2 134.99	118.73	0.79	0.25	117.70	0.0030	NO
2018	2 333.44	129.83	0.65	0.10	129.08	0.0015	NO
2019	2 174.36	120.99	0.56	0.09	120.33	0.0025	NO
Decrease 1988-2019	86.7%	89.4%	-	100.0%	-	-	-
Decrease 1990-2019	93.9%	95.5%	98.5%	100.0%	88.4%	-	-
Decrease 2018-2019	6.8%	6.8%	13.7%	6.5%	6.8%	-63.4%	-

3.3.11.1.1 Source-specific recalculations, including changes made in response to the review process

In 2012 after a discussion regarding the non-energy use of Coke Oven Coke in the iron and steel industry, the National Statistics Institute initiated talks with the plant operators in order to clarify the

situation, which led to the revision of the national energy balances. The quantities of Coke Oven Coke, which were previously reported under energy use are now accounted as non-energy use.
In addition, following the recommendation of the Technical review of GHG inventories under the EU Effort Sharing Decision (ESD) in 2012, we revised the methodology concerning Iron & Steel sector in order to remove the double counting with the IP sector. The quantities of coke oven gas reported under blast furnaces; blast furnace gas reported under blast furnaces, autoproducers and Iron and Steel; coke oven coke in blast furnaces were disregarded from the Energy sector.

3.3.11.2 Non-Ferrous Metals (CRF 1.A.2.b.)

Category 1.A.2.b Non-Ferrous Metals enfolds emissions from fuel combustion in non-ferrous metal industry.

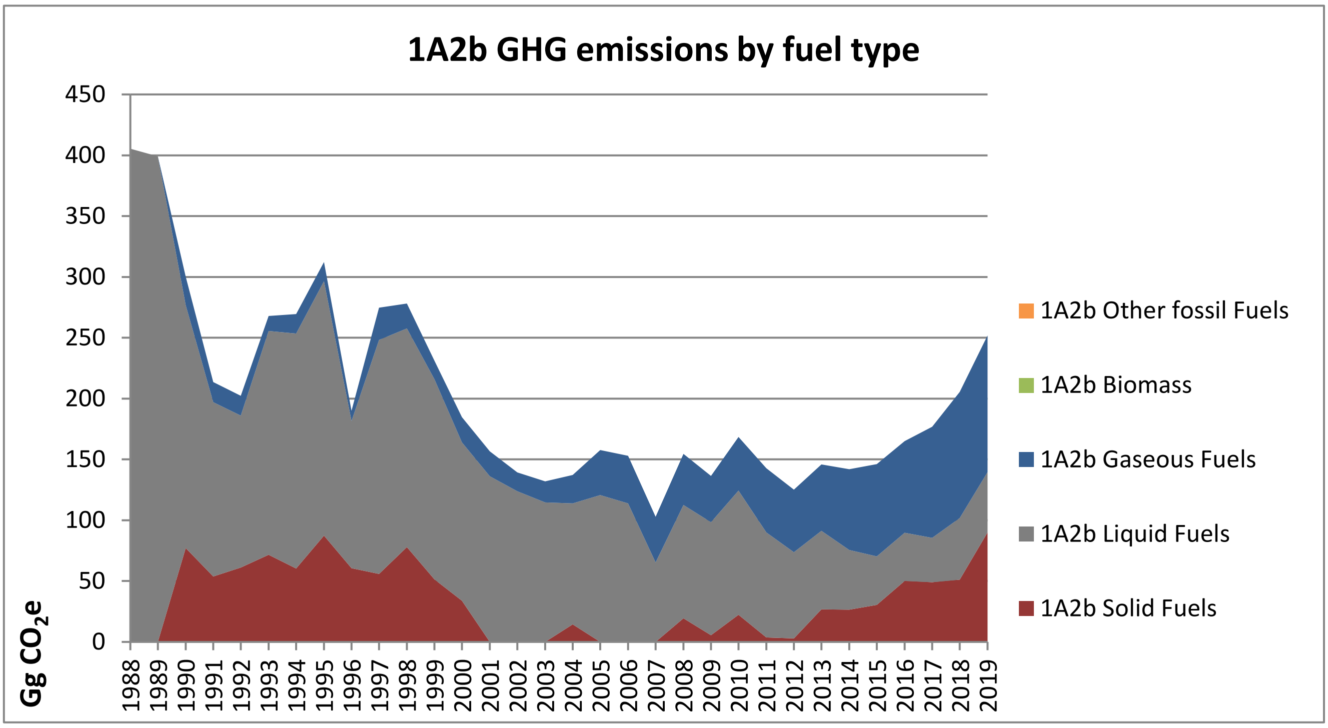

Figure 31 GHG emissions from CRF 1.A.2.b. Non-Ferrous Metals

The share of this subcategory from sector 1.A is 0.7% for the year 2019, which is equivalent to 0.5% of the total GHG emissions.

Table 50 CO_2 emissions in CRF 1.A.2.b. Non-Ferrous Metals

CO_2 (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	404.06	404.06	NO	NO	NO	NO
1990	299.16	199.30	76.46	23.40	NO	NO
1995	310.99	208.43	86.86	15.70	1.9040	NO
2000	183.95	129.65	33.58	20.72	0.2240	NO
2005	157.17	120.36	NO	36.82	NO	NO
2010	167.92	101.63	22.20	44.10	0.1120	NO
2011	142.40	86.15	3.43	52.82	NO	NO
2012	124.92	70.67	2.73	51.52	NO	NO
2013	145.51	64.44	26.41	54.66	NO	NO
2014	141.66	48.99	26.31	66.36	NO	NO
2015	145.85	39.67	30.28	75.90	NO	NO
2016	164.50	39.67	49.72	75.11	NO	NO
2017	176.23	36.45	48.60	91.18	NO	NO
2018	204.98	50.59	50.80	103.60	NO	NO
2019	251.18	49.40	89.38	112.41	0.0448	NO
Decrease	37.8%	87.8%	-	-	-	-

CO_2 (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988-2019						
Decrease 1990-2019	16.0%	75.2%	-16.9%	-380.4%	-	-
Decrease 2018-2019	-22.5%	2.3%	-75.9%	-8.5%	-	-

Table 51 CH_4 emissions in CRF 1.A.2.b. Non-Ferrous Metals

CH_4 (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0158	0.0158	NO	NO	NO	NO
1990	0.0155	0.0079	0.0072	0.0004	NO	NO
1995	0.0172	0.0082	0.0082	0.0003	0.0005	NO
2000	0.0085	0.0049	0.0031	0.0004	0.0001	NO
2005	0.0052	0.0045	NO	0.0007	NO	NO
2010	0.0066	0.0037	0.0021	0.0008	0.0000	NO
2011	0.0044	0.0031	0.0003	0.0010	NO	NO
2012	0.0037	0.0025	0.0003	0.0009	NO	NO
2013	0.0058	0.0023	0.0025	0.0010	NO	NO
2014	0.0054	0.0017	0.0025	0.0012	NO	NO
2015	0.0055	0.0013	0.0028	0.0014	NO	NO
2016	0.0073	0.0013	0.0046	0.0014	NO	NO
2017	0.0074	0.0012	0.0045	0.0016	NO	NO
2018	0.0083	0.0017	0.0047	0.0019	NO	NO
2019	0.0121	0.0017	0.0084	0.0020	0.0000	NO
Decrease 1988-2019	23.6%	89.3%	-	-	-	-
Decrease 1990-2019	22.3%	78.6%	-15.7%	-377.2%	-	-
Decrease 2018-2019	-45.9%	-1.4%	-75.9%	-8.5%	-	-

Table 52 N_2O emissions in CRF 1.A.2.b. Non-Ferrous Metals

N_2O (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0032	0.0032	NO	NO	NO	NO
1990	0.0027	0.0016	0.0011	0.0000	NO	NO
1995	0.0030	0.0016	0.0012	0.0000	0.0001	NO
2000	0.0015	0.0010	0.0005	0.0000	0.0000	NO
2005	0.0010	0.0009	NO	0.0001	NO	NO
2010	0.0011	0.0007	0.0003	0.0001	0.0000	NO
2011	0.0008	0.0006	0.0000	0.0001	NO	NO
2012	0.0006	0.0005	0.0000	0.0001	NO	NO
2013	0.0009	0.0004	0.0004	0.0001	NO	NO
2014	0.0008	0.0003	0.0004	0.0001	NO	NO
2015	0.0008	0.0003	0.0004	0.0001	NO	NO
2016	0.0011	0.0003	0.0007	0.0001	NO	NO
2017	0.0011	0.0002	0.0007	0.0002	NO	NO
2018	0.0012	0.0003	0.0007	0.0002	NO	NO
2019	0.0018	0.0003	0.0013	0.0002	0.0000	NO
Decrease 1988-2019	43.7%	89.8%	-	-	-	-
Decrease 1990-2019	34.1%	79.5%	-15.7%	-377.2%	-	-
Decrease 2018-2019	-46.8%	-3.1%	-75.9%	-8.5%	-	-

Table 53 GHG emissions in CRF 1.A.2.b. Non-Ferrous Metals

GHG (Gg)	TJ	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	5 267.60	405.39	405.39	NO	NO	NO	NO
1990	3 774.83	300.35	199.96	76.97	23.42	NO	NO
1995	3 876.91	312.30	209.12	87.43	15.72	0.0330	NO
2000	2 383.18	184.60	130.06	33.80	20.74	0.0039	NO
2005	2 238.90	157.59	120.74	NO	36.85	NO	NO
2010	2 347.07	168.43	101.94	22.34	44.14	0.0019	NO
2011	2 128.19	142.74	86.41	3.46	52.87	NO	NO
2012	1 899.14	125.20	70.88	2.75	51.57	NO	NO
2013	2 092.11	145.92	64.63	26.58	54.72	NO	NO
2014	2 103.23	142.04	49.13	26.49	66.42	NO	NO
2015	2 185.40	146.23	39.78	30.48	75.97	NO	NO
2016	2 352.66	165.00	39.78	50.04	75.18	NO	NO
2017	2 590.59	176.74	36.55	48.92	91.28	NO	NO
2018	3 021.83	205.55	50.72	51.13	103.70	NO	NO
2019	3 514.94	252.02	49.54	89.96	112.52	0.0008	NO
Decrease 1988-2019	33.3%	37.8%	87.8%	-	-	-	-
Decrease 1990-2019	6.9%	16.1%	75.2%	-16.9%	-380.4%	-	-
Decrease 2018-2019	-16.3%	-22.6%	2.3%	-75.9%	-8.5%	-	-

3.3.11.2.1 Source-specific recalculations, including changes made in response to the review process

Since the National Energy Balances do not report any non-energy use of coke oven coke for the period before 2007, a methodology for allocation of energy and non-energy use of coke oven coke in the non-ferrous sector was adopted, resulting in reallocation of a significant part of previously reported emissions to subcategory 2C. In order to avoid double counting with the IP sector, the calculated quantities of coke oven coke used for the production of lead and zinc are subtracted from the total quantities reported in the National Energy Balance, with the remainder considered to be energy use.

3.3.11.3 Chemicals (CRF 1.A.2.c.)

Category 1.A.2.c Chemicals enfolds emissions from fuel combustion in chemical and petrochemical industries.

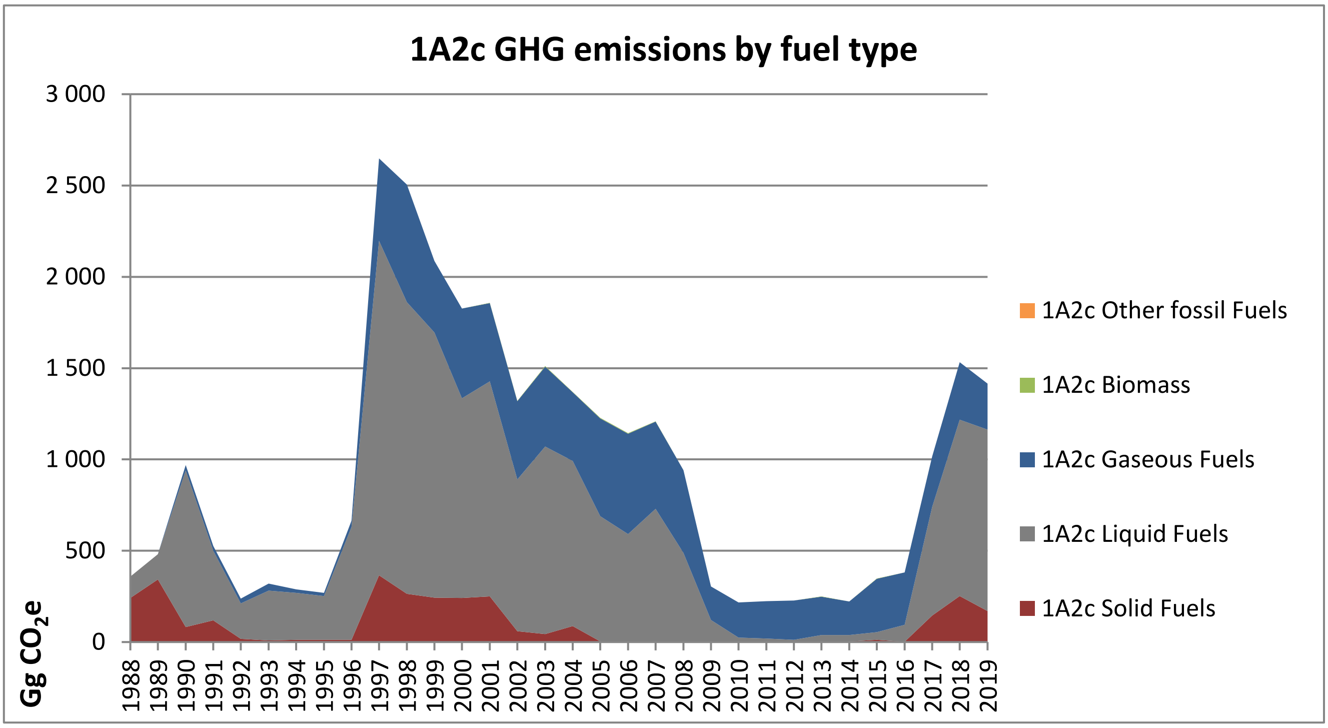

Figure 32 GHG emissions from CRF 1.A.2.c. Chemicals

The share of this subcategory from sector 1.A is 3.7% for the year 2019, which is equivalent to 2.5% out of the total GHG emissions.

The trend analysis shows some significant variability in the fuel consumption in this category – after 1997 there is an increase in the liquid fuels and a decrease in the gaseous fuels. Additional checks revealed two separate factors contributing to this trend – after 1997 the National Statistics changed the methodologies for fuel allocation: fuels consumed by autoproducer electricity, CHP and heat plants were reallocated from transformation sector to the respective industry sector. The second factor, responsible for the decrease in gaseous fuel consumption is the long-term crisis in the fertilizer production industry in Bulgaria, which has caused the gradual closure of two of the plants around 2001. The increase in the recent years is due to the use of petroleum coke and solid fuels.

Table 54 CO_2 emissions in CRF 1.A.2.c. Chemicals

CO_2 (Gg)	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	356.63	116.80	239.84	NO	NO	NO
1990	967.34	856.74	80.38	30.23	NO	NO
1995	267.42	238.35	11.56	17.51	0.2240	NO
2000	1 822.56	1 091.49	239.06	492.01	7.9520	NO
2005	1 222.61	685.21	2.21	535.19	189.3920	NO
2010	215.68	24.16	NO	191.52	0.2240	NO
2011	223.74	17.97	NO	205.77	0.1120	NO
2012	225.87	12.46	NO	213.41	0.2240	NO
2013	248.48	38.48	NO	210.00	3.9200	NO
2014	221.08	35.38	2.36	183.33	31.8080	NO
2015	345.67	40.63	12.30	292.74	50.7360	NO
2016	380.63	92.71	0.48	287.44	3.6960	NO
2017	1 012.76	594.78	143.16	274.81	64.1869	NO
2018	1 527.25	964.24	249.36	313.65	30.9213	NO
2019	1 410.33	990.48	168.66	251.19	59.2321	NO
Decrease 1988-2019	-295.5%	-748.0%	29.7%	-	-	-
Decrease 1990-2019	-45.8%	-15.6%	-109.8%	-731.0%	-	-
Decrease	7.7%	-2.7%	32.4%	19.9%	-91.6%	-

CO_2 (Gg)	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2018-2019						

Table 55 CH_4 emissions in CRF 1.A.2.c. Chemicals

CH_4 (Gg)	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0271	0.0047	0.0224	NO	NO	NO
1990	0.0302	0.0221	0.0075	0.0005	NO	NO
1995	0.0098	0.0083	0.0012	0.0003	0.0001	NO
2000	0.0678	0.0321	0.0246	0.0089	0.0021	NO
2005	0.0817	0.0211	0.0002	0.0097	0.0507	NO
2010	0.0043	0.0008	NO	0.0035	0.0001	NO
2011	0.0043	0.0005	NO	0.0037	0.0000	NO
2012	0.0044	0.0005	NO	0.0039	0.0001	NO
2013	0.0058	0.0009	NO	0.0038	0.0011	NO
2014	0.0129	0.0008	0.0002	0.0033	0.0085	NO
2015	0.0210	0.0009	0.0012	0.0053	0.0136	NO
2016	0.0080	0.0018	0.0000	0.0052	0.0010	NO
2017	0.0556	0.0176	0.0158	0.0050	0.0172	NO
2018	0.0720	0.0300	0.0281	0.0056	0.0083	NO
2019	0.0700	0.0305	0.0190	0.0045	0.0159	NO
Decrease 1988-2019	-157.7%	-546.0%	15.1%	-	-	-
Decrease 1990-2019	-131.7%	-38.0%	-153.1%	-725.6%	-	-
Decrease 2018-2019	2.9%	-1.9%	32.4%	20.0%	-91.6%	-

Table 56 N_2O emissions in CRF 1.A.2.c. Chemicals

N_2O (Gg)	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0043	0.0009	0.0034	NO	NO	NO
1990	0.0047	0.0035	0.0011	0.0001	NO	NO
1995	0.0018	0.0016	0.0002	0.0000	0.0000	NO
2000	0.0104	0.0056	0.0037	0.0009	0.0003	NO
2005	0.0115	0.0037	0.0000	0.0010	0.0068	NO
2010	0.0005	0.0001	NO	0.0003	0.0000	NO
2011	0.0005	0.0001	NO	0.0004	0.0000	NO
2012	0.0005	0.0001	NO	0.0004	0.0000	NO
2013	0.0007	0.0001	NO	0.0004	0.0001	NO
2014	0.0016	0.0001	0.0000	0.0003	0.0011	NO
2015	0.0027	0.0001	0.0002	0.0005	0.0018	NO
2016	0.0009	0.0002	0.0000	0.0005	0.0001	NO
2017	0.0085	0.0033	0.0024	0.0005	0.0023	NO
2018	0.0118	0.0059	0.0042	0.0006	0.0011	NO
2019	0.0114	0.0060	0.0029	0.0005	0.0021	NO
Decrease 1988-2019	-164.2%	-530.2%	15.1%	-	-	-
Decrease 1990-2019	-142.4%	-69.7%	-153.1%	-725.6%	-	-
Decrease 2018-2019	3.3%	-1.3%	32.4%	20.0%	-91.6%	-

Table 57 GHG emissions in CRF 1.A.2.c. Chemicals

GHG (Gg)	TJ	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	3 817.68	358.60	117.20	241.40	NO	NO	NO
1990	14 774.60	969.50	858.34	80.90	30.26	NO	NO
1995	3 762.88	268.20	239.02	11.64	17.53	0.0039	NO
2000	27 881.70	1 827.36	1 093.95	240.77	492.50	0.1379	NO
2005	21 813.74	1 228.07	686.84	2.22	535.72	3.2839	NO
2010	3 821.21	215.93	24.22	NO	191.71	0.0039	NO
2011	3 996.80	223.98	18.01	NO	205.97	0.0019	NO
2012	4 032.82	226.13	12.50	NO	213.62	0.0039	NO
2013	4 442.69	248.83	38.55	NO	210.21	0.0680	NO
2014	4 187.91	221.88	35.44	2.37	183.52	0.5515	NO
2015	6 506.90	346.99	40.69	12.38	293.03	0.8797	NO
2016	6 773.86	381.09	92.82	0.49	287.72	0.0641	NO
2017	14 093.72	1 016.68	596.22	144.27	275.08	1.1130	NO
2018	19 459.48	1 532.56	966.75	251.32	313.96	0.5362	NO
2019	18 125.81	1 415.47	993.02	169.98	251.44	1.0270	NO
Decrease 1988-2019	-374.8%	-294.7%	-747.3%	29.6%	-	-	-
Decrease 1990-2019	-22.7%	-46.0%	-15.7%	-110.1%	-731.0%	-	-
Decrease 2018-2019	6.9%	7.6%	-2.7%	32.4%	19.9%	-91.6%	-

3.3.11.3.1 Source-specific recalculations, including changes made in response to the review process

Following the recommendation of the Technical review of GHG inventories under the EU Effort Sharing Decision (ESD) in 2012, we revised the methodology concerning Chemical sector in order to remove the double counting within the IP sector. The National Statistics Institute initiated talks with the plant operators in order to clarify the situation, but the revision of the national energy balances is still pending due to disagreements with some of the companies required to report. This mandates a correction of the National Energy Balance for the purposes of elaborating the National GHG inventory. Using a stoichiometric calculation (based on the reported production of ammonia, soda ash and calcium carbide) the actual quantities of natural gas and solid fuels as non-energy use in the chemical industry are estimated. The remaining quantities of natural gas and solid fuels, which are reported under Chemical industry, are considered to be energy use and accounted in the Energy sector.
The following fuels have been reallocated to the industrial processes sector:

- Natural gas used for ammonia production
- Anthracite used for soda ash and for calcium carbide
- Other bituminous coal used for soda ash and for calcium carbide
- Coke oven coke used for soda ash

3.3.11.4 Pulp, Paper and Print (CRF 1.A.2.d.)

Category 1.A.2.d Pulp, Paper and Print enfolds emissions from the fuel combustion in pulp, paper and print industries.

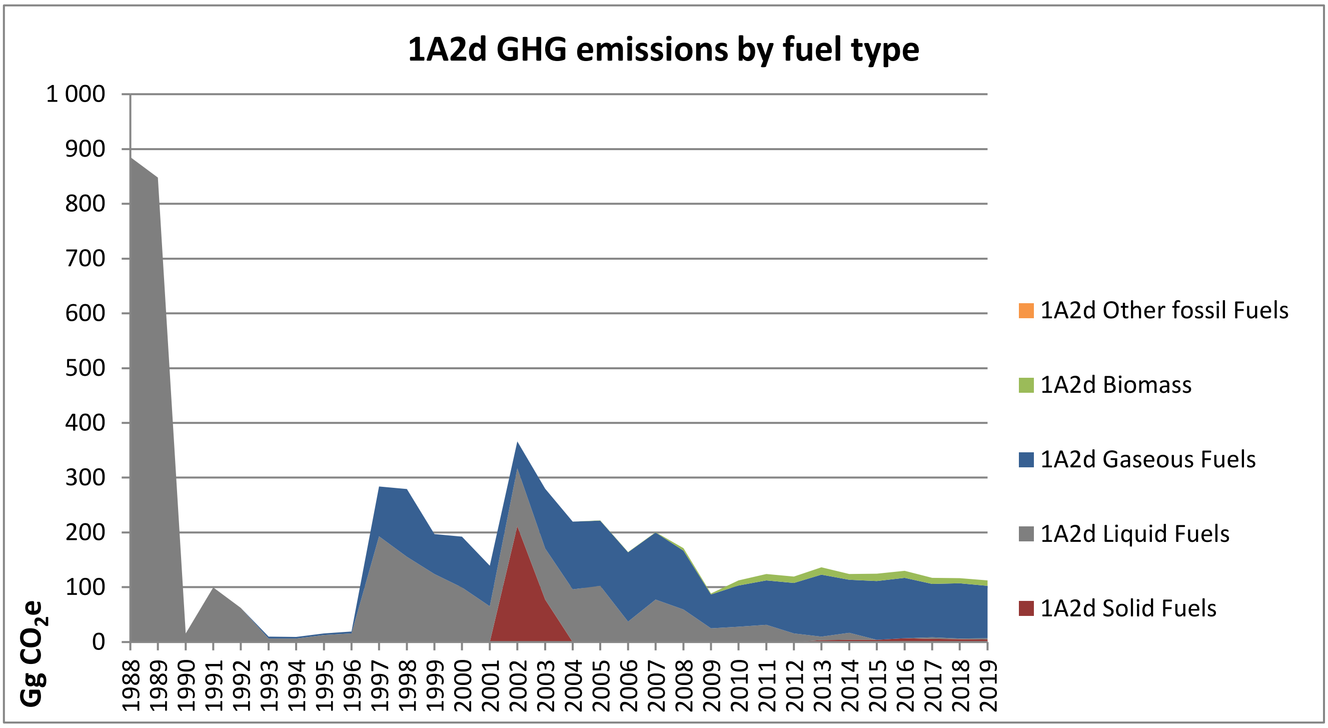

Figure 33 GHG emissions from CRF 1.A.2.d. Pulp, Paper and Print

The share of this subcategory from sector 1.A is 0.3% for 2019, which is equivalent to 0.2% of the total GHG emissions.

Table 58 CO_2 emissions in CRF 1.A.2.d. Pulp, Paper and Print

CO_2 (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	882.36	882.36	NO	NO	NO	NO
1990	15.56	15.56	NO	NO	NO	NO
1995	15.39	12.46	NO	2.93	0.2240	NO
2000	192.07	99.11	NO	92.96	0.1120	NO
2005	221.22	102.17	NO	119.04	32.8160	NO
2010	102.69	27.86	NO	74.82	540.8480	NO
2011	112.48	30.96	NO	81.52	660.2400	NO
2012	107.78	15.48	NO	92.30	649.7120	NO
2013	122.97	6.19	3.37	113.41	772.1280	NO
2014	113.31	12.38	4.13	96.79	612.1920	NO
2015	111.17	NO	3.63	107.54	762.0480	NO
2016	117.01	NO	6.65	110.36	729.4560	NO
2017	105.62	2.67	5.84	97.11	648.3276	NO
2018	106.78	1.40	4.88	100.50	549.1898	NO
2019	102.19	2.77	4.18	95.24	595.6262	NO
Decrease 1988-2019	88.4%	99.7%	-	-	-	-
Decrease 1990-2019	-556.9%	82.2%	-	-	-	-
Decrease 2018-2019	4.3%	-97.3%	14.3%	5.2%	-8.5%	-

Table 59 CH_4 emissions in CRF 1.A.2.d. Pulp, Paper and Print

CH_4 (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0342	0.0342	NO	NO	NO	NO
1990	0.0006	0.0006	NO	NO	NO	NO

CH_4 (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1995	0.0006	0.0005	NO	0.0001	0.0001	NO
2000	0.0056	0.0038	NO	0.0017	0.0000	NO
2005	0.0149	0.0040	NO	0.0022	0.0088	NO
2010	0.1473	0.0011	NO	0.0014	0.1449	NO
2011	0.1795	0.0012	NO	0.0015	0.1769	NO
2012	0.1763	0.0006	NO	0.0017	0.1740	NO
2013	0.2094	0.0002	0.0003	0.0020	0.2068	NO
2014	0.1666	0.0005	0.0004	0.0017	0.1640	NO
2015	0.2064	NO	0.0003	0.0019	0.2041	NO
2016	0.1980	NO	0.0006	0.0020	0.1954	NO
2017	0.1761	0.0001	0.0006	0.0018	0.1737	NO
2018	0.1494	0.0000	0.0005	0.0018	0.1471	NO
2019	0.1617	0.0001	0.0004	0.0017	0.1595	NO
Decrease 1988-2019	-372.9%	99.7%	-	-	-	-
Decrease 1990-2019	-26252.0%	85.8%	-	-	-	-
Decrease 2018-2019	-8.2%	-180.1%	16.5%	5.3%	-8.5%	-

Table 60 N_2O emissions in CRF 1.A.2.d. Pulp, Paper and Print

N_2O (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0068	0.0068	NO	NO	NO	NO
1990	0.0001	0.0001	NO	NO	NO	NO
1995	0.0001	0.0001	NO	0.0000	0.0000	NO
2000	0.0009	0.0008	NO	0.0002	0.0000	NO
2005	0.0022	0.0008	NO	0.0002	0.0012	NO
2010	0.0197	0.0002	NO	0.0001	0.0193	NO
2011	0.0240	0.0002	NO	0.0001	0.0236	NO
2012	0.0235	0.0001	NO	0.0002	0.0232	NO
2013	0.0279	0.0000	0.0000	0.0002	0.0276	NO
2014	0.0222	0.0001	0.0001	0.0002	0.0219	NO
2015	0.0275	NO	0.0001	0.0002	0.0272	NO
2016	0.0263	NO	0.0001	0.0002	0.0261	NO
2017	0.0234	0.0000	0.0001	0.0002	0.0232	NO
2018	0.0199	0.0000	0.0001	0.0002	0.0196	NO
2019	0.0215	0.0000	0.0001	0.0002	0.0213	NO
Decrease 1988-2019	-214.6%	99.8%	-	-	-	-
Decrease 1990-2019	-17430.4%	87.1%	-	-	-	-
Decrease 2018-2019	-8.3%	-246.2%	16.5%	5.3%	-8.5%	-

Table 61 GHG emissions in CRF 1.A.2.d. Pulp, Paper and Print

GHG (Gg)	TJ	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	11 400.00	885.25	885.25	NO	NO	NO	NO
1990	204.60	15.61	15.61	NO	NO	NO	NO
1995	219.70	15.44	12.50	NO	2.93	0.0039	NO
2000	2 967.20	192.49	99.44	NO	93.05	0.0019	NO
2005	3 771.27	222.24	102.51	NO	119.16	0.5690	NO
2010	6 543.50	112.23	27.96	NO	74.90	9.3779	NO
2011	7 770.10	124.11	31.06	NO	81.60	11.4481	NO

GHG (Gg)	TJ	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2012	7 673.20	119.19	15.53	NO	92.39	11.2655	NO
2013	9 054.56	136.52	6.21	3.39	113.52	13.3881	NO
2014	7 413.95	124.09	12.42	4.16	96.89	10.6150	NO
2015	8 772.00	124.52	NO	3.66	107.64	13.2134	NO
2016	8 560.20	129.81	NO	6.70	110.47	12.6482	NO
2017	7 633.64	117.00	2.68	5.88	97.21	11.2415	NO
2018	6 782.83	116.44	1.41	4.91	100.60	9.5226	NO
2019	7 112.42	112.65	2.78	4.21	95.34	10.3277	NO
Decrease 1988-2019	37.6%	87.3%	99.7%	-	-	-	-
Decrease 1990-2019	-3376.3%	-621.7%	82.2%	-	-	-	-
Decrease 2018-2019	-4.9%	3.3%	-97.5%	14.3%	5.2%	-8.5%	-

3.3.11.5 Food Processing, Beverages and Tobacco (CRF 1.A.2.e.)

Category 1.A.2.e Food Processing, Beverages and Tobacco enfolds emissions from fuel combustion in food processing, beverages and tobacco industry.

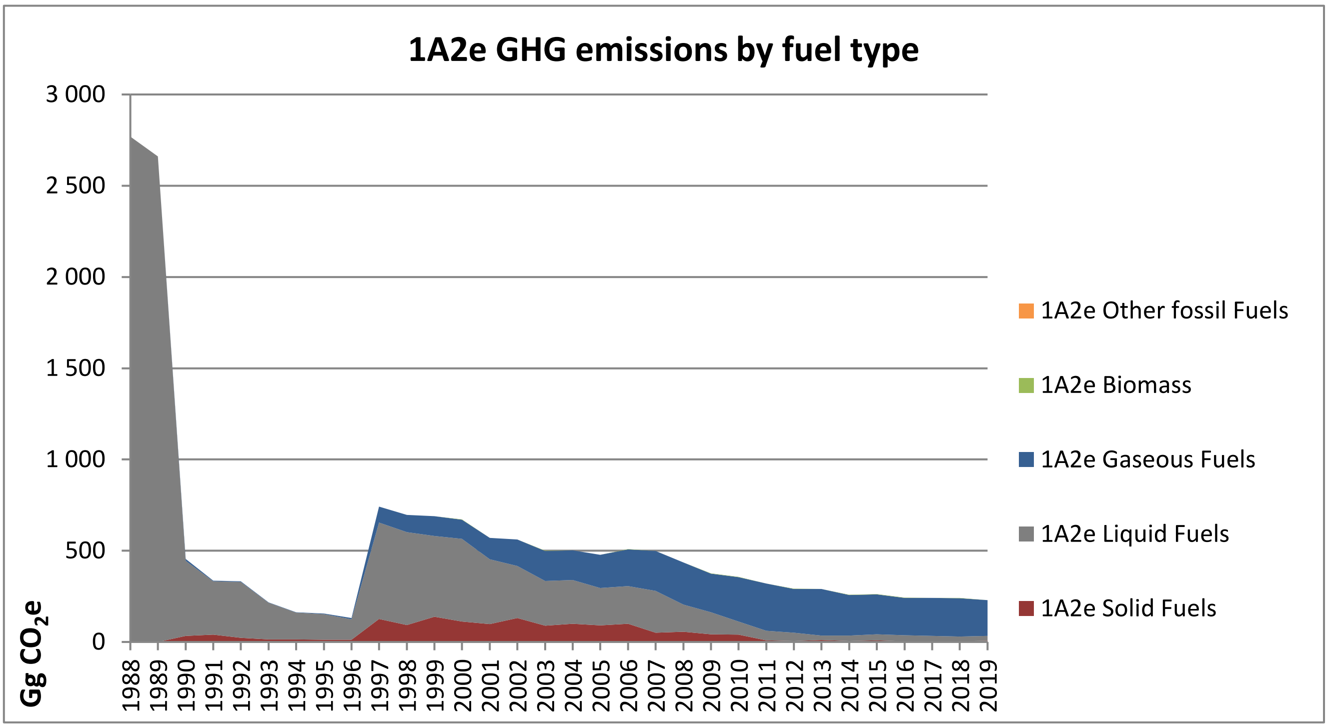

Figure 34 GHG emissions from 1.A.2.e. Food Processing, Beverages and Tobacco

The share of this subcategory from sector 1.A is 0.6% for 2019, which is equivalent to 0.4% of total GHG emissions.

Table 62 CO_2 emissions in CRF 1.A.2.e. Food Processing, Beverages and Tobacco

CO_2 (Gg)	CRF 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	2 760.71	2 760.71	NO	NO	NO	NO
1990	453.59	409.27	32.90	11.43	NO	NO
1995	154.80	140.32	11.05	3.43	1.9040	NO
2000	668.07	450.17	111.43	106.47	36.8480	NO
2005	476.12	204.15	89.93	182.04	19.4880	NO
2010	354.30	70.59	39.85	243.86	33.0400	NO

CO_2 (Gg)	CRF 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2011	318.41	51.82	8.96	257.64	24.7520	NO
2012	289.79	46.01	4.42	239.35	60.9280	NO
2013	289.28	24.50	10.35	254.43	63.0560	NO
2014	256.40	30.75	4.13	221.52	94.4160	NO
2015	259.19	33.86	7.45	217.88	129.6960	NO
2016	239.90	33.43	2.53	203.94	114.2400	NO
2017	240.19	30.05	3.16	206.98	34.6145	NO
2018	238.42	25.51	2.83	210.08	123.9194	NO
2019	228.03	26.71	5.66	195.66	67.7597	NO
Decrease 1988-2019	91.7%	99.0%	-	-	-	-
Decrease 1990-2019	49.7%	93.5%	82.8%	-1612.2%	-	-
Decrease 2018-2019	4.4%	-4.7%	-100.2%	6.9%	45.3%	-

Table 63 CH_4 emissions in 1.A.2.e. Food Processing, Beverages and Tobacco

CH_4 (Gg)	CRF 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.1080	0.1080	NO	NO	NO	NO
1990	0.0198	0.0164	0.0032	0.0002	NO	NO
1995	0.0072	0.0056	0.0011	0.0001	0.0005	NO
2000	0.0408	0.0176	0.0114	0.0019	0.0099	NO
2005	0.0256	0.0079	0.0093	0.0033	0.0052	NO
2010	0.0199	0.0025	0.0042	0.0044	0.0089	NO
2011	0.0139	0.0017	0.0009	0.0047	0.0066	NO
2012	0.0227	0.0016	0.0004	0.0043	0.0163	NO
2013	0.0234	0.0008	0.0010	0.0046	0.0169	NO
2014	0.0308	0.0011	0.0004	0.0040	0.0253	NO
2015	0.0406	0.0012	0.0007	0.0039	0.0347	NO
2016	0.0356	0.0011	0.0003	0.0037	0.0306	NO
2017	0.0120	0.0009	0.0003	0.0037	0.0070	NO
2018	0.0360	0.0008	0.0003	0.0038	0.0311	NO
2019	0.0211	0.0009	0.0006	0.0035	0.0161	NO
Decrease 1988-2019	80.5%	99.2%	-	-	-	-
Decrease 1990-2019	-6.8%	94.7%	80.8%	-1601.1%	-	-
Decrease 2018-2019	41.4%	-6.3%	-92.3%	6.9%	48.2%	-

Table 64 N_2O emissions in 1.A.2.e. Food Processing, Beverages and Tobacco

N_2O (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0216	0.0216	NO	NO	NO	NO
1990	0.0038	0.0033	0.0005	0.0000	NO	NO
1995	0.0014	0.0011	0.0002	0.0000	0.0001	NO
2000	0.0067	0.0035	0.0017	0.0002	0.0013	NO
2005	0.0040	0.0016	0.0014	0.0003	0.0007	NO
2010	0.0027	0.0005	0.0006	0.0004	0.0012	NO
2011	0.0018	0.0003	0.0001	0.0005	0.0009	NO
2012	0.0030	0.0003	0.0001	0.0004	0.0022	NO
2013	0.0030	0.0002	0.0002	0.0005	0.0023	NO
2014	0.0040	0.0002	0.0001	0.0004	0.0034	NO
2015	0.0054	0.0002	0.0001	0.0004	0.0046	NO

N_2O (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2016	0.0047	0.0002	0.0000	0.0004	0.0041	NO
2017	0.0015	0.0002	0.0001	0.0004	0.0009	NO
2018	0.0047	0.0002	0.0000	0.0004	0.0041	NO
2019	0.0027	0.0002	0.0001	0.0004	0.0021	NO
Decrease 1988-2019	87.3%	99.3%	-	-	-	-
Decrease 1990-2019	27.2%	95.1%	80.8%	-1601.1%	-	-
Decrease 2018-2019	41.8%	-7.0%	-92.3%	6.9%	48.3%	-

Table 65 GHG emissions in 1.A.2.e. Food Processing, Beverages and Tobacco

GHG (Gg)	TJ	CRF 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	36 011.40	2 769.85	2 769.85	NO	NO	NO	NO
1990	5 984.34	455.21	410.65	33.12	11.44	NO	NO
1995	2 045.98	155.38	140.79	11.12	3.43	0.0330	NO
2000	9 289.09	671.10	451.66	112.22	106.58	0.6389	NO
2005	7 078.26	477.95	204.81	90.57	182.22	0.3379	NO
2010	6 082.06	355.62	70.79	40.15	244.10	0.5729	NO
2011	5 690.71	319.30	51.96	9.02	257.89	0.4292	NO
2012	5 551.54	291.24	46.15	4.45	239.59	1.0564	NO
2013	5 600.49	290.76	24.56	10.42	254.68	1.0933	NO
2014	5 304.20	258.37	30.84	4.16	221.74	1.6371	NO
2015	5 613.63	261.81	33.96	7.50	218.10	2.2488	NO
2016	5 187.53	242.19	33.51	2.55	204.15	1.9808	NO
2017	4 588.44	240.94	30.12	3.18	207.19	0.4539	NO
2018	5 359.80	240.72	25.57	2.85	210.29	2.0119	NO
2019	4 639.86	229.38	26.78	5.70	195.85	1.0411	NO
Decrease 1988-2019	87.1%	91.7%	99.0%	-	-	-	-
Decrease 1990-2019	22.5%	49.6%	93.5%	82.8%	-1612.2%	-	-
Decrease 2018-2019	13.4%	4.7%	-4.7%	-100.1%	6.9%	48.3%	-

3.3.11.6 Non-metallic minerals (CRF 1.A.2.f.)

Category 1.A.2.f Non-metallic minerals enfolds emissions from fuel combustion from all activities in the non-metallic minerals industry (mostly cement production industry).

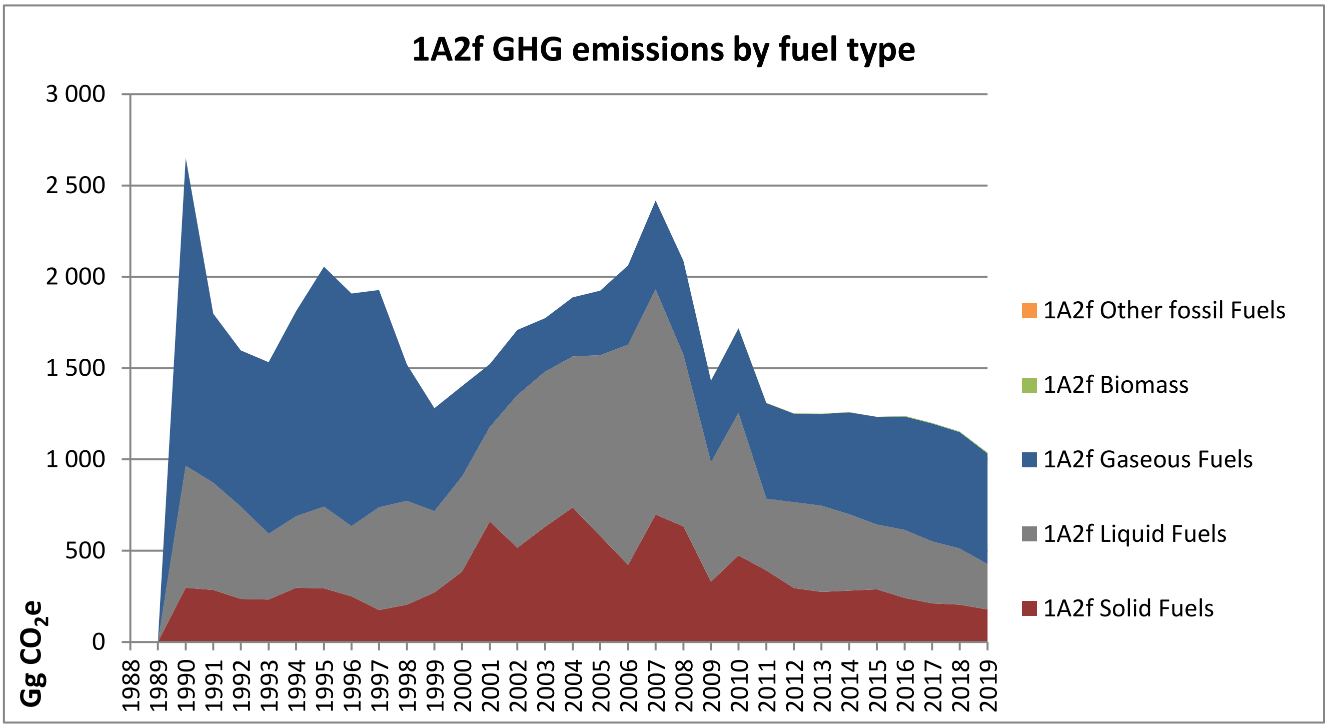

Figure 35 GHG emissions from 1.A.2.f. Non-metallic minerals

The share of this subcategory from sector 1.A is 2.7% for 2019, which is equivalent to 1.9% of total GHG emissions.
This industry experienced a notable growth until 2007, which was followed by a significant decline after 2008 as a result of the global financial crisis and the following decline in the construction sector. Additionally, the sector experienced some restructuring resulting in the closure of some of the cement plants in the country.

Table 66 CO_2 emissions in 1.A.2.f. Non-metallic minerals

CO_2 (Gg)	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1990	2 645.80	666.44	295.28	1 684.09	NO	NO
1995	2 050.57	445.93	292.19	1 312.45	1.5680	NO
2000	1 397.08	520.00	382.32	494.75	0.6720	NO
2005	1 916.65	987.09	577.05	352.51	1.8953	NO
2010	1 712.41	778.07	470.09	464.26	70.1145	NO
2011	1 304.59	393.31	388.05	523.23	54.6819	NO
2012	1 246.25	468.16	293.77	484.32	106.5080	NO
2013	1 244.78	470.38	272.51	501.88	108.8629	NO
2014	1 254.45	417.00	279.71	557.74	78.3885	NO
2015	1 228.79	354.02	286.60	588.16	90.9762	NO
2016	1 232.14	370.38	239.72	622.05	137.0180	NO
2017	1 194.11	338.65	209.15	646.30	154.8104	NO
2018	1 145.57	306.99	203.34	635.25	231.2777	NO
2019	1 030.03	246.89	177.40	605.74	302.4066	NO
Decrease 1988-2019	-	-	-	-	-	-
Decrease 1990-2019	61.1%	63.0%	39.9%	64.0%	-	-
Decrease 2018-2019	10.1%	19.6%	12.8%	4.6%	-30.8%	-

Table 67 CH_4 emissions in 1.A.2.f. Non-metallic minerals

CH_4 (Gg)	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1990	0.0857	0.0256	0.0296	0.0305	NO	NO
1995	0.0715	0.0171	0.0302	0.0238	0.0004	NO
2000	0.0659	0.0175	0.0393	0.0090	0.0002	NO
2005	0.0973	0.0316	0.0588	0.0064	0.0005	NO
2010	0.1013	0.0250	0.0492	0.0084	0.0188	NO
2011	0.0774	0.0129	0.0403	0.0095	0.0146	NO
2012	0.0828	0.0151	0.0303	0.0088	0.0285	NO
2013	0.0816	0.0150	0.0284	0.0091	0.0292	NO
2014	0.0735	0.0133	0.0292	0.0101	0.0210	NO
2015	0.0765	0.0113	0.0303	0.0106	0.0244	NO
2016	0.0846	0.0118	0.0250	0.0112	0.0367	NO
2017	0.0865	0.0108	0.0226	0.0116	0.0415	NO
2018	0.1056	0.0099	0.0223	0.0114	0.0619	NO
2019	0.1194	0.0080	0.0195	0.0109	0.0810	NO
Decrease 1988-2019	-	-	-	-	-	-
Decrease 1990-2019	-39.3%	68.9%	34.1%	64.3%	-	-
Decrease 2018-2019	-13.1%	19.2%	12.5%	4.7%	-30.8%	-

Table 68 N_2O emissions in 1.A.2.f. Non-metallic minerals

N_2O (Gg)	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1990	0.0126	0.0051	0.0044	0.0031	NO	NO
1995	0.0104	0.0034	0.0045	0.0024	0.0001	NO
2000	0.0103	0.0035	0.0059	0.0009	0.0000	NO
2005	0.0158	0.0063	0.0088	0.0006	0.0001	NO
2010	0.0157	0.0050	0.0074	0.0008	0.0025	NO
2011	0.0115	0.0026	0.0061	0.0009	0.0020	NO
2012	0.0123	0.0030	0.0045	0.0009	0.0038	NO
2013	0.0121	0.0030	0.0043	0.0009	0.0039	NO
2014	0.0108	0.0026	0.0044	0.0010	0.0028	NO
2015	0.0111	0.0023	0.0045	0.0011	0.0032	NO
2016	0.0121	0.0024	0.0037	0.0011	0.0049	NO
2017	0.0122	0.0022	0.0034	0.0012	0.0055	NO
2018	0.0147	0.0020	0.0033	0.0011	0.0083	NO
2019	0.0164	0.0016	0.0029	0.0011	0.0108	NO
Decrease 1988-2019	-	-	-	-	-	-
Decrease 1990-2019	-30.5%	68.7%	34.1%	64.3%	-	-
Decrease 2018-2019	-11.5%	19.3%	12.5%	4.7%	-30.8%	-

Table 69 GHG emissions in CRF 1.A.2.f. Non-metallic minerals

GHG (Gg)	TJ	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO	NO
1990	42 276.98	2 651.70	668.59	297.35	1 685.76	NO	NO
1995	32 659.47	2 055.45	447.37	294.29	1 313.75	0.0272	NO
2000	18 825.47	1 401.79	521.48	385.06	495.24	0.0117	NO

GHG (Gg)	TJ	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2005	22 845.24	1 923.80	989.76	581.15	352.86	0.0329	NO
2010	22 307.72	1 719.63	780.18	473.51	464.72	1.2157	NO
2011	18 324.45	1 309.96	394.40	390.86	523.75	0.9481	NO
2012	17 834.21	1 251.97	469.44	295.88	484.80	1.8468	NO
2013	17 916.26	1 250.41	471.65	274.49	502.38	1.8876	NO
2014	18 135.10	1 259.52	418.12	281.75	558.29	1.3592	NO
2015	18 222.31	1 234.01	354.98	288.71	588.74	1.5775	NO
2016	18 859.20	1 237.87	371.37	241.46	622.66	2.3758	NO
2017	18 928.94	1 199.92	339.57	210.73	646.94	2.6843	NO
2018	19 068.02	1 152.60	307.82	204.90	635.88	4.0102	NO
2019	18 260.25	1 037.91	247.56	178.76	606.34	5.2435	NO
Decrease 1988-2019	-	-	-	-	-	-	-
Decrease 1990-2019	56.8%	60.9%	63.0%	39.9%	64.0%	-	-
Decrease 2018-2019	4.2%	10.0%	19.6%	12.8%	4.6%	-30.8%	-

3.3.11.7 Other (CRF 1.A.2.g.)

Category 1.A.2.g Other, includes emissions from fuel combustion from all activities which could not be classified under any of the other subcategories from 1.A.2 subcategory.
Most notably these are:

- Autoproducer Electricity Plants
- Autoproducer CHP Plants
- Autoproducer Heat Plants
- Manufacturing of machinery
- Manufacturing of transport equipment
- Mining and quarrying
- Wood and wood products
- Construction
- Textile and leather
- Off-road vehicles and other machinery
- Other non-specified (Industry)

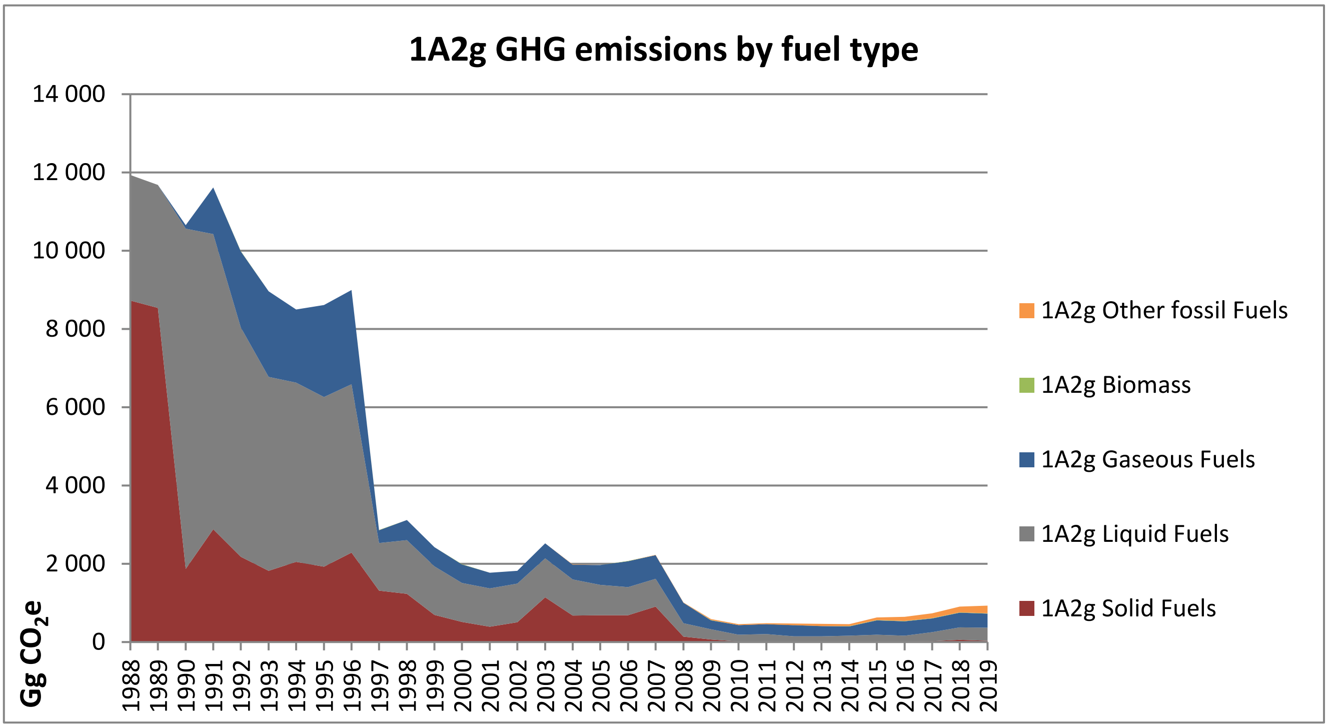

Figure 36 GHG emissions from 1.A.2.g. Other industries

The share of this subcategory from sector 1.A is 2.4% for 2019, which is equivalent to 1.7% total GHG emissions.
Up to 1997 there was a significantly higher consumption in this sector, due to the fact that the total amount of fuels used by autoproducers CHP and heat plants was reported under autoproducers instead of reporting only the quantities sold to third parties. The National statistics changed their methodologies after 1997 and reallocated fuels used for the production of electricity and heat for own use to the respective subcategories from category 1.A.2. This sector also includes the emissions from the use of alternative fuels (e.g. SRF/RDF, waste oils and tires, etc.) in cement and other industries, which started after 2004.

Table 70 CO_2 emissions in 1.A.2.g. Other industries

CO_2 (Gg)	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	11 822.55	3 155.83	8 666.72	NO	NO	NO
1990	10 579.45	8 632.34	1 858.13	88.98	NO	NO
1995	8 572.11	4 312.13	1 909.43	2 350.55	134.9600	NO
2000	1 974.35	990.09	510.62	473.64	128.1280	NO
2005	1 949.68	768.29	679.80	498.78	117.1520	2.8073
2010	444.56	167.11	12.26	240.13	163.8182	25.0545
2011	469.10	179.77	10.36	252.56	155.6198	26.4152
2012	461.40	124.04	12.67	284.96	220.0744	39.7299
2013	448.46	127.13	12.94	256.82	281.3230	51.5697
2014	441.79	139.72	9.81	242.82	335.6318	49.4349
2015	614.05	157.17	15.81	372.78	352.0846	68.2941
2016	625.51	143.72	13.24	365.28	338.2638	103.2707
2017	716.22	216.28	24.35	357.52	335.4148	118.0783
2018	881.61	305.54	56.18	377.17	339.9084	142.7187
2019	909.27	322.57	32.71	359.13	386.4356	194.8689
Decrease 1988-2019	92.3%	89.8%	99.6%	-	-	-
Decrease 1990-2019	91.4%	96.3%	98.2%	-303.6%	-	-
Decrease 2018-2019	-3.1%	-5.6%	41.8%	4.8%	-13.7%	-36.5%

Table 71 CH_4 emissions in 1.A.2.g. Other industries

CH_4 (Gg)	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1.0085	0.1312	0.8774	NO	NO	NO
1990	0.5157	0.3397	0.1743	0.0016	NO	NO
1995	0.4307	0.1677	0.1843	0.0426	0.0362	NO
2000	0.1323	0.0392	0.0502	0.0086	0.0343	NO
2005	0.1419	0.0308	0.0697	0.0090	0.0314	0.0010
2010	0.0660	0.0072	0.0013	0.0043	0.0430	0.0103
2011	0.0631	0.0078	0.0011	0.0046	0.0406	0.0091
2012	0.0847	0.0054	0.0013	0.0052	0.0589	0.0140
2013	0.1033	0.0058	0.0014	0.0046	0.0746	0.0169
2014	0.1168	0.0065	0.0010	0.0044	0.0880	0.0170
2015	0.1306	0.0070	0.0017	0.0067	0.0912	0.0241
2016	0.1402	0.0058	0.0014	0.0066	0.0859	0.0405
2017	0.1492	0.0075	0.0026	0.0064	0.0835	0.0491
2018	0.1694	0.0110	0.0063	0.0068	0.0848	0.0605
2019	0.1985	0.0113	0.0037	0.0065	0.0992	0.0779
Decrease 1988-2019	80.3%	91.4%	99.6%	-	-	-
Decrease 1990-2019	61.5%	96.7%	97.9%	-301.0%	-	-
Decrease 2018-2019	-17.2%	-3.1%	41.8%	4.8%	-16.9%	-28.7%

Table 72 N_2O emissions in 1.A.2.g. Other industries

N_2O (Gg)	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.3020	0.1704	0.1316	NO	NO	NO
1990	0.2138	0.1877	0.0260	0.0002	NO	NO
1995	0.1106	0.0740	0.0275	0.0043	0.0048	NO
2000	0.0313	0.0184	0.0075	0.0009	0.0046	NO
2005	0.0473	0.0317	0.0104	0.0009	0.0042	0.0001
2010	0.0303	0.0225	0.0002	0.0004	0.0057	0.0014
2011	0.0323	0.0250	0.0002	0.0005	0.0054	0.0012
2012	0.0267	0.0163	0.0002	0.0005	0.0079	0.0019
2013	0.0350	0.0221	0.0002	0.0005	0.0099	0.0023
2014	0.0404	0.0258	0.0002	0.0004	0.0117	0.0023
2015	0.0422	0.0259	0.0003	0.0007	0.0121	0.0032
2016	0.0398	0.0221	0.0002	0.0007	0.0114	0.0054
2017	0.0408	0.0220	0.0004	0.0006	0.0111	0.0066
2018	0.0474	0.0264	0.0009	0.0007	0.0113	0.0081
2019	0.0547	0.0299	0.0006	0.0006	0.0132	0.0104
Decrease 1988-2019	81.9%	82.5%	99.6%	-	-	-
Decrease 1990-2019	74.4%	84.1%	97.9%	-301.0%	-	-
Decrease 2018-2019	-15.4%	-13.2%	41.8%	4.8%	-17.0%	-28.7%

Table 73 GHG emissions in CRF 1.A.2.g. Other industries

GHG (Gg)	TJ	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	129 467.42	11 937.77	3 209.90	8 727.87	NO	NO	NO
1990	134 955.71	10 656.06	8 696.75	1 870.23	89.07	NO	NO
1995	120 844.05	8 615.84	4 338.38	1 922.24	2 352.88	2.3401	NO
2000	28 554.65	1 986.99	996.55	514.11	474.11	2.2216	NO

GHG (Gg)	TJ	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2005	27 868.06	1 967.32	778.49	684.66	499.27	2.0313	2.8728
2010	8 561.55	455.22	174.00	12.35	240.37	2.7807	25.7211
2011	8 819.60	480.29	187.41	10.43	252.81	2.6243	27.0050
2012	9 383.54	471.47	129.02	12.77	285.24	3.8124	40.6337
2013	9 585.88	461.48	133.88	13.03	257.08	4.8289	52.6650
2014	9 997.93	456.74	147.57	9.88	243.06	5.6921	50.5349
2015	13 073.86	629.89	165.05	15.93	373.15	5.8989	69.8561
2016	13 296.61	640.88	150.45	13.34	365.64	5.5593	105.8944
2017	14 611.84	732.10	223.04	24.53	357.87	5.4010	121.2594
2018	16 532.61	899.95	313.68	56.61	377.54	5.4866	146.6340
2019	17 268.41	930.52	331.75	32.96	359.49	6.4175	199.9089
Decrease 1988-2019	86.7%	92.2%	89.7%	99.6%	-	-	-
Decrease 1990-2019	87.2%	91.3%	96.2%	98.2%	-303.6%	-	-
Decrease 2018-2019	-4.5%	-3.4%	-5.8%	41.8%	4.8%	-17.0%	-36.3%

3.3.11.7.1 Source-specific recalculations, including changes made in response to the review process

During the 2014 submission a calculation error for the CH_4 and N_2O emissions was identified. Before that, the use of alternative fuels was leading to double counting of the emissions, as they were reported both under 'Biomass' and 'Other fuels'. Since the alternative fuels contain both a biomass and a fossil fraction, the resulting emissions from the biomass fraction are currently reported under biomass, while the emissions from the fossil fraction are reported under 'Other fuels'.
In 2021 we have identified an omission from last year ETS reports for one operator, which started using RDF fuel and which we had not considered. For the 2021 submission we have corrected the value for 2018.

3.3.12 TRANSPORT (CRF 1.A.3)

The GHG emissions in Transport (CRF 1.A.3) are estimated following the 2006 IPCC Guidelines and the recommendations of ERT set out in FCCC/ARR/2013/BGR and FCCC/ARR/2014/BGR.

3.3.12.1 Source category description

The IPCC source category for transport covers all types of mobile sources and the range of characteristics that affect the emission factors and consequently the emissions. Those are compiled according to the source in the following five categories:

Table 74 Transport sector categories

Number	Category	CO_2	CH_4	N_2O	Method
CRF 1.A.3.a	Civil aviation (domestic)	✓	✓	✓	TIER 2
CRF 1.A.3.b	Road transport	✓	✓	✓	TIER 2
CRF 1.A.3.c	Railways	✓	✓	✓	TIER 1
CRF 1.A.3.d	Navigation	✓	✓	✓	TIER 1
CRF 1.A.3.e	Other Transport	✓	✓	✓	TIER 1

For each of the main emissions from transport – carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) – the most appropriate calculation method based on the type of emission, transport category and data availability has been selected. The uncertainty of the main inputs regarding the emission type has been considered and evaluated. Furthermore, for the GHG inventory compilation, the ERT recommendations set out in FCCC/ARR/2012/BGR have been followed.

Emission trends over the years depend mostly on the amount of fuel consumed for CO_2, whereas for CH_4 and N_2O the vehicle fleet and the fuel quality parameters are more important factors. The fuel quantities used in the CRF 1.A.3 Transport for 1988 – 2019 are shown below.

Table 75 Fuels for CRF 1.A.3 Transport in TJ 1988 – 2019

CRF 1A3 Transport	a. Civil Aviation	b. Road Transportation	c. Railways	d. Navigation	e. Other Transport
	TJ				
1988	1 083	96 173	NO	NO	NO
1990	700	81 973	4 357	761	1 777
1995	382	56 070	3 106	167	40
2000	239	68 599	1 607	85	6 887
2005	235	97 954	1 227	153	9 042
2010	301	104 200	846	117	5 896
2011	367	104 123	761	127	8 528
2012	342	111 430	931	115	8 519
2013	273	100 027	630	96	7 608
2014	258	113 134	505	116	7 032
2015	264	125 871	673	137	6 141
2016	257	128 227	546	99	6 013
2017	299	129 317	563	88	7 158
2018	302	133 129	462	69	5 751
2019	**287**	**138 354**	**421**	**87**	**2 269**

The fuel consumption associated with navigation (where notation key NO assigned in the years) is elaborated in section CRF 1.A.3.d Navigation and CRF 1.A.3.c Railways.

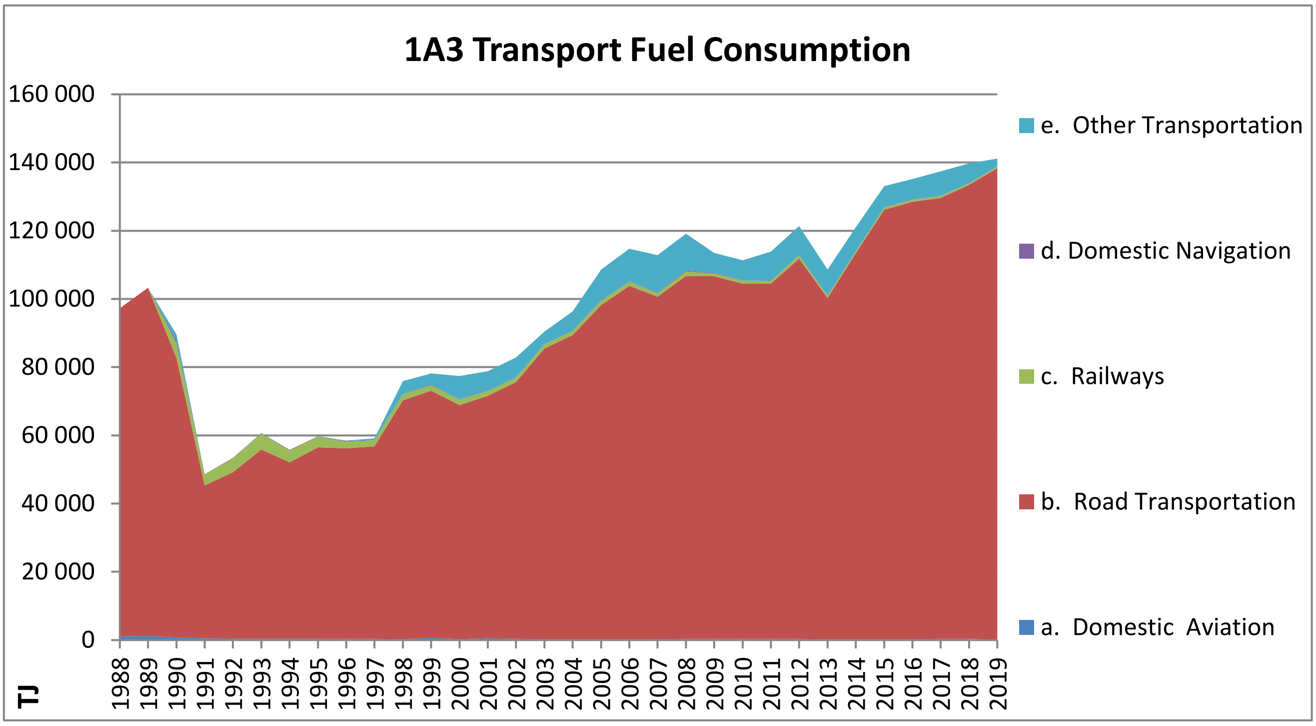

Figure 37 Fuels for CRF 1.A.3 transport for 1988 - 2019

In the period between 1988 and 1991 fuel consumption in the transport sector decreased by 49% due to the collapse of the economy. Since 1991 fuel consumption has been increasing steadily mainly due to road transport. Even though a decrease was observed in 2013, as of 2014 the use of road transport fuels has started to increase again. The share of transport categories for the last decade is as follows:

Table 76 Share of fuel consumption in 1A3 Transport fuel

CRF 1A3 Transport	a. Civil Aviation	b. Road Transportation	c. Railways	d. Navigation	e. Other Transport
1988	1.1%	98.9%	-	-	-
1990	0.8%	91.5%	4.9%	0.9%	2.0%
1995	0.6%	93.8%	5.2%	0.3%	0.1%
2000	0.3%	88.6%	2.1%	0.1%	8.9%
2005	0.2%	90.2%	1.1%	0.1%	8.3%
2010	0.3%	93.6%	0.8%	0.1%	5.3%
2011	0.3%	91.4%	0.7%	0.1%	7.5%
2012	0.3%	91.8%	0.8%	0.1%	7.0%
2013	0.3%	92.1%	0.6%	0.1%	7.0%
2014	0.2%	93.5%	0.4%	0.1%	5.8%
2015	0.2%	94.6%	0.5%	0.1%	4.6%
2016	0.2%	94.9%	0.4%	0.1%	4.4%
2017	0.2%	94.1%	0.4%	0.1%	5.2%
2018	0.2%	95.3%	0.3%	0.0%	4.1%
2019	0.2%	97.8%	0.3%	0.1%	1.6%

3.3.12.2 CRF 1.A.3.a Civil Aviation

3.3.12.2.1 Source description

Until the 2021 submission, category 1.A.3.a Civil Aviation included all domestic civil use of airplanes, but also military use. Starting from the 2021 submission, emissions from military aviation were reallocated under CRF category 1.A.5.b Other mobile. Disaggregation is performed based on fuel consumption for civil aviation, provided by Eurocontrol. The IPCC source category for civil aviation includes emissions from domestic aviation consisting of scheduled and charter traffic for passengers and freight as well as general aviation. Emissions from aviation are derived from the combustion of jet kerosene and aviation gasoline. Aircrafts emit carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), as well as carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO2), particulate matter (PM) and nitrogen oxides (NOx). Domestic aviation is related to the transport of passengers and cargo as well as general aviation. The types of flights include both scheduled and non-scheduled. International aviation is differentiated from domestic aviation on the basis of departure and landing locations.

3.3.12.2.2 Emission trend

For 2019 there was a decrease of 72.9% in the emissions from civil aviation compared to the base year, and a decrease of 4.8% compared to the year before. In 2019 the sector was responsible for 0.05% of the emissions allocated to 1.A Fuel combustion and for 0.04% of the total GHG emissions (excluding LULUCF). The main source of emissions was the use of jet kerosene with only insignificant amounts of aviation gasoline being consumed.

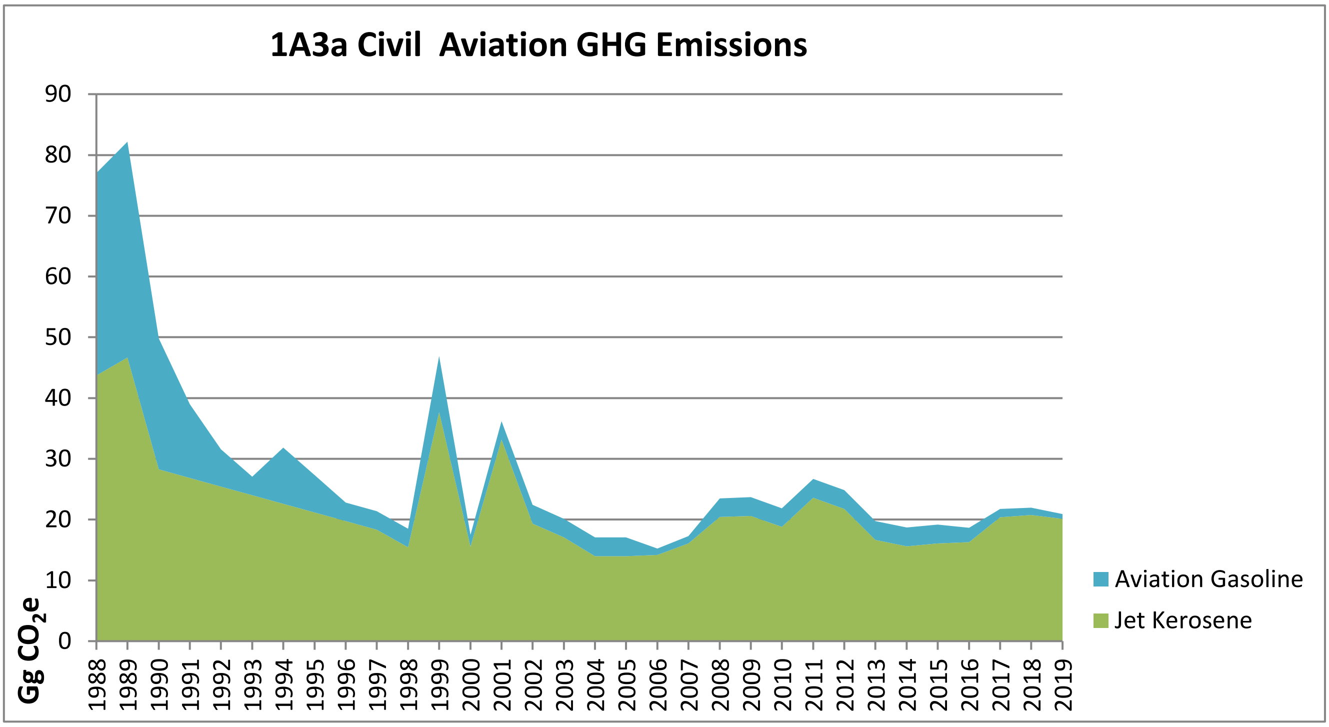

Figure 38 GHG emission in CRF 1.A.3.a Civil aviation – domestic (1988 - 2019)

Table 77 Fuel consumption and emissions from Civil aviation - all fuels

Year	TJ	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1988	1 082.52	76.35	0.0005	0.0022	77.01
1990	700.00	49.37	0.0003	0.0014	49.80
1995	381.62	27.09	0.0002	0.0008	27.32
2000	239.08	17.28	0.0015	0.0005	17.48
2005	235.23	16.88	0.0009	0.0006	17.07
2010	301.02	21.64	0.0006	0.0008	21.88
2011	367.19	26.40	0.0009	0.0009	26.69
2012	341.97	24.57	0.0008	0.0008	24.84
2013	272.50	19.56	0.0004	0.0006	19.75
2014	258.02	18.52	0.0005	0.0006	18.70
2015	264.37	18.97	0.0004	0.0006	19.16
2016	257.07	18.48	0.0004	0.0006	18.66
2017	299.26	21.56	0.0004	0.0007	21.78
2018	301.88	21.74	0.0004	0.0007	21.95
2019	286.72	20.68	0.0005	0.0007	20.89

Table 78 Fuel consumption and emissions from Civil aviation - jet kerosene

Year	TJ	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1988	606.21	43.34	0.0003	0.0012	43.71
1990	392.00	28.03	0.0002	0.0008	28.27
1995	293.62	20.99	0.0001	0.0006	21.17
2000	211.89	15.40	0.0015	0.0005	15.58
2005	191.27	13.84	0.0009	0.0005	14.00
2010	257.02	18.59	0.0006	0.0007	18.80
2011	323.19	23.35	0.0009	0.0008	23.62
2012	297.97	21.52	0.0007	0.0008	21.76
2013	228.50	16.52	0.0004	0.0005	16.68
2014	214.02	15.47	0.0005	0.0005	15.62
2015	220.37	15.92	0.0004	0.0005	16.08
2016	222.97	16.12	0.0004	0.0005	16.28
2017	279.11	20.17	0.0004	0.0006	20.37
2018	284.94	20.57	0.0004	0.0006	20.77

Year	TJ	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
2019	275.94	19.93	0.0005	0.0006	20.14

Table 79 Fuel consumption and emissions from Civil aviation – aviation gasoline

Year	TJ	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1988	476.31	33.01	0.00024	0.0010	33.30
1990	308.00	21.34	0.00015	0.0006	21.53
1995	88.00	6.10	0.00004	0.0002	6.15
2000	27.19	1.88	0.00001	0.0001	1.90
2005	43.96	3.05	0.00002	0.0001	3.07
2010	44.00	3.05	0.00002	0.0001	3.08
2011	44.00	3.05	0.00002	0.0001	3.08
2012	44.00	3.05	0.00002	0.0001	3.08
2013	44.00	3.05	0.00002	0.0001	3.08
2014	44.00	3.05	0.00002	0.0001	3.08
2015	44.00	3.05	0.00002	0.0001	3.08
2016	34.10	2.36	0.00002	0.0001	2.38
2017	20.15	1.40	0.00001	0.0000	1.41
2018	16.94	1.17	0.00001	0.0000	1.18
2019	10.78	0.75	0.00001	0.0000	0.75

3.3.12.2.3 Methods

Civil aviation is considered a minor contributor to Transport sector emissions as a result of the limited quantities of fuel consumed, as reported by the NSI. Nevertheless, on the basis of planned methodology improvement, the emission estimates for domestic aviation were calculated according to Tier 2 and following 2006 IPCC GL.

The Tier 2 method requires as a first step to perform a calculation based on landing and take-off (LTO) cycles per aircraft type per year, separately for domestic and international flights. Corresponding emission factors and fuel consumption factors are applied per LTO and per aircraft type and according to the following equations:

LTO Emissions = Number of LTOs • Emission Factor LTO

LTO Fuel Consumption = Number of LTOs • Fuel Consumption per LTO

As a second step the total amount of fuel consumed in all LTOs is subtracted from the total fuel reported in order to calculate the cruise fuel consumption. The appropriate cruise emission factors are the applied via the following equation:

Cruise Emissions = (Total Fuel Consumption – LTO Fuel Consumption) • Emission Factor Cruise

The final step includes the sum of LTOs and cruise emissions in order to calculate the total emissions from aviation. This is calculated via the following equation:

Total Emissions = LTO Emissions + Cruise Emissions

3.3.12.2.4 Activity data

Total fuel consumption is obtained from the Energy balance and converted into energy units using the country-specific NCV.

The LTOs per aircraft type per year were obtained from Eurocontrol for the period 1996-2019 with the note that data for 1996 and 1997 is incomplete, since Bulgaria became an Eurocontrol member on 1st June 1997. The primary data for all years consists of more than 500 airplane types classified by ICAO code. The data was matched with the information from ICAO DOC 8643 Aircraft Type Designators document, which currently consists of more than 10 000 type designators in order to identify the manufacturer, model, engine type, engine count and wake turbulence category. About 90 of the ICAO type designators, reported by Eurocontrol, were not present in the ICAO DOC 8643. For those airplanes a manual search was performed in order to identify the exact type of airplane.

As a second step, all aircraft type designators were manually matched to the appropriate aircraft types from 2006 IPCC GL, Vol.2, Ch. 3, Table 3.6.9.

Since the IPCC guidelines provide information for only about 50 different aircraft types, the following correspondence table was used for the remaining aircrafts for which it was not possible to manually match the aircrafts based on their model:

Table 80 Correspondence between aircraft characteristics and generic aircraft types

WTC	Engine number	Engine type	Generic aircraft type	ICAO
L	1	Turboprop	King Air	BE30
L	1	Jet	Dornier 328 Jet	D328
L	2	Turboprop	BEECHCRAFT King Air	BE30
L	2	Jet	Dornier 328 Jet	D328
M	1	Jet	Gulfstream IV	G550
M	2	Turboprop	ATR72-500	ATR75
M	2	Jet	Fokker 100/70/28	F100
M	3	Turboprop	Dornier 328 Jet	D328
M	3	Jet	Yak-42M	YK42
M	4	Turboprop	BAE146	B463
M	4	Jet	BAE146	B463
H	2	Jet	Average fleet (B767)	B767
H	3	Jet	Lockheed Tristar	L1011
H	4	Jet	A340-300	A343
H	6	Jet	Old Fleet747-100	B741

The outcome of the updated Tier 2 methodology results in increase of the GHG emissions from jet kerosene by an average of 1%.

3.3.12.2.5 Emission factors

The default Tier 2 emissions factors for jet kerosene from 2006 IPCC GL, Vol.2, Ch. 3, Table 3.6.9 were used.

3.3.12.2.6 Uncertainties

Since the default emission factors are used, the following default uncertainties are assumed (2006 IPCC GL):

AD: 5 %
EF CO_2: ±5 %
EF N_2O (for all fuel): -70 %/ +150 %
EF CH_4 (for all fuel): -57 % / +100 %

3.3.12.2.7 Source-specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, CO_2 emissions, emission factors and IEF (time series);
- Time series consistency;
- Plausibility checks of dips and jumps;
- Documentation and archiving of all information required in NIR, background documentation and archive;
- Comparison of Tier 1 and Tier 2 approach.

3.3.12.2.8 Source-specific recalculations

No recalculations have been performed for the 2021 submission.

3.3.12.2.9 Source-specific planned improvements

No improvements are planned for next submission.

3.3.12.3 CRF 1.A.3.b Road transport

3.3.12.3.1 Source description

The IPCC source category for road transport includes emissions from all types of vehicles, light-duty vehicles such as automobiles and light trucks, and heavy-duty vehicles such as tractor trailers and buses, and on-road motorcycles (including mopeds, scooters, and three-wheelers). Road transport emits significant amounts of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), as well as several other pollutants.

Road transport is defined as a key category, as a result of the considerable amount of CO_2 emissions from the use of diesel, gasoline and LPG presented below.

A unique feature of the Bulgarian vehicle fleet is its age structure. In 2019 about 86.9% of the vehicles were above 10 years old, whereas new vehicles (1 to 5 years) were 6.1% of the total and 6.9% were aged between 6 and 10 years.

The total number of registered vehicles in Bulgaria for the period 1988 – 2019 is presented in the following table.

Table 81 Number of vehicles by type

Vehicle type	Passenger cars	LDV and HDV	Busses	Motor-cycles	Mopeds
1988	1 220 784	210 805	5 486	217 360	276 901
1990	1 317 437	227 782	7 468	225 533	281 270
1995	1 647 571	289 430	15 371	233 365	285 901
2000	1 992 748	326 204	17 290	236 327	286 047
2005	2 544 198	393 565	12 584	97 754	48 667
2010	2 602 461	368 195	20 458	70 394	54 983
2011	2 694 862	382 324	20 120	73 805	58 019
2012	2 806 814	402 648	20 040	77 972	61 840
2013	2 910 235	424 299	20 277	82 481	65 479
2014	3 013 863	449 458	20 685	88 035	68 982
2015	3 162 037	483 945	21 265	93 869	71 885
2016	3 143 634	496 038	21 302	99 806	74 690
2017	2 775 758	459 927	19 350	106 047	78 114
2018	2 773 401	475 045	19 232	112 387	80 813
2019	2 829 998	490 212	19 189	118 738	83 713

Road transport accounts for the largest share in total fuel consumption in the Transport subsector. In 2019 road transport was responsible 98.1% of the consumed energy in the sector.

3.3.12.3.2 Emission trend

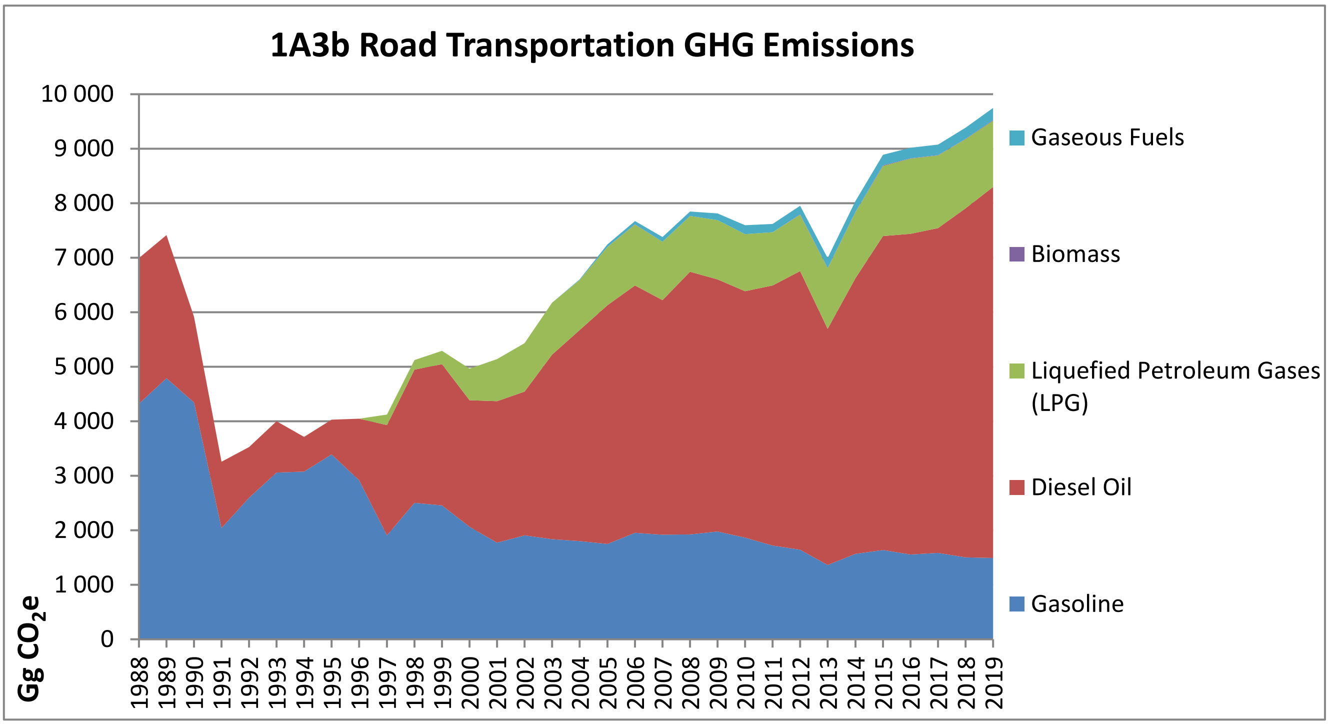

Figure 39 GHG emissions in CRF 1.A.3.b Road transport 1988 - 2019

Following a steep decline after 1989 as a result of the political and economic crisis, a distinct uptrend of GHG emissions can be observed ever since 2000. That change came as a result of the economic recovery, ushered in by the introduction of a currency board regime in 1997 and rigorous economic and political reforms. The main contributing gas is CO_2, followed by CH_4 and N_2O.The CO_2 emission trend is directly related to fuel consumption and therefore shows a decrease in the period 1990-2000. However, in line with the reviving economy, CO_2 emissions grew steadily until 2006. Afterwards, a period of stabilization took place until 2009 when a slight drop in emissions was observed, mainly related to the economic crisis and the consequent decline in transportation. For 2013 there was again a drop in the fuel consumption (mostly for diesel fuel), which resulted in a decrease of emissions, but the drop was compensated after 2014. In 2015 the fuel consumption increased significantly and since then it grows steadily.

Overall, the GHG emissions from road transport increased by 39.8% compared to the base year level of 6 994 Gg CO_2e and reached 9 775 Gg CO_2e in 2019.

The most significant contributor to GHG emissions were passenger cars, followed by heavy-duty vehicles, light-duty vehicles and motorcycles and mopeds. As it can be observed in the following figure, in 2019 passenger cars accounted for 61.3%, light-duty vehicles were responsible for 15.7%, and heavy-duty vehicles (incl. buses) for 22.7% of road transport GHG CO_2e emissions; and the share of passenger cars was clearly increasing over the time series. The remaining 0.4% were shared among mopeds and motorcycles.

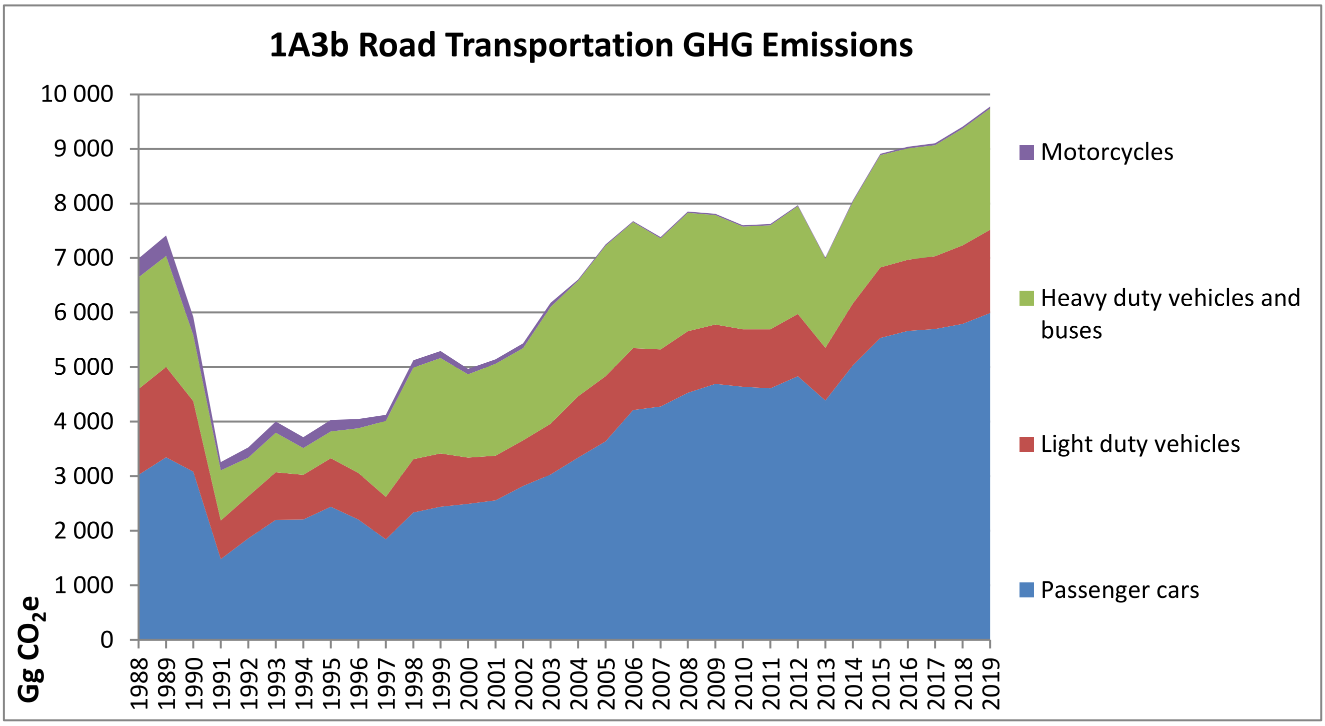

Figure 40 Emissions allocated to vehicle categories for the period 1988-2019

Whereas CO_2 emissions were closely linked to fuel consumption, CH_4 and N_2O emissions were considerably impacted by engine technology and did not follow the trend in the fuel consumption. As it can be observed in the following figure, N_2O emissions and implied emission factors tend to fluctuate for the period of the inventory following the introduction to the market of various engine technologies implementing EURO emission standards and various fuel quality standards (e.g. lead and sulphur content). However, the trend is not always downward, e.g. there was an increase in the IEF for the years up to 2003 which was closely linked to the gradual introduction of gasoline Euro 1 vehicles - a category known for its higher N_2O emissions. As the technology improves in time, there is a noticeable N_2O decrease resulting from the introduction of fuels with lower sulphur content (moving from Euro 1 to Euro 3) which is clearly observed after 2004.

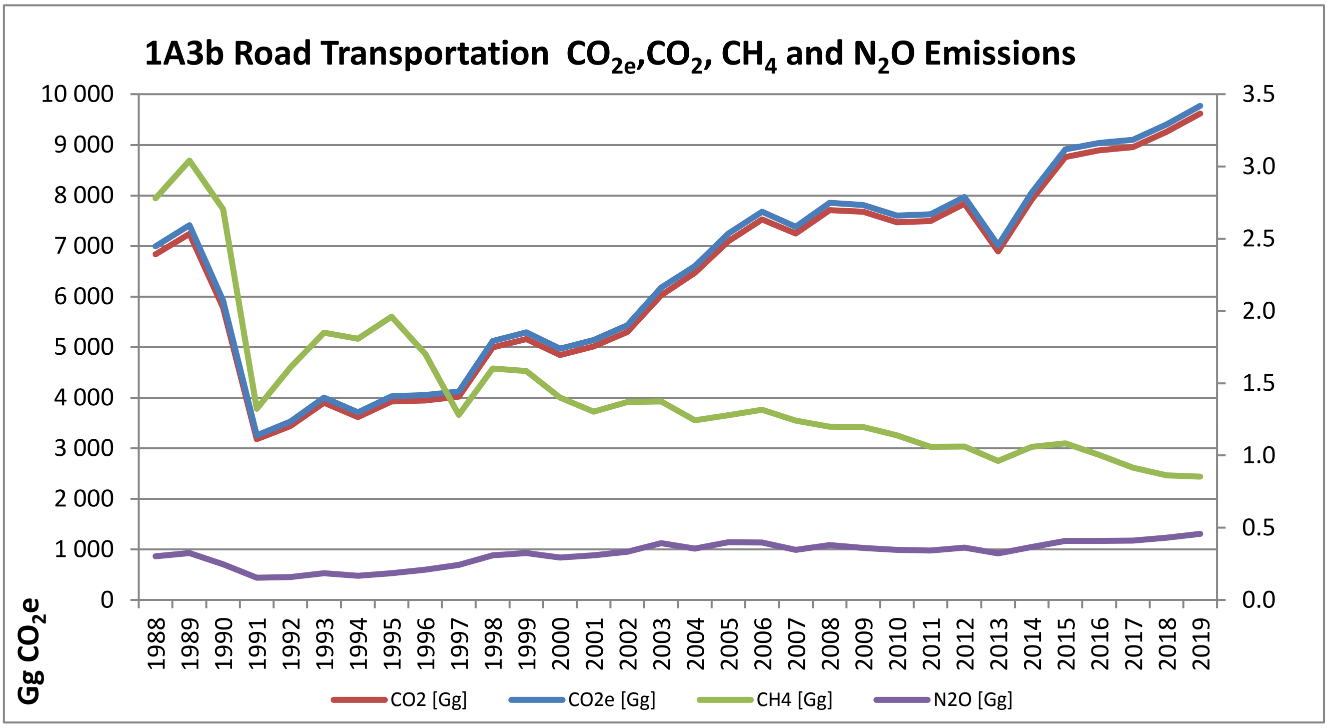

Figure 41 CO2, CO2e, CH4 and N2O emissions trends for the period 1988-2019

CH_4 emissions plummet, following Bulgarian gasoline consumption pattern, as the main source of those emissions proves to be pre-EURO gasoline passenger cars. After the crisis in the early 90s, a slight increase in the period 1992 – 1995 can be observed, followed by downward trend. Ultimately, compliance with strict Euro emission standards significantly influences CH_4 emissions and results in decreased levels of methane.

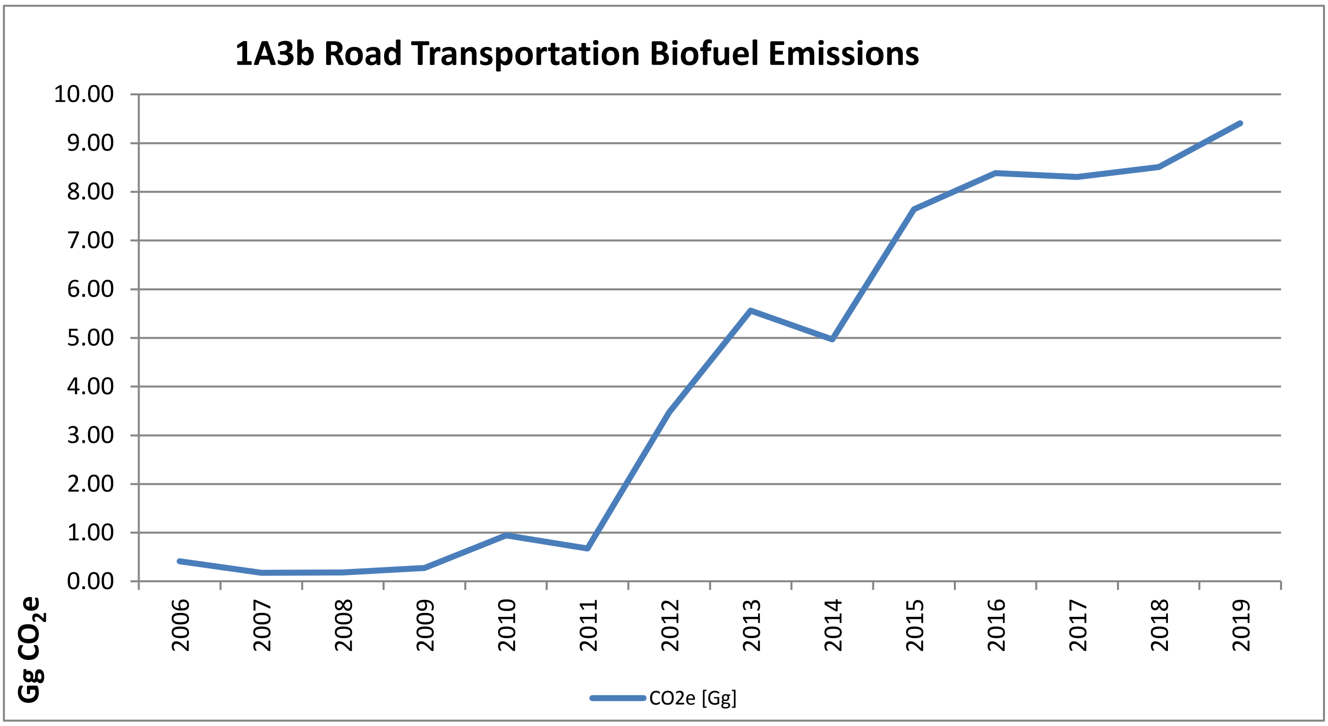

Figure 42 Emissions by biofuels from Road Transport for the period 2006-2019

Bulgarian market transport diesel and gasoline contain a small percentage of biofuels which are reported in the Energy balances as biofuels for blending. The reporting approach subtracts the amounts of biofuels for blending from the total amounts of road diesel and gasoline. A steep upward trend can be noticed due to an increase in biodiesel consumption since 2011. For the 2020 submission biofuel consumption was revised in order to account for fossil carbon content in biodiesel resulting from methanol use.

3.3.12.3.3 Methods

CO_2 emissions are best calculated based on the amount and type of fuel combusted and its carbon content. The emissions of CH_4 and N_2O are more difficult to estimate accurately because emission factors depend on vehicle technology, fuel and operating characteristics.

Road transport is a key category as a source of CO_2. In view of Review Report FCCC/ARR/2010/BGR, emission calculations of road transport have been conducted with the use of the COPERT computer model version 5.3 with subsequent adjustments, corresponding to Tier 2 methodology, according to the 2006 IPCC GL. Country-specific technology-based emission factors have been derived using the COPERT model, based on various country-specific and default parameters.

A number of changes regarding new passenger cars subsectors and emission factor updates have been made in COPERT's latest version – 5.3.

For the 2020 submission, a complete recalculation has been performed, introducing the new COPERT version 5.3 In order to apply the new version, an updated vehicle distribution matrix has been developed.

In the COPERT model emissions are calculated through numerous input parameters like data on average daily trip distance, fuel Reid vapor pressure (RVP), monthly minimum and maximum temperatures, fuel consumption and fuel specifications, vehicle fleet categorized by sectors, subsectors and technologies, vehicle stock, annual mileage, speed, driving shares and others. Comparison of Tier 2 with Tier 1 is performed as a verification cross-check.

3.3.12.3.4 Activity data

Fuel consumption (liquid, gaseous and biofuels) is obtained from the Energy balance and converted into energy units using the country-specific NCV (as recommended by the ERT (FCCC/ARR/2013/BGR). Further, as recommended by the ERT (FCCC/ARR/2011/BGR), CO_2 emissions are calculated based on total fuels sold in the country. The total amount of fuels sold is compared to the amount of fuels calculated according to the model and the difference is used for mileage adjustment to correspond to the fuel quantities from the Energy balance, as explained under "Mileage" below.

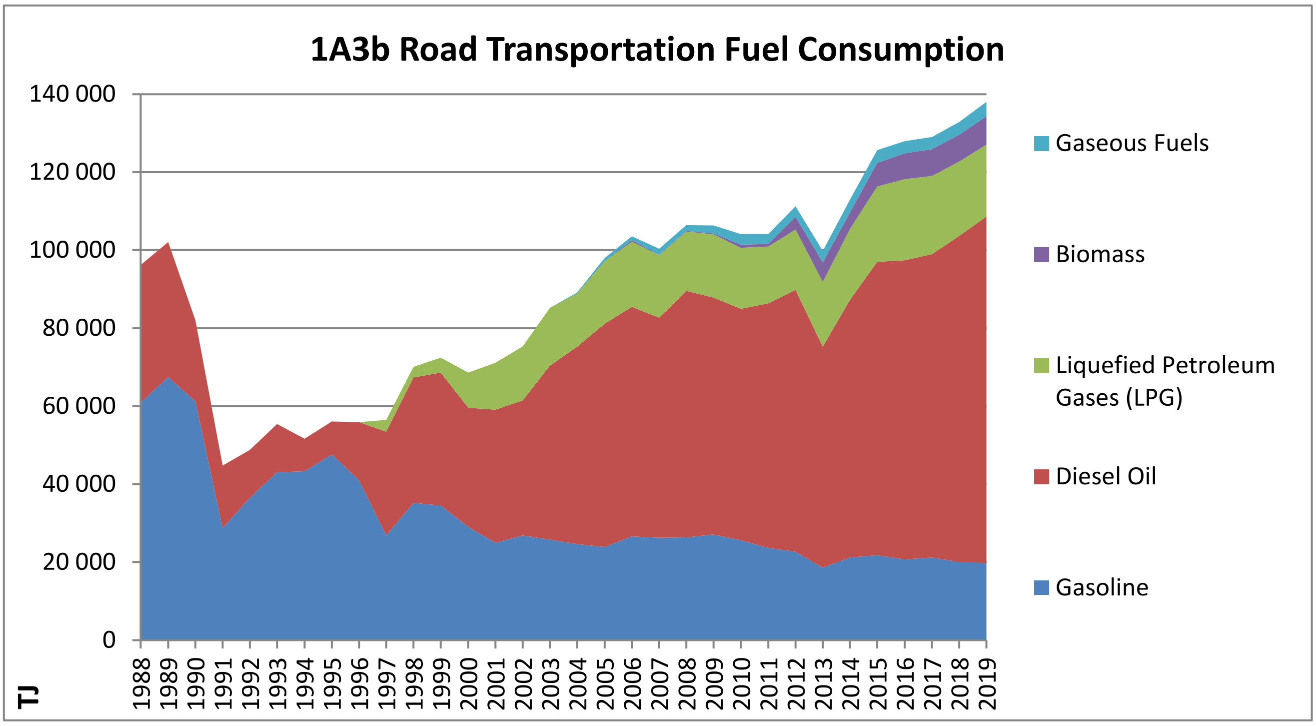

Figure 43 Fuel consumption in CRF 1.A.3.b Road transport (1988 - 2019)

Other data, necessary for implementation of the COPERT model has been provided by national institutions and companies (National Statistical Institute, National Institute of Meteorology and Hydrology, Ministry of Internal affairs, Department Traffic police, Lukoil Neftohim oil refinery, State Agency for Metrological and Technical Surveillance). However, in some cases, the completeness and quality of submitted information was not of the required detail. When directly related data was not available, surrogate data from various sources was used to complete the missing gaps and ensure the representativeness of the inputs to the COPERT model. A degree of expert judgment was required as well.
The following input data is compiled for the emission calculations with the use of COPERT 5:

Average daily trip distance

Average daily trip distance was calculated through www.bgmaps.com, one of the most popular websites for maps, routes, records and services to find individual addresses, locations and other information on the maps. An analysis of major cities' population and plausible daily journeys was performed; available data lead to an estimation of 15.1 km as average daily trip distance. Even though, the average European value of 12.4 km (Samaras et al. 2000) is slightly lower, the calculated figure seems to be more appropriate for Bulgarian conditions and driving culture. Time trip duration was estimated at 0.42 hour.

Minimum and maximum temperatures

Complete, country-specific data on monthly average minimum and maximum temperatures for the whole period of 1988 to 2019 was compiled by the National Institute of Meteorology and Hydrology.

Fuel specifications

Fuel specifications of liquid fuels were provided by Lukoil Neftohim – Burgas (as most of the liquid fuels sold on the national market are produced by Lukoil) and by the State Agency for Metrological and Technical Surveillance (SAMTS). The latter conduct quality inspections of the liquid fuels placed on the market according to national and European legislation requirements and by using accredited laboratories. As fuel sold at gas stations in the country is sampled regularly, SAMTS fuel quality data is considered representative for the fuel delivered to the final customer and utilized by the national fleet. Country specific data for diesel and gasoline for some of the fuel specifications was provided for the years 2005-2019 by Lukoil Neftohim – Burgas and SAMTS. Fuel quality data on LPG, biofuels and CNG was not obtained. Hence, literature information and regulatory technical requirements were used instead. In some cases, default values provided by COPERT were used and extrapolation of the existing numbers was applied to fill the gaps in the available data (Samaras 2000). It is important to note that since 2004 only unleaded gasoline is sold in Bulgaria (National Program to phase out lead in petrol). The percentage of leaded gasoline varies in the years before 2004, however, in 2003 the leaded gasoline share was only 2% (National Statistical Institute). An investigation of required fuel quality measurements showed that values for H:C and O:C ratios are not measured as a required fuel quality parameter in Bulgaria. Thus, country specific data on H:C and O:C values cannot be obtained at this stage (FCCC/ARR/2013/BGR). Further, as fuels sold in Bulgaria comply with European fuel quality requirements it is assumed that default COPERT values better represent the national circumstances.

Values for fuel volatility (RVP – Reid vapor pressure) are available for the period 2006-2019 (provided by Lukoil Neftohim oil refinery). For the previous periods, a summer and winter ranges are specified according to the technical requirements. Therefore, RVP data for the years 2000-2005 is estimated based on the available values and the legal requirements. RVP of 62 kPa (summer) and 67 kPa (winter) for the period 1988 -1999 is applied, based on the market average for 1996 (Samaras et al. et al. 2000) and the ratio of legal requirements to measured data, submitted in recent years.

Speed

Infrastructure and vehicle stock differ significantly in different regions. Vehicle speed varies between big and small agglomerations, being quite low in the rush hours, especially in densely populated areas. However, detailed data for speed variations is not available for the whole period. Krzywkowska et al. (2004) report approximate value of 24 km/h for mini buses in the urban region of Sofia. Additionally, a number of studies (André 2006, Samaras et al. 2002, Coronas Metropolitanas 2006) document various average speeds for several European cities. Also, private measurement of passenger cars average speed per day is considered. Ultimately, an average urban speed of 36.2 km/h was calculated via www.bgmaps.com, applying the above-stated methods for average daily trip distance calculation. That value is preferred for the inventory, considering traffic conditions in urban areas and literature research. A slightly higher value of 37 km/h is estimated for the period 1989-2000 regarding the traffic conditions in the past and the fluctuation in bus speed.

Considering public transport, buses are the most well-developed mode of transport in Sofia (MottMacDonald 2009), as that is the case for the other large cities (e.g. Plovdiv, Varna). Trams and trolleybuses occupy the second and third place, as trams are only used in the capital and are not subject to road transport category. Bus transport remains the preferred method of public and long-distance transportation as well. Average public transport speed for buses in Sofia is 19.4 km/h (Krzywkowska 2004), and for trolleybuses – 14.4 km/h (MottMacDonald 2009). These numbers vary back in the years as demonstrated by Breshkov, 2005.

Table 82 Average operational speed (km/h)

Vehicle type/ Year	2009	2006	2002	1995	1989
Trolleybus	14.4		14	14	14
Urban bus	19.4	19.65	18.1	18.1	19.5

Since bus lines are limited only to some areas, traffic jams frequently impede the free flow not only of private cars, but also of buses and trolley busses. That being said, the average speed of private cars is expected to be the highest under most circumstances, thus making the car one of the most preferred ways of city transport.

Speed values for rural and highway roads depend not only on vehicle type and purpose of the trip, but also on road quality. In Bulgaria, there are four classes of road classification: Motorway, Class I, II and

III. Class III roads represent 60% of the total length and are characterized by extremely poor quality, compared to other classes. Hence, the free flow speed variation in relation to the above-stated classes is the following (AECOM 2010):

Table 83 Average free flow speed (km/h) per type of road class

Road Class	Average free flow speed (km/h)
Class I	79
Class II	70
Class III	55
Motorway (Highway)	110

In view of available data, the average speed for emission calculations was estimated at 68km/h for rural areas for all types of vehicles (except for mopeds) and 110 km/h for motorway, except for coaches. When inappropriate data was available or it was missing altogether, the legal requirement speed limit was applied instead of the above-stated figures. Finally, a comparison of road classes for the years 2010-2002 revealed a negligible change in relation to rural speed variation. Therefore, an identical value of 68 km/h was used for all years.

Driving share

In most regards, Bulgarian road network density is similar to the average density of other EU member states. Still, in terms of high speed roads and motorways the country lags far behind – 3.8 km/1000 km^2 compared to Austria - 19 km/1000 km^2 in Slovenia - 14 km/1000 km^2, and in Lithuania - 6 km/1000 km^2 (MRDPW 2010).
Due to lack of data for Bulgaria on mileage split between urban, rural and highway driving, literature survey of driving cycles (André, 2006) based on information from 80 representative European private cars in France, the UK, Germany and Greece was performed. Additionally, comparison of road statistics for Slovakia and Bulgaria shows a number of similarities related to road classes' ratio, length of network, geography and GDP trends. Taking into account the above-mentioned surveys, the driving share split for Slovakia was adopted. Where necessary, data gaps for some years and categories were filled in by extrapolating the existing values.

Vehicle fleet

Corresponding to the COPERT methodology, detailed knowledge of the structure of the vehicle fleet is required in order to accurately estimate the emissions. The main sources of data on vehicle stock and classifications are the National Statistical Institute and the Ministry of Internal affairs. However, apart from the total numbers for main vehicle categories, only partial data considering distribution into fuel, weight, technology classes and age was provided for this submission, as well. Irrespective of those data gaps, a country specific vehicle fleet matrix was developed, as described below (FCCC/ARR/2013/BGR).
Data regarding the total number of vehicle types by age is represented in 6 ranges, from 1 to more than 20-year-old vehicles. This data is available for the period 2005 – 2019. Thus, the technology split for each vehicle category is determined based on the age structure and EURO standard year of market adoption. This approach is applied to estimate the vehicle numbers by sector and technology for the period 2005-2019. Additionally, data on vehicles by brand and expert judgment was used to estimate the entire time series back to 1988, especially concerning old gasoline cars.
Additionally, a split by fuel and engine volume is conducted. National data on vehicle type per fuel type for the period 2005 – 2019 is applied in a model, in order to generate the required subsector split. There are more than 10 vehicle categories by fuel (including bi-fuel combinations) according to national data, among which hybrids as well. This is why a conservative approach is applied to apportion vehicle figures to relevant COPERT vehicle groups. The resulting allocation by vehicle category is combined with data on engine volume extracted from TRACCS EU project. Since TRACCS provide data for 2005 to 2010, data gaps for the remaining years were filled in by extrapolation and expert judgement. Finally, total numbers for the national vehicle fleet were distributed in accordance with COPERT categories following the previously generated split by fuel, engine and EURO standard.
Mopeds classification to 2-sroke and 4-stroke engines is another type of split, required by COPERT. It is assumed, based on expert judgement, that 4-stroke mopeds are very rare and applicable for the

matrix only for some countries (e.g. Italy). Thus, this subsector is considered irrelevant in the current matrix.

Mileage

As only basic information on mileage per urban buses, coaches and heavy-duty vehicles (>6t) was obtained from the National Statistics Institute, mileage for 2005 was estimated based on the average for 16 European countries that provided such data (Ntziachristos et al. 2008). However, the average EU15 mileage data may lead to overestimations of emissions. As recommended by Ntziachristos et al. (2008) mileage values were adjusted in order to better match the statistical fuel consumption (actual fuel sold). This was performed in relation to the fact that CO_2 emissions are calculated on the basis of fuel consumption (Ntziachristos et al., 2008) and that CO_2 emissions from road transport are indicated as a key category. The calibration procedure seeks to ensure an exact match between statistical and calculated fuel consumption. The updated COPERT 5 model performs this calibration automatically. The calibration procedure ultimately ensures that CO_2 emission estimates are prepared based on the quantities of fuel sold, according to the IPCC guidelines.
For all other required parameters (e.g. fuel injection, evaporation control, evaporation distribution, slope factor, load factor) the default values provided by the COPERT model were used.

3.3.12.3.5 Emission factors

According to the IPCC guidelines, an emission factor is defined as the average emission rate of a given GHG for a given source, relative to units of activity. Whereas, an implied emission factor (IEF) is defined as emissions divided by the relevant measure of activity:

IEF = Emissions / Activity data

IEF are not equivalent to the emissions factors for emissions calculations. IEF are akin to results providing average values for complex categories such as road transport, where the emissions are dependent on many parameters related to vehicle fleet distribution.
The emission factors used for the calculations of GHG emissions from road transport subsector are based on the algorithms of COPERT. The emission factors are internal parameters that depend both on the input data (e.g. average trip distance, driving and climatic conditions, etc.) and COPERT algorithms. However, the COPERT model uses different emission factors for each vehicle category and technology. Thus, it is only possible to provide the implied emission factors which take into account the calculated emissions of greenhouse gases per fuel and the model related to the reported fuel consumption.
The decrease in the CH_4 implied emission factor (IEF) for gasoline and diesel fuel is a result of the gradual increase in the number of vehicles that meet the standards set out in the EU directive on emissions from motor vehicles (mostly EURO 2 and EURO 3 vehicles), which slowly replaced the older technologies. It has to be noted, that the Bulgarian car fleet consists mostly of second hand vehicles, imported from Western Europe. This leads to a delay in the introduction of each new vehicle technology by 4 to 7 years, compared to other EU countries. It is also slightly more complex to model a vehicle distribution matrix, since it is influenced both by the sales of new vehicles and by the imports of second hand vehicles. Finally, there is still a very large number of very old vehicles in operation – the average vehicle age is much higher than in the other European countries.

Table 84 Implied emission factors of CO_2, N_2O and CH_4 by fuel types

Fuel type	Gasoline			Diesel		
Emissions	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Year	t/TJ	kg/TJ	kg/TJ	t/TJ	kg/TJ	kg/TJ
1988	69.30	41.28	2.21	74.10	7.59	4.77
1990	69.30	41.61	2.26	74.10	7.65	5.19
1995	69.30	39.78	2.83	74.10	7.76	6.03
2000	69.30	34.46	3.39	74.10	7.27	5.72
2005	71.58	24.94	3.39	74.93	6.19	4.89
2010	71.71	19.43	2.72	74.93	4.46	3.82
2011	71.60	18.54	2.64	74.93	4.23	3.69
2012	71.51	17.90	2.52	74.93	4.02	3.59
2013	72.31	17.36	2.41	75.42	3.79	3.56

Fuel type	Gasoline			Diesel		
Emissions	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Year	t/TJ	kg/TJ	kg/TJ	t/TJ	kg/TJ	kg/TJ
2014	72.94	16.92	2.36	75.37	3.56	3.55
2015	74.28	16.06	2.23	75.40	3.31	3.56
2016	74.49	14.92	2.06	75.46	2.97	3.58
2017	74.01	13.71	1.81	75.49	2.56	3.64
2018	74.32	12.92	1.69	75.45	2.32	3.66
2019	74.61	13.05	1.70	75.47	2.12	3.69

Table 85 Implied emission factors of CO_2, N_2O and CH_4 by fuel types

Fuel type	LPG			CNG		
Emissions	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Year	t/TJ	kg/TJ		t/TJ	kg/TJ	
1988	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
2000	63.10	19.77	2.33	NO	NO	NO
2005	65.73	18.02	2.18	56.71	49.41	5.55
2010	65.73	16.10	2.00	56.04	43.90	5.91
2011	65.73	15.67	1.94	56.03	48.86	7.45
2012	65.73	15.12	1.86	55.96	50.93	8.43
2013	65.73	14.60	1.77	56.08	53.22	9.46
2014	65.73	14.20	1.71	56.14	55.96	10.70
2015	65.73	13.62	1.61	56.20	56.64	11.51
2016	65.73	12.90	1.46	56.04	52.46	11.27
2017	65.73	11.99	1.26	56.03	49.81	11.72
2018	65.73	11.52	1.16	56.05	48.79	12.40
2019	65.73	11.13	1.09	56.08	47.46	12.80

A new approach was adopted as a result of the ERT recommendation (FCCC/ARR/2014/BGR) to conduct a Tier 2 estimate of CO_2 emissions from gasoline fuel, based on country-specific EFs, due to the introduction of biofuels to road transportation. Biofuels in transport are mostly consumed in the form of biodiesel blended with diesel and biogasoline (consumption started in 2013 in insignificant amounts. but increased rapidly). Thus, the consumption of biofuels cannot be linked to the decreasing trend of CO_2 IEF for gasoline. Regarding the recommendation to use a Tier 2 approach, Lukoil Neftochim was approached in order to obtain country-specific values for the carbon content of the liquid fuels produced. However, it was established that the fuel producer did not measure this fuel feature properly. On a related note, Bulgaria imports significant amounts of diesel and gasoline from neighbouring countries, which makes the estimate of a country-specific emission factor highly uncertain.

The 2006 IPCC GL do allow the CO_2 emission factors to be adjusted to take account of un-oxidized carbon or carbon emitted as a non-CO_2 gas at higher tiers (Chapter 3.2.1.2). The COPERT model, utilizing all available country-specific parameters, is considered to produce country-specific emission factors to the best possible extent, even though some of the parameters are used with their default values.

During emission estimates it was ensured that activity data regarding fuel consumption used in the COPERT model matched exactly the amounts of fuel sold reported by the National statistics. Using emission factors from the COPERT model (which is partly based on some default fuel properties according to EMEP/EEA air pollutant emission inventory guidebook) is considered to be much more relevant than the default IPCC emission factors. The EMEP/EEA emission factors are also higher than the default IPCC factors, which helps to avoid underestimating emissions from Road transport.

Additionally, the IEF of LPG for the period 2004-2006 is varying as a result of fluctuations in NCV provided by national statistics. Up to 2006 Bulgaria used the NCVs for liquid fuels provided by the producers/importers. In order to harmonize Bulgarian and EU statistics (IEA/Eurostat uses average NCVs for all liquid fuels) the preferred EU approach has been adopted since 2007. In this regard, discussions with Lukouil Neftochim revealed that NCVs had never been measured by laboratory tests,

since the process was too costly. Instead, other relevant characteristics were monitored to ensure compliance with international standards. This is the key reason to use the average European NCVs for the years after 2007.
The NCV methodology adopted adjusts the annual mileage in order to have an exact match with the reported fuel consumption in natural units (Gg) and the calculated fuel consumption by the COPERT model. It is considered that the NCV difference does not influence emission estimates, but only reflects the IEF.

3.3.12.3.6 Uncertainties

The following default uncertainties are assumed (IPCC 2006 GLs, Ch. 3.2.2 Uncertainty Assessment. page 3.29 – 3.30):

AD	+/-5 %		EF CO_2	EF N_2O	EF CH_4
		Motor Gasoline	5% / -3%	244% / -70%	233% / -71%
		Gas / Diesel Oil	1% / -2%	208% / -67%	144% / -59%
		LPG	4% / -2%	200% / -68%	238% / -70%

Except for the above-mentioned uncertainty values, the inherited uncertainty of COPERT is associated with model formulation and input data. Emission factors, derived from experimental data, comprise an internal parameter of significant uncertainty. With respect to inputs, vehicle fleet information and related data on vehicle movements are the most probable source of uncertainties. Monte Carlo simulations reveal that 16 or 17 items comprising a total 51 of internal parameters and input variables are responsible for more than 90% of the total uncertainty in countries with good and poor statistics, respectively. In our case, as a country with relatively poor transport statistics, the most probable factors, according to this research, could be hot and cold-start emission factors, technology distribution, mileage, mean trip distance. Further, coefficient of variation for the following was estimated (Kioutsioukisa et al., 2010):

Parameter	Uncertainty for countries with poor transport statistics (%)
Fuel consumption and CO_2	<10
CH_4	>20
N_2O	>20

3.3.12.3.7 Source-specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, CO_2 emissions, emission factors and IEF (time series)
- Time series consistency
- Plausibility checks of dips and jumps (this is due to the Energy balance)
- Documentation and archiving of all information required in NIR, background documentation and archive.

3.3.12.3.8 Source-specific recalculations

Following a recommendation from FCCC/ARR/2010/BGR §79, a recalculation of the entire time series is undertaken due to implementation of higher tier method and incorporation of the COPERT model, version 11, into the national road transport inventory.
Following a recommendation from FCCC/ARR/2010/BGR §76, the allocation of reported consumption of residual fuel oil in Road and Rail transport categories for the period 1991–1996 to Commercial and public services category is continued.
Regarding recommendation from FCCC/ARR/2011/BGR §70, a detailed review of the activity data and parameters used in the COPERT model was undertaken. It was concluded that the main cause for the decrease of the implied emission factor for gasoline is the gradual increase of EURO-standard vehicles (mostly Euro 2 and Euro 3) introduced in the country, which replaced the older Pre-ECE and ECE vehicles. As the CH_4 EF of the Pre-ECE and ECE vehicles is 5 times higher than the EURO

vehicles, a significant drop in the IEF is observed. This is also why a generally stable downwards trend in the IEF is observed.
For the 2015 submission a detailed investigation of country-specific parameters used in the COPERT model concerning vehicle fleet and split was conducted. As a result, a new vehicle distribution matrix was developed which better represents relevant national circumstances compared to the vehicle distribution matrix of Slovenia, used previously.
Additionally, following a recommendation from the ERT from the 2016 review cycle, CO_2 emissions from Road transport were recalculated. For the period 1988-2003, the IPCC default EF for gasoline, diesel oil and LPG (69.3 t/TJ, 74.1 t/TJ and 63.1 t/TJ respectively) were applied, as the EFs provided by the EMEP/EEA Emission Inventory Guidebook (adopted by the COPERT model) were deemed unsuitable, due to the different fuel quality standards applicable for that period. For the period 2004-2018 the EFs derived by the COPERT model were applied, considering the fact the EMEP/EEA Emission Inventory Guidebook provides better EFs regarding fuels sold in Europe. Post 2003 the production of leaded gasoline has been discontinued, so it was assumed that the produced fuels fully comply with the European fuel quality standards and thus the COPERT EFs were considered to better represent national circumstances.
For the 2020 submission an updated version of the COPERT 5.3 model was introduced, which corrects some errors, including in the algorithm for performing an energy balance and introduces new emission factors. As usual, a complete recalculation of the entire time-series was performed with the updated software.
A methodological change was introduced in the 2020 submission related to emissions from biofuels. Following conversations with Ministry of Environment, National Statistics and producers of biofuels were assessed the types of biofuels, which are imported and produced in Bulgaria. For biogasoline it was confirmed, that both production and imports are bioalcohols and there are no bioethers (MTBE, ETBE or TAEE) used for blending, thus all 100% of the emissions related to biogasoline are assumed to be of biogenic origin. For biodiesel it was confirmed with producer that fossil-derived methanol is used in the production. As there was no information on the imports, it was assumed that 100% are also FAME. A default value of 5.4% was assumed for the carbon content of the fossil part (estimated by considering that FAME composition is 50% rapeseed / 30% sunflower / 20% palm oil), which led to recalculation of biodiesel emissions for the entire time series. The emissions from the fossil part of carbon content of FAME were reported under Other fossil fuels in respective subcategories.
For the 2021 submission an updated version of the COPERT 5.3 model was introduced, which corrects some errors, including in the algorithm for performing an energy balance and introduces new emission factors. Additionally, vehicle fleet matrix was expanded in order to include Euro 6d category. As usual, a complete recalculation of the entire time-series was performed with the updated software.

3.3.12.3.9 Source-specific planned improvements

We had several conversations with our refinery on the possibility to perform samples on the produced fuels in order to derive a country-specific emission factors for liquid fuels, as recommended by ERT. The refinery is not currently measuring any fuel parameters related to carbon content or H:C and O:C ratios. Additionally, the refinery was also not aware of the applicable laboratory standards, that should be used for determining the diesel and gasoline carbon content. We also considered the possibility to take fuel samples at gas stations, but we concluded that this approach would not be correct, as the fuels sold are already blended with biofuels. Additional complication provided the fact, that out refinery delivers to around 50% of the market, with the rest being covered by imports from Romania, Greece and other countries with varying annual shares. In order to calculate a representative country-specific EF, we would have to consider those annual variations, provided that we would be able to obtain the carbon content of the imported fuels. As a conclusion, we consider that the default fuel parameters, provided in the EMEP/EEA emission inventory guidebook and subsequently used by the COPERT model are much more certain and relevant nationally (considering the fact that liquid fuels are following common European standards), than a potential approach for deriving a country-specific emission factor, which is based on a limited number of laboratory measurements and some hard to obtain parameters of imported fuels.
We plan to update the calculation methodology for CO_2 emissions when country-specific CO_2 emission factors are available (if provided by the Lukoil Neftochim – the national refinery).
For the 2022 submission we plan to reallocate the emissions from lubricants consumed in 2-stroke engines to the Energy sector, as they are currently reported under the IPPU sector.

3.3.12.4 Railways (CRF 1.A.3.c)

3.3.12.4.1 Source category description

GHG emissions from the Railways sector is not defined as a key source category. The main emission source is the use of gas-diesel oil.

3.3.12.4.2 Emission trend

Fuel consumption from Railway transport constitutes 0.5% of the total Transport sector and thus, as a category does not contribute significantly to the total emissions from the Transport sector in Bulgaria. Railways related GHG emissions are quite low in Bulgaria, due to decreasing railway transport of passengers and freight and the fact that most of the locomotives in use are electricity-powered. A clear downward trend in GHG emissions has been observed in recent years:

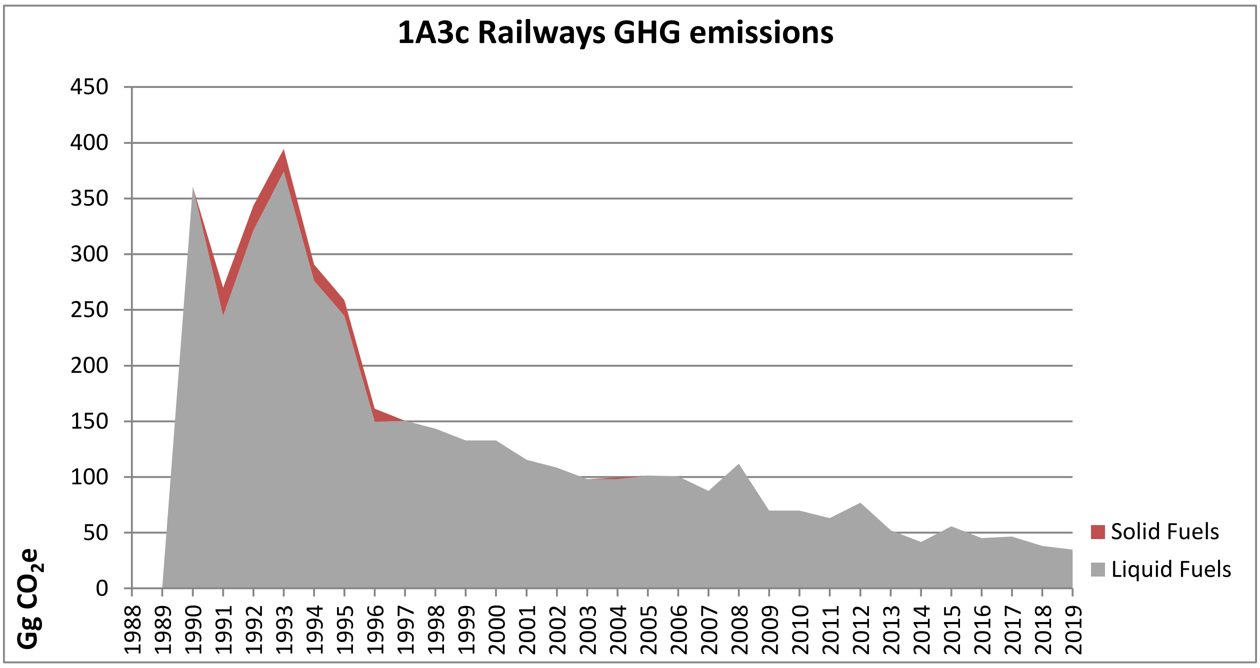

Figure 44 GHG emissions in CRF 1.A.3.c Railway transport (1988 - 2019)

As the figure above demonstrates, emissions from Railway transport in 2019 have plummeted by 90.3% since 1990. The emissions are mainly due to the consumption of liquid fuels (gas-diesel oil). Regarding the years 1988-1989, fuels consumed in the Railways category have not been reported; therefore the data entries are marked as NO. However, it has been assumed that the relevant quantities are reported under CRF 1.A.5 Other.

3.3.12.4.3 Methods

Following the recommendations of ERT set out in FCCC/ARR/2010/BGR §75 the emissions from Railway are calculated based on Revised 2006 IPCC GL and Tier 1 approach has been applied. Equation 3.4.1 (GENERAL METHOD FOR EMISSIONS FROM LOCOMOTIVES) has been applied:

$$\textbf{Emissions} = \Sigma(\textbf{Fuel}_j \bullet \textbf{EF}_j)$$

Where:
Emissions = emissions (kg)
Fuel j = fuel type j consumed (as represented by fuel sold) in (TJ)
EF j = emission factor for fuel type j. (kg/TJ)
j = fuel type

For Tier 1, emissions are estimated using fuel-specific default emission factors, assuming that for each fuel type the total fuel is consumed by a single locomotive type.

3.3.12.4.4 Activity data

Fuel consumption (liquid and solid) is obtained from Eurostat Energy balance and converted into energy units using country-specific NCV. The energy balance provides activity data for consumption of residual fuel oil both in railways and road transport in the period 1991 – 1996. This is an improbable allocation and following the recommendations of ERT set out in FCCC/ARR/2010/BGR §76, quantities of this fuel reported under railways and road transport have been allocated to subcategory 1A4a Stationary combustion in Commercial/Institutional, as this fuel has probably been used for heating purposes.

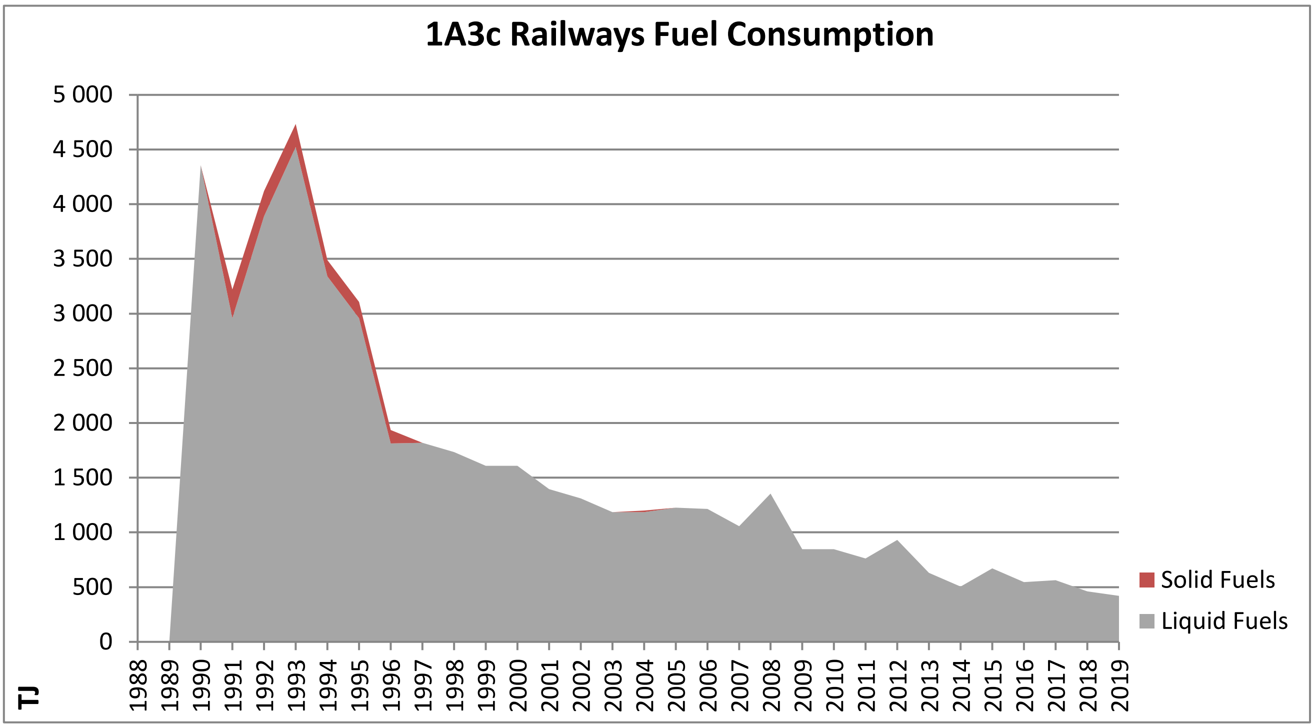

Figure 45 Fuel consumption in CRF 1.A.3.c Railway transport (1988 - 2019)

Table 86 Activity data for Gas-Diesel Oil, emissions and emission factors for subcategory 1A3c Railways

	Gas-Diesel Oil			EF* CO_2	CO_2 emission	EF* N_2O	N_2O emission	EF* CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	0	NO	42.6	74.10	NO	0.0286	NO	0.00415	NO
1990	103	4 357	42.3	74.10	323	0.0286	0.125	0.00415	0.018
1995	69	2 919	42.3	74.10	216	0.0286	0.083	0.00415	0.012
2000	38	1 607	42.3	74.10	119	0.0286	0.046	0.00415	0.007
2005	29	1 227	42.3	74.10	91	0.0286	0.035	0.00415	0.005
2010	20	846	42.3	74.10	63	0.0286	0.024	0.00415	0.004
2011	18	761	42.3	74.10	56	0.0286	0.022	0.00415	0.003
2012	22	931	42.3	74.10	69	0.0286	0.027	0.00415	0.004
2013	15	630	42.0	74.10	47	0.0286	0.018	0.00415	0.003
2014	12	505	42.1	74.10	37	0.0286	0.014	0.00415	0.002
2015	16	673	42.0	74.10	50	0.0286	0.019	0.00415	0.003
2016	13	546	42.0	74.10	40	0.0286	0.016	0.00415	0.002
2017	13	563	42.0	74.10	42	0.0286	0.016	0.00415	0.002
2018	11	462	42.0	74.10	34	0.0286	0.0132	0.00415	0.002
2019	10	421	42.0	74.10	31	0.0286	0.0120	0.00415	0.002

** 2006 IPCC Guidelines, Vol. 2, Ch. 3, Table 3.4.1*

3.3.12.4.5 Emission factors

The 2006 IPCC GL default GHG EFs for liquid and solid fuels have been applied.

3.3.12.4.6 Uncertainties

The following default uncertainties are assumed (2006 IPCC GL, Ch. 3.4.1.6 Uncertainty Assessment, page 3.45 – 3.46):

	EF CO_2	EF N_2O	EF CH_4
Diesel	1.5%	58%	60%
AD	+/-5 %		

3.3.12.4.7 Source-specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.

- Check of methodology, CO_2 emissions, emission factors and IEF (time series)
- Time series consistency
- Plausibility checks of dips and jumps (due to the Energy balance)
- Documentation and archiving of all information required in NIR, Background documentation and archive.

3.3.12.4.8 Source-specific recalculations

Following a recommendation made by FCCC/ARR/2013/BGR emissions from residual fuel oil in the railways subcategory are reallocated to the category commercial/institutional for the entire time series.

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

3.3.12.5.1 Source category description

GHG emissions from navigation are not defined as key source.
In Bulgaria navigation is used mostly for transportation of freights. However, the consumption patterns have been unstable since 2000, as it can be observed from the figures below.
The previous assumption regarding residual fuel oil and gas/diesel oil consumed by navigation and marine transport was that it was reported in the industry sector, since there were some discussions regarding erroneously allocated fuel quantities. In addition, in the earlier years of the time series, NSI reported in the energy balances all quantities of fuels loaded on Bulgarian ships regardless of the port the fuel was loaded on. This explains the large quantities reported for the years before 1997. More recently, it has been clarified by the NSI that vessels do not load fuels at Bulgarian ports because of the low fuel quality and higher prices.
Currently cargo is predominantly transported on international routes. Very limited amounts are transported within Bulgaria and this usually happens as part of an international route. Still, there is high uncertainty regarding the way fuel loading is accounted in this particular scenario. It is assumed that freight companies load their fuel mainly outside Bulgaria – either in Romania or on their way to other countries.

3.3.12.5.2 Emission trend

Navigation is a very minor source of emissions for Bulgaria.

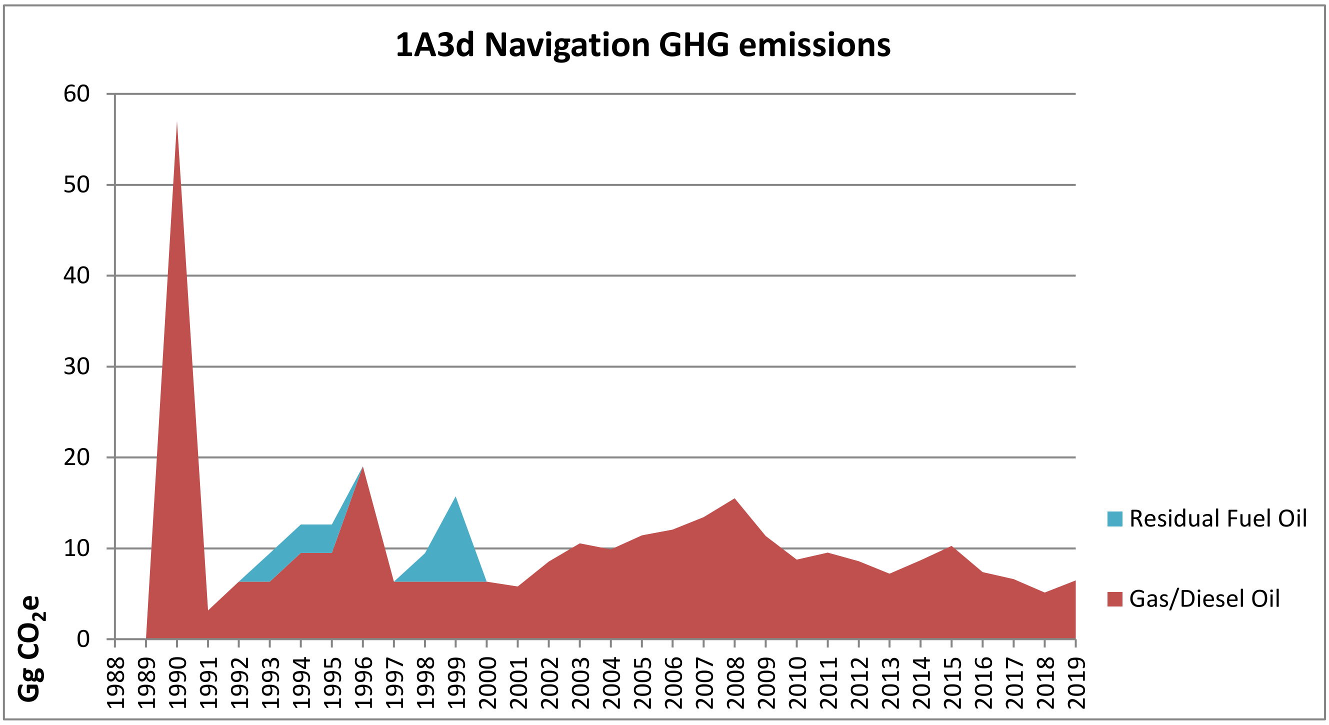

Figure 46 GHG emissions in CRF 1.A.3.d Navigation (1988 - 2019)

3.3.12.5.3 Methods

The 2006 IPCC Guidelines Tier 1 approach has been applied (Equation 3.5.1. Water-Borne Navigation Equation)

$$\textbf{Emissions} = \Sigma(\textbf{Fuel Consumed}_{ab} \bullet \textbf{Emission Factor}_{ab})$$

Where:
a = fuel type (diesel, gasoline, LPG, bunker, etc.)
b = water-borne navigation type (i.e., ship or boat, and possibly engine type.) (Only at Tier 2 is the fuel used differentiated by type of vessel so b can be ignored at Tier 1)

3.3.12.5.4 Activity data

Considering the fuel consumption fluctuations described above and in order to avoid underestimating emissions from navigation, the amount of fuel consumed is calculated based on the cargo transported inland (domestic transport of goods) for the period 2001-2017. Data on transported cargo inland is obtained from the National Statistics Institute (NSI) and the Danube Commission (DC). Data on transported goods for previous years (1988 – 2000) is not available, thus the reported quantities of fuels sold are used for the present emission estimates.
Average freight distance is calculated at 205 km, based on the distance between western and eastern Bulgarian ports. Further, distance in tonne kilometres travelled goods (tkm) is derived from the average distance and weight of domestic goods transported.
Fuel economy for barge operation (kg/tkm) is estimated as average European data from Ecoinvent database is applied to calculate the tonnes of fuel consumed.

Table 87 Data on transported goods and fuel consumed for transportation

Year	Transported goods (DC)	Transported goods (NSI)	Transported goods (domestic)	Average distance	Distance	Fuel economy	Fuel consumed
Unit	1000t			km	tkm	kg diesel/tkm	t
2001	950	0	950	205	194 647 500	0.00939	1828
2002	1402	0	1402	205	287 410 000	0.00939	2699
2003	1731	0	1731	205	354 855 000	0.00939	3332
2004	1621	0	1621	205	332 202 500	0.00939	3119

2005	1741	1875	1875	205	384 375 000	0.00939	3609
2006	1001	2000	2000	205	410 000 000	0.00939	3850
2007	1130	2203	2203	205	451 615 000	0.00939	4241
2008	1392	2543	2543	205	521 315 000	0.00939	4895
2009	842	1864	1864	205	382 120 000	0.00939	3588
2010	390	1434	1434	205	293 970 000	0.00939	2760
2011	390	1563	1563	205	320 415 000	0.00939	3009
2012	0	1407	1407	205	288 435 000	0.00939	2708
2013	0	1190	1190	205	243 950 000	0.00939	2291
2014	0	1431	1431	205	293 355 000	0.00939	2755
2015	0	1695	1695	205	347 475 000	0.00939	3263
2016	0	1222	1222	205	250 510 000	0.00939	2352
2017	0	1092	1092	205	223 860 000	0.00939	2102
2018	0	850	850	205	174 250 000	0.00939	1636
2019	0	1070	1070	205	219 350 000	0.00939	2060

3.3.12.5.5 Emission factors

The 2006 IPCC Guidelines default GHG EFs for Gas-Diesel Oil and Residual Fuel Oil have been applied (assuming an oxidation factor of 1). The emission factors are provided in the following tables:

Table 88 Activity data, emissions and emission factors for subcategory 1A3d Navigation

	Gas-Diesel Oil			EF* CO_2	CO_2 emission	EF* N_2O	N_2O emission	EF* CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	0	NO	42.60	74.10	NO	0.002	NO	0.007	NO
1990	18	761.4	42.30	74.10	56.4	0.002	0.0015	0.007	0.0053
1995	3	126.9	42.30	74.10	9.4	0.002	0.0003	0.007	0.0009
2000	2	84.6	42.30	74.10	6.3	0.002	0.0002	0.007	0.0006
2005	4	152.7	42.30	74.10	11.3	0.002	0.0003	0.007	0.0011
2010	3	116.8	42.30	74.10	8.7	0.002	0.0002	0.007	0.0008
2011	3	127.3	42.30	74.10	9.4	0.002	0.0003	0.007	0.0009
2012	3	114.6	42.30	74.10	8.5	0.002	0.0002	0.007	0.0008
2013	2	96.3	42.03	74.10	7.1	0.002	0.0002	0.007	0.0007
2014	3	115.8	42.05	74.10	8.6	0.002	0.0002	0.007	0.0008
2015	3	137.2	42.04	74.10	10.2	0.002	0.0003	0.007	0.0010
2016	2	98.8	42.00	74.10	7.3	0.002	0.0002	0.007	0.0007
2017	2	88.3	41.99	74.10	6.5	0.002	0.0002	0.007	0.0006
2018	2	68.7	42.01	74.10	5.1	0.002	0.0001	0.007	0.0005
2019	2	86.5	42.00	74.10	6.4	0.002	0.0002	0.007	0.0006

Table 89 Activity data, emissions and emission factors for subcategory 1A3d Navigation

	Residual Fuel Oil			EF* CO_2	CO_2 emission	EF* N_2O	N_2O emission	EF* CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	0	NO	40	77.40	NO	0.002	NO	0.007	NO
1990	0	NO	40	77.40	NO	0.002	NO	0.007	NO
1995	1	40	40	77.40	3.1	0.002	0.0001	0.007	0.0003
2000	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2005	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2010	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2011	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2012	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2013	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2014	0	NO	40	77.40	NO	0.002	NO	0.007	NO

	Residual Fuel Oil			EF* CO_2	CO_2 emission	EF* N_2O	N_2O emission	EF* CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
2015	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2016	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2017	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2018	0	NO	40	77.40	NO	0.002	NO	0.007	NO
2019	0	NO	40	77.40	NO	0.002	NO	0.007	NO

** For N_2O and CH_4 the default values from table 3.5.3 IPCC 2006 GL have been used.*

3.3.12.5.6 Uncertainties

The following default uncertainties are assumed (2006 IPCC GL, Ch. 3.5.1.7 Uncertainty Assessment, page 3.54):

	EF CO_2	EF N_2O	EF CH_4
Diesel	± -1.5%	-40%/+140%	±50%
Residual Fuel Oil	± -3%		
AD	+/-50%		

3.3.12.5.7 Source-specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, CO_2 emissions, emission factors and IEF (time series)
- Time series consistency
- Plausibility checks of dips and jumps (at this stage not possible - this is due to the Energy balance / see trend description)
- Documentation and archiving of all information required in NIR, Background documentation and archive.

3.3.12.5.8 Source-specific planned improvements

No specific improvements for this subcategory are planned.

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

3.3.12.6.1 Source category description

The category (1.A.3.e) includes emissions from all remaining transport activities including pipeline transportation, related to the operation of compressor stations and maintenance of pipelines. This is a key category for 2019, mainly because of the significant volume of natural gas consumed for pipeline transport.

3.3.12.6.2 Emission trend

Some small quantities of liquid fuels are reported at the beginning of the time series, but in general natural gas remains the main source of emissions from this subcategory. Data regarding the consumption is provided in the Energy balance.

Table 90 Activity data, emissions and emission factors for gas-diesel oil

	Gas-Diesel Oil			EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	0	NO	42.60	74.10	NO	0.03	NO	0.00	NO
1990	42	1 777	42.30	74.10	131.65	0.03	0.051	0.00	0.0074

	Gas-Diesel Oil			EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1995	0	NO	42.30	74.10	NO	0.03	NO	0.00	NO
2000	0	NO	42.30	74.10	NO	0.03	NO	0.00	NO
2005	0	NO	42.30	74.10	NO	0.03	NO	0.00	NO
2010	0	NO	42.30	74.10	NO	0.03	NO	0.00	NO
2011	0	NO	42.30	74.10	NO	0.03	NO	0.00	NO
2012	0	NO	42.30	74.10	NO	0.03	NO	0.00	NO
2013	0	NO	42.03	74.10	NO	0.03	NO	0.00	NO
2014	0	NO	42.05	74.10	NO	0.03	NO	0.00	NO
2015	0	NO	42.04	74.10	NO	0.03	NO	0.00	NO
2016	0	NO	42.00	74.10	NO	0.03	NO	0.00	NO
2017	0	NO	41.99	74.10	NO	0.03	NO	0.00	NO
2018	0	NO	42.01	74.10	NO	0.03	NO	0.00	NO
2019	0	NO	42.00	74.10	NO	0.03	NO	0.00	NO

Table 91 Activity data, emissions and emission factors for residual fuel oil

	Residual fuel oil			EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
1990	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
1995	1	40	40.00	77.40	3.1	0.002	0.0001	0.007	0.0003
2000	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2005	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2010	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2011	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2012	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2013	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2014	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2015	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2016	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2017	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2018	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2019	0	NO	40.00	77.40	NO	0.002	NO	0.007	NO

Table 92 Activity data, emissions and emission factors for natural gas

	Natural gas	EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	TJ	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	NO	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO	NO
2000	6886.8	55.20	380.2	0.10	0.001	1.0	0.007
2005	9042.3	55.20	499.2	0.10	0.001	1.0	0.009
2010	5895.9	55.24	325.7	0.10	0.001	1.0	0.006
2011	8527.5	55.26	471.3	0.10	0.001	1.0	0.009
2012	8518.5	55.20	470.2	0.10	0.001	1.0	0.009

	Natural gas	EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	TJ	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
2013	7607.7	55.37	421.2	0.10	0.001	1.0	0.008
2014	7031.7	55.43	389.8	0.10	0.001	1.0	0.007
2015	6140.7	55.63	341.6	0.10	0.001	1.0	0.006
2016	6012.9	55.64	334.5	0.10	0.001	1.0	0.006
2017	7157.8	55.48	397.1	0.10	0.001	1.0	0.007
2018	5751.0	55.54	319.4	0.10	0.001	1.0	0.006
2019	2268.6	55.56	126.1	0.10	0.000	1.0	0.002

3.3.12.6.3 Methods

The 2006 IPCC Guidelines Tier 2 approach has been applied for gaseous fuels, Tier 1 for liquid fuels. Emissions from off-road sources have been allocated under construction and agriculture/forestry sectors, while the fuel quantities used by vehicles at airports and harbours have been reported under road transport sector.

3.3.12.6.4 Activity data

The National energy balances have been used to obtain the fuel consumption and net calorific values.

3.3.12.6.5 Emission factors

The default EFs from the 2006 IPCC Guidelines for Gas-Diesel Oil and Residual Fuel Oil has been applied. For the calculation of pipeline transport emissions, the country-specific emission factors have been used.

3.3.12.6.6 Uncertainties

Greenhouse gas emissions from other transport sources are typically much smaller than those from road transportation, but activities in this category are diverse and are thus typically associated with higher uncertainties because of the extra uncertainty in activity data.
The types of equipment and their operating conditions are typically more diverse than those for road transportation. This may give rise to a larger variation in emission factors and thus to larger uncertainties. However, the uncertainty estimate is likely to be dominated by the activity data for natural gas. Therefore, it is reasonable to assume as a default that the values for gaseous fuels apply.
The following default uncertainties are assumed based on the lower and higher values of the EFs (2006 IPCC GL, Ch. 3, Table 3.2.2 Uncertainty Assessment):

AD	+/-5 %		EF CO_2	EF N_2O	EF CH_4
		Natural gas	1% / -2%	208% / -67%	144% /-59%

3.3.12.6.7 Source specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, CO_2 emissions, emission factors and IEF (time series)
- Time series consistency
- Plausibility checks of dips and jumps (at this stage not possible due to the Energy balance - see trend description)
- Documentation and archiving of all information required in NIR, background documentation and archive.

There are some variations of the IEF for liquid fuels for some of the years, e.g. for 1990 the value is lower (74.10 t/TJ) than the rest of the time series (77.40 t/TJ). This is due to the fuel mix in this category - some quantities of Gas/Diesel Oil are reported as Not elsewhere specified (Transport) in the National Energy Balance, which has an EF of 74.1 t/TJ. For the period 1993-1996 and 1999 the value of the IEF (77.4 t/TJ) is higher than the rest of the time series. This is due to some quantities of Residual Fuel Oil reported as Not elsewhere specified (Transport) in the National Energy Balance, which has an EF of 77.4 t/TJ.

3.3.13 OTHER SECTORS (CRF 1.A.4)

Other sectors include the following subcategories:

- Commercial / Institutional (1.A.4.a);
- Residential (1.A.4.b);
- Agriculture / Forestry / Fisheries (1.A.4.c);

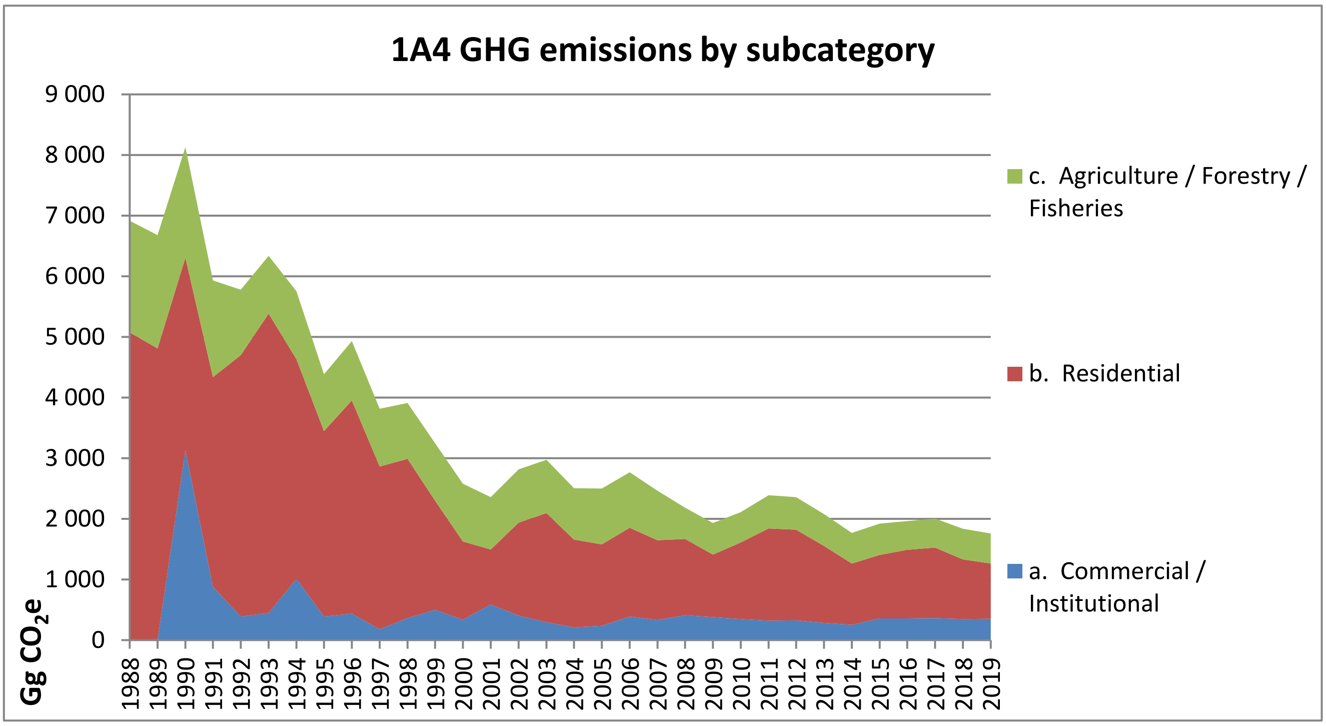

Figure 47 Total GHG emissions from 1.A.4 Other Sectors

The general trend in CRF category 1.A.4 is a decrease of 74.6% compared to base year and a decrease of 1.1% compared to last year.

3.3.13.1 Commercial/Institutional (CRF 1.A.4.a.)

Category 1.A.4.a. Commercial/Institutional covers emissions from fuel combustion in the commercial and Institutional sectors.

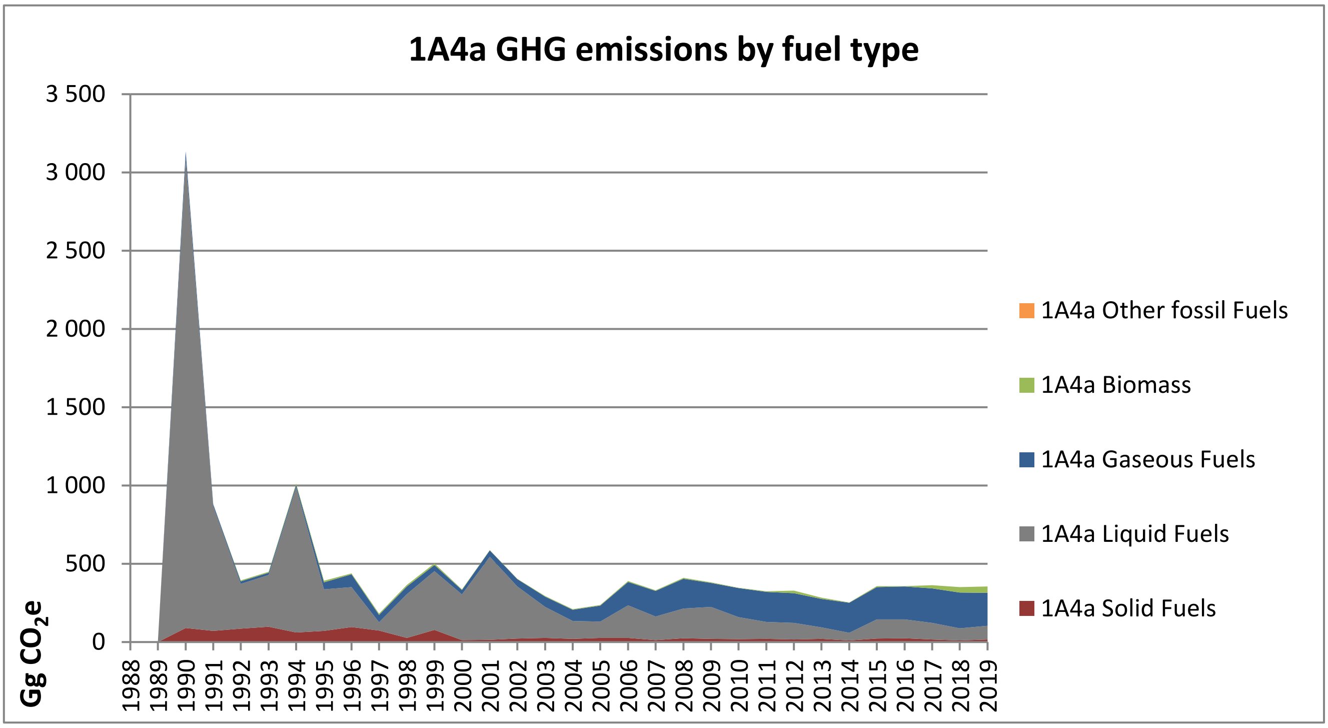

Figure 48 GHG emissions from CRF 1.A.4.a. Commercial/Institutional

The share of this subcategory from sector 1.A is 0.9% for 2019, whereas the share of the total GHG emissions is 0.6%.
For the years before 1990 no consumption is reported in this subcategory. Instead, it is reported under category 1.A.5.

Table 93 CO_2 emissions in CRF 1.A.4.a. Commercial/Institutional

CO_2 (Gg)	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1990	3 116.96	2 985.60	89.33	42.03	NO	NO
1995	379.98	262.45	71.08	46.45	125.6640	NO
2000	330.75	290.54	11.89	28.32	45.4720	NO
2005	230.79	105.40	24.68	100.71	63.5040	NO
2010	342.37	139.62	17.40	185.35	50.7290	NO
2011	318.57	108.01	19.52	191.04	52.1136	NO
2012	310.23	106.73	14.77	188.73	231.2226	NO
2013	273.25	73.15	19.31	180.78	129.5672	NO
2014	250.59	48.93	8.63	193.03	28.5838	NO
2015	349.92	120.24	22.27	207.42	75.7148	NO
2016	353.04	120.06	24.23	208.75	57.9292	NO
2017	341.30	105.26	16.00	220.03	282.3675	NO
2018	314.17	76.57	10.21	227.40	466.9339	NO
2019	312.42	88.82	15.07	208.53	534.9191	NO
Decrease 1988-2019	-	-	-	-	-	-
Decrease 1990-2019	90.0%	97.0%	83.1%	-396.1%	-	-
Decrease 2018-2019	0.6%	-16.0%	-47.6%	8.3%	-14.6%	-

Table 94 CH_4 emissions in CRF 1.A.4.a. Commercial/Institutional

CH_4 (Gg)	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO

CH_4 (Gg)	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1990	0.4104	0.3977	0.0088	0.0038	NO	NO
1995	0.3832	0.0350	0.0073	0.0042	0.3366	NO
2000	0.1642	0.0387	0.0012	0.0026	0.1218	NO
2005	0.1957	0.0140	0.0025	0.0091	0.1701	NO
2010	0.1570	0.0179	0.0018	0.0168	0.1205	NO
2011	0.1584	0.0135	0.0020	0.0173	0.1257	NO
2012	0.6382	0.0124	0.0015	0.0171	0.6072	NO
2013	0.3602	0.0085	0.0020	0.0163	0.3334	NO
2014	0.0884	0.0058	0.0009	0.0174	0.0643	NO
2015	0.2075	0.0151	0.0023	0.0186	0.1715	NO
2016	0.1337	0.0149	0.0025	0.0188	0.0975	NO
2017	0.7587	0.0127	0.0016	0.0198	0.7245	NO
2018	1.2397	0.0088	0.0011	0.0205	1.2094	NO
2019	1.4320	0.0104	0.0016	0.0188	1.4012	NO
Decrease 1988-2019	-	-	-	-	-	-
Decrease 1990-2019	-249.0%	97.4%	81.8%	-392.9%	-	-
Decrease 2018-2019	-15.5%	-18.5%	-51.3%	8.3%	-15.9%	-

Table 95 N_2O emissions in CRF 1.A.4.a. Commercial/Institutional

N_2O (Gg)	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1990	0.0252	0.0238	0.0013	0.0001	NO	NO
1995	0.0078	0.0021	0.0011	0.0001	0.0045	NO
2000	0.0042	0.0023	0.0002	0.0001	0.0016	NO
2005	0.0037	0.0008	0.0004	0.0002	0.0023	NO
2010	0.0031	0.0010	0.0003	0.0003	0.0015	NO
2011	0.0030	0.0008	0.0003	0.0003	0.0016	NO
2012	0.0091	0.0006	0.0002	0.0003	0.0079	NO
2013	0.0053	0.0004	0.0003	0.0003	0.0042	NO
2014	0.0015	0.0003	0.0001	0.0003	0.0007	NO
2015	0.0037	0.0009	0.0003	0.0004	0.0021	NO
2016	0.0027	0.0008	0.0004	0.0004	0.0011	NO
2017	0.0107	0.0007	0.0002	0.0004	0.0094	NO
2018	0.0168	0.0004	0.0002	0.0004	0.0158	NO
2019	0.0196	0.0005	0.0002	0.0004	0.0184	NO
Decrease 1988-2019	-	-	-	-	-	-
Decrease 1990-2019	22.5%	97.7%	81.8%	-392.9%	-	-
Decrease 2018-2019	-16.2%	-21.6%	-51.3%	8.3%	-16.3%	-

Table 96 GHG emissions in CRF 1.A.4.a. Commercial/Institutional

GHG (Gg)	TJ	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO	NO
1990	41 464.19	3 134.74	3 002.65	89.94	42.15	NO	NO
1995	6 199.60	391.87	263.95	71.59	46.58	9.7524	NO
2000	4 930.42	336.09	292.20	11.97	28.40	3.5290	NO
2005	4 042.48	236.78	106.00	24.86	100.99	4.9284	NO
2010	5 916.11	347.22	140.38	17.53	185.86	3.4478	NO

GHG (Gg)	TJ	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2011	5 636.14	323.42	108.57	19.66	191.57	3.6121	NO
2012	7 130.77	328.90	107.23	14.88	189.26	17.5332	NO
2013	5 664.80	283.84	73.50	19.45	181.29	9.5991	NO
2014	4 530.63	253.25	49.17	8.69	193.57	1.8189	NO
2015	6 339.38	356.22	120.87	22.43	208.00	4.9255	NO
2016	6 306.57	357.17	120.69	24.40	209.33	2.7537	NO
2017	8 159.24	363.46	105.79	16.11	220.65	20.9130	NO
2018	9 547.41	350.19	76.92	10.28	228.03	34.9544	NO
2019	10 006.69	354.05	89.24	15.19	209.11	40.5188	NO
Decrease 1988-2019	-	-	-	-	-	-	-
Decrease 1990-2019	75.9%	88.7%	97.0%	83.1%	-396.1%	-	-
Decrease 2018-2019	-4.8%	-1.1%	-16.0%	-47.7%	8.3%	-15.9%	-

3.3.13.2 Residential (CRF 1.A.4.b.)

Category 1.A.4.b. Residential covers emissions from fuel combustion in the residential sector.

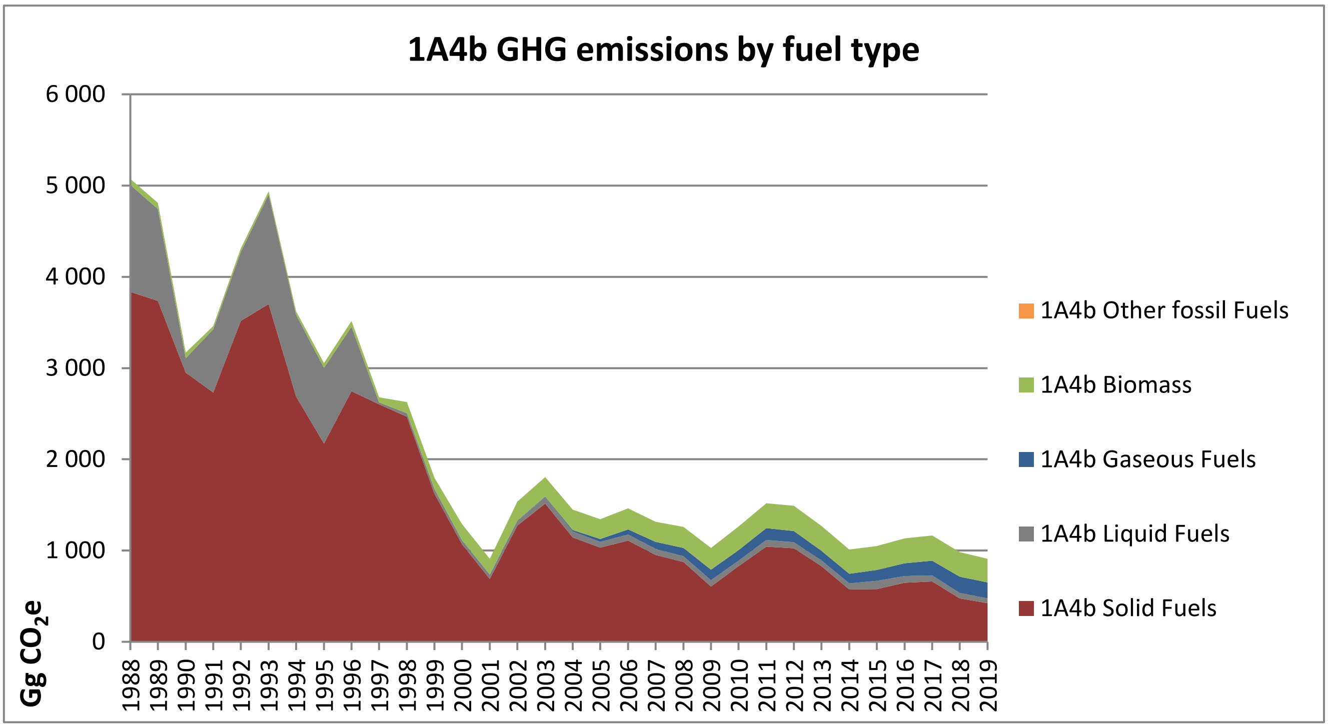

Figure 49 GHG emissions from CRF 1.A.4.b. Residential

The share of this subcategory from sector 1.A is 2.4% for 2019, whereas the share of total GHG emissions is 1.6%. The emissions from this category decreased by 82.1% compared to base year. There are two separate trends contributing to this decrease. At the beginning of the period, due to economic reasons, a transition from liquid fuels occurred. Those fuels, previously used for heating, started to be used for electricity. Some social groups also drastically reduced the consumed energy for heating due to their very low income. The second trend is the increase of the use of biomass – in 2019 about 4 times more biomass was used by the residential sector compared to 1988. This trend is also complimented by the increasing gasification of the households, although to a much smaller extent.

Table 97 CO_2 emissions in CRF 1.A.4.b. Residential

CO_2 (Gg)	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	4 715.89	1 167.81	3 548.08	NO	889.3920	NO
1990	2 887.26	157.69	2 729.57	NO	808.7520	NO
1995	2 834.67	825.89	2 008.78	NO	674.9120	NO
2000	1 034.19	44.47	989.28	0.45	2 292.0800	NO
2005	1 047.81	61.15	954.11	32.54	2 812.4320	NO
2010	939.08	61.42	763.56	114.10	3 334.1280	NO
2011	1 166.33	72.80	964.07	129.46	3 502.6880	NO
2012	1 137.61	66.99	947.11	123.50	3 557.9040	NO
2013	933.84	63.86	765.79	104.19	3 515.2320	NO
2014	698.66	64.09	529.70	104.87	3 438.6240	NO
2015	743.14	89.98	532.60	120.56	3 357.9840	NO
2016	807.72	72.57	597.96	137.20	3 554.5440	NO
2017	833.23	66.26	608.86	158.11	3 561.9913	NO
2018	674.11	58.46	435.95	179.70	3 463.8040	NO
2019	616.93	52.37	387.07	177.49	3 331.9829	NO
Decrease 1988-2019	86.9%	95.5%	89.1%	-	-274.6%	-
Decrease 1990-2019	78.6%	66.8%	85.8%	-	-312.0%	-
Decrease 2018-2019	8.5%	10.4%	11.2%	1.2%	3.8%	-

Table 98 CH_4 emissions in CRF 1.A.4.b. Residential

CH_4 (Gg)	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	13.2877	0.1332	10.7722	NO	2.3823	NO
1990	10.4734	0.0134	8.2936	NO	2.1663	NO
1995	8.0763	0.1016	6.1669	NO	1.8078	NO
2000	9.1482	0.0042	3.0045	0.0000	6.1395	NO
2005	10.4837	0.0050	2.9424	0.0029	7.5333	NO
2010	11.3488	0.0052	2.4026	0.0103	8.9307	NO
2011	12.3939	0.0059	2.9941	0.0117	9.3822	NO
2012	12.4494	0.0055	2.9026	0.0112	9.5301	NO
2013	11.8037	0.0051	2.3735	0.0094	9.4158	NO
2014	10.8791	0.0053	1.6538	0.0095	9.2106	NO
2015	10.6887	0.0071	1.6762	0.0108	8.9946	NO
2016	11.4306	0.0058	1.8914	0.0123	9.5211	NO
2017	11.5537	0.0054	1.9930	0.0142	9.5410	NO
2018	10.7394	0.0047	1.4405	0.0162	9.2780	NO
2019	10.2301	0.0042	1.2850	0.0160	8.9250	NO
Decrease 1988-2019	23.0%	96.8%	88.1%	-	-274.6%	-
Decrease 1990-2019	2.3%	68.7%	84.5%	-	-312.0%	-
Decrease 2018-2019	4.7%	9.7%	10.8%	1.3%	3.8%	-

Table 99 N_2O emissions in CRF 1.A.4.b. Residential

N_2O (Gg)	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0921	0.0064	0.0539	NO	0.0318	NO
1990	0.0707	0.0004	0.0415	NO	0.0289	NO
1995	0.0605	0.0055	0.0308	NO	0.0241	NO
2000	0.0970	0.0002	0.0150	0.0000	0.0819	NO

N_2O (Gg)	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2005	0.1153	0.0001	0.0147	0.0001	0.1004	NO
2010	0.1314	0.0001	0.0120	0.0002	0.1191	NO
2011	0.1404	0.0001	0.0150	0.0002	0.1251	NO
2012	0.1419	0.0001	0.0145	0.0002	0.1271	NO
2013	0.1377	0.0001	0.0119	0.0002	0.1255	NO
2014	0.1314	0.0001	0.0083	0.0002	0.1228	NO
2015	0.1287	0.0001	0.0084	0.0002	0.1199	NO
2016	0.1368	0.0001	0.0095	0.0002	0.1269	NO
2017	0.1376	0.0001	0.0100	0.0003	0.1272	NO
2018	0.1313	0.0001	0.0072	0.0003	0.1237	NO
2019	0.1258	0.0001	0.0064	0.0003	0.1190	NO
Decrease 1988-2019	-36.7%	98.6%	88.1%	-	-274.6%	-
Decrease 1990-2019	-78.0%	74.9%	84.5%	-	-312.0%	-
Decrease 2018-2019	4.2%	6.4%	10.8%	1.3%	3.8%	-

Table 100 GHG emissions in CRF 1.A.4.b. Residential

GHG (Gg)	TJ	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	61 036.20	5 075.52	1 173.06	3 833.43	NO	69.0232	NO
1990	37 335.50	3 170.16	158.13	2 949.27	NO	62.7649	NO
1995	38 144.56	3 054.60	830.07	2 172.14	NO	52.3780	NO
2000	31 163.18	1 291.81	44.62	1 068.86	0.45	177.8818	NO
2005	36 470.41	1 344.27	61.31	1 032.06	32.63	218.2648	NO
2010	40 801.64	1 261.97	61.59	827.21	114.42	258.7521	NO
2011	44 743.19	1 518.03	72.99	1 043.38	129.83	271.8336	NO
2012	44 734.15	1 491.14	67.17	1 024.00	123.85	276.1188	NO
2013	42 191.49	1 269.96	64.01	828.66	104.48	272.8071	NO
2014	39 114.84	1 009.79	64.26	573.51	105.16	266.8618	NO
2015	39 162.39	1 048.70	90.20	577.00	120.89	260.6035	NO
2016	41 657.59	1 134.24	72.74	648.06	137.58	275.8580	NO
2017	42 340.78	1 163.07	66.43	661.65	158.55	276.4360	NO
2018	39 889.81	981.73	58.61	474.11	180.20	268.8159	NO
2019	38 055.10	910.18	52.50	421.11	177.98	258.5857	NO
Decrease 1988-2019	37.7%	82.1%	95.5%	89.0%	-	-274.6%	-
Decrease 1990-2019	-1.9%	71.3%	66.8%	85.7%	-	-312.0%	-
Decrease 2018-2019	4.6%	7.3%	10.4%	11.2%	1.2%	3.8%	-

3.3.13.3 Agriculture/Forestry/Fisheries (CRF 1.A.4.c.)

Category 1.A.4.c. Agriculture/Forestry/Fisheries covers emissions from fuel combustion in the agriculture, forestry and fisheries sectors.

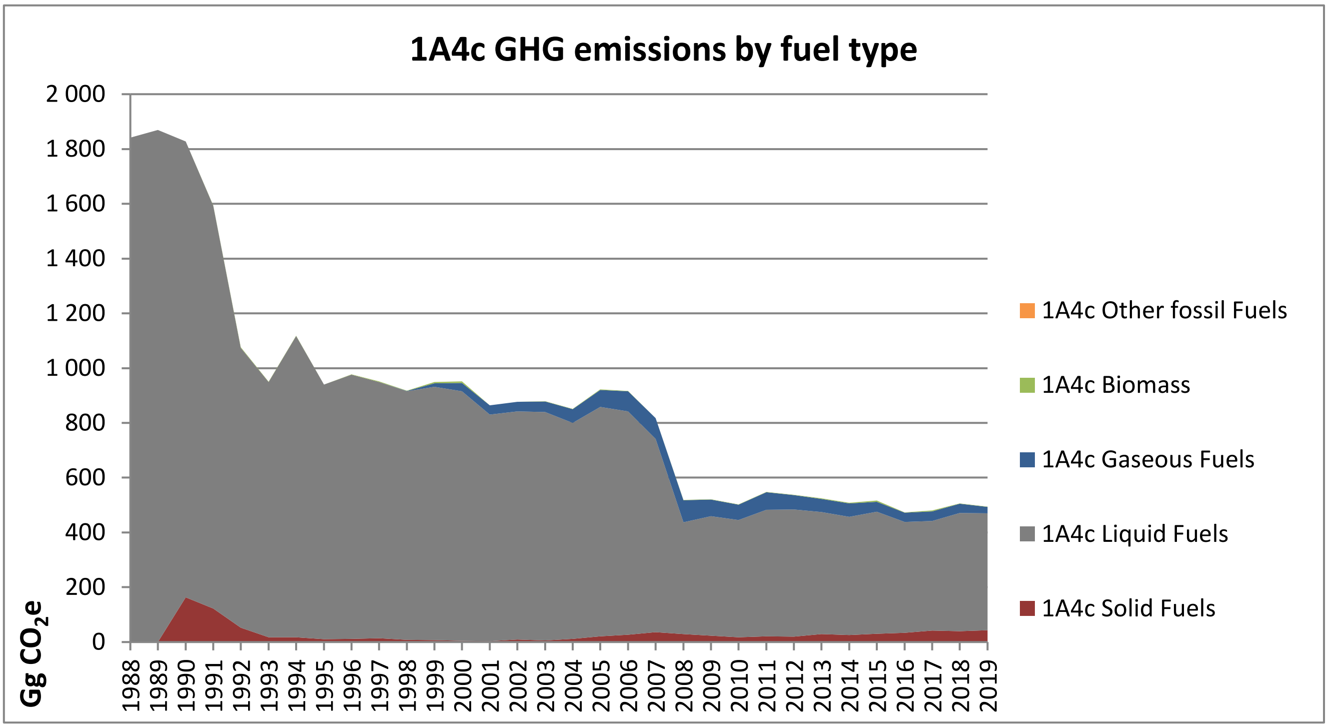

Figure 50 GHG emissions from CRF 1.A.4.c. Agriculture/Forestry/Fisheries

The share of this subcategory from sector 1.A is 1.3% for 2019, whereas the share of total GHG emissions is 0.9%.

Table 101 CO_2 emissions in CRF 1.A.4.c. Agriculture/Forestry/Fisheries

CO_2 (Gg)	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1 657.25	1 657.25	NO	NO,IE	NO,IE	NO
1990	1 649.29	1 498.15	150.94	0.20	NO,IE	NO
1995	854.38	845.22	9.16	NO,IE	4.1440	NO
2000	860.24	826.57	3.86	29.81	68.4320	NO
2005	839.84	759.36	19.11	61.36	24.8640	NO
2010	457.08	384.40	16.00	56.68	15.6800	NO
2011	498.91	415.76	19.39	63.76	16.8000	NO
2012	487.23	417.36	17.76	52.11	18.7040	NO
2013	475.53	401.03	27.06	47.44	25.8720	NO
2014	461.15	388.93	22.88	49.34	32.2560	NO
2015	464.80	401.43	27.28	36.10	52.6400	NO
2016	428.66	363.74	30.96	33.95	46.2560	NO
2017	433.08	359.22	38.69	35.17	33.5278	NO
2018	457.25	387.45	36.52	33.29	20.1370	NO
2019	445.52	383.05	39.35	23.12	19.7729	NO
Decrease 1988-2019	73.1%	76.9%	-	-	-	-
Decrease 1990-2019	73.0%	74.4%	73.9%	-11535.4%	-	-
Decrease 2018-2019	2.6%	1.1%	-7.8%	30.5%	1.8%	-

Table 102 CH_4 emissions in CRF 1.A.4.c. Agriculture/Forestry/Fisheries

CH_4 (Gg)	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0987	0.0987	NO	NO,IE	NO,IE	NO
1990	0.5496	0.0897	0.4599	0.0000	NO,IE	NO
1995	0.0957	0.0564	0.0283	NO,IE	0.0111	NO

CH_4 (Gg)	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2000	0.2513	0.0537	0.0117	0.0027	0.1833	NO
2005	0.1798	0.0485	0.0591	0.0056	0.0666	NO
2010	0.1194	0.0222	0.0501	0.0051	0.0420	NO
2011	0.1355	0.0242	0.0605	0.0058	0.0450	NO
2012	0.1340	0.0243	0.0550	0.0047	0.0501	NO
2013	0.1812	0.0236	0.0840	0.0043	0.0693	NO
2014	0.1854	0.0230	0.0715	0.0045	0.0864	NO
2015	0.2529	0.0236	0.0851	0.0032	0.1410	NO
2016	0.1518	0.0210	0.0942	0.0031	0.0335	NO
2017	0.2256	0.0203	0.1194	0.0032	0.0827	NO
2018	0.1851	0.0219	0.1134	0.0030	0.0469	NO
2019	0.1952	0.0216	0.1257	0.0021	0.0459	NO
Decrease 1988-2019	-97.9%	78.1%	-	-	-	-
Decrease 1990-2019	64.5%	75.9%	72.7%	-11460.1%	-	-
Decrease 2018-2019	-5.5%	1.3%	-10.8%	30.6%	2.1%	-

Table 103 N_2O emissions in CRF 1.A.4.c. Agriculture/Forestry/Fisheries

N_2O (Gg)	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.6116	0.6116	NO	NO,IE	NO,IE	NO
1990	0.5530	0.5507	0.0023	0.0000	NO,IE	NO
1995	0.2809	0.2806	0.0001	NO,IE	0.0001	NO
2000	0.2840	0.2814	0.0001	0.0001	0.0024	NO
2005	0.2618	0.2605	0.0003	0.0001	0.0009	NO
2010	0.1436	0.1426	0.0003	0.0001	0.0006	NO
2011	0.1546	0.1536	0.0003	0.0001	0.0006	NO
2012	0.1563	0.1553	0.0003	0.0001	0.0007	NO
2013	0.1493	0.1478	0.0004	0.0001	0.0009	NO
2014	0.1436	0.1420	0.0004	0.0001	0.0012	NO
2015	0.1503	0.1480	0.0004	0.0001	0.0019	NO
2016	0.1368	0.1358	0.0005	0.0001	0.0005	NO
2017	0.1377	0.1359	0.0006	0.0001	0.0011	NO
2018	0.1478	0.1465	0.0006	0.0001	0.0006	NO
2019	0.1467	0.1454	0.0006	0.0000	0.0006	NO
Decrease 1988-2019	76.0%	76.2%	-	-	-	-
Decrease 1990-2019	73.5%	73.6%	72.7%	-11460.1%	-	-
Decrease 2018-2019	0.7%	0.8%	-10.8%	30.6%	2.1%	-

Table 104 GHG emissions in CRF 1.A.4.c. Agriculture/Forestry/Fisheries

GHG (Gg)	TJ	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	22 365.00	1 841.98	1 841.98	NO	NO	NO	NO
1990	21 759.27	1 827.82	1 664.50	163.12	0.20	NO	NO
1995	11 487.90	940.49	930.25	9.91	NO	0.3216	NO
2000	12 319.45	951.15	911.78	4.17	29.89	5.3108	NO
2005	11 763.22	922.33	838.19	20.68	61.53	1.9296	NO
2010	6 540.96	502.85	427.47	17.33	56.84	1.2169	NO
2011	7 136.82	548.37	462.13	21.00	63.94	1.3038	NO
2012	6 940.35	537.17	464.25	19.22	52.26	1.4516	NO

GHG (Gg)	TJ	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2013	6 793.46	524.53	445.67	29.28	47.57	2.0079	NO
2014	6 685.78	508.59	431.83	24.77	49.48	2.5033	NO
2015	6 833.55	515.93	446.11	29.54	36.20	4.0852	NO
2016	6 587.72	473.21	404.74	33.46	34.04	0.9770	NO
2017	6 220.66	479.75	400.23	41.85	35.27	2.3979	NO
2018	6 429.00	505.91	431.65	39.52	33.38	1.3587	NO
2019	6 221.16	494.11	426.91	42.67	23.19	1.3304	NO
Decrease 1988-2019	72.2%	73.2%	76.8%	-	-	-	-
Decrease 1990-2019	71.4%	73.0%	74.4%	73.8%	-11535.2%	-	-
Decrease 2018-2019	3.2%	2.3%	1.1%	-8.0%	30.5%	2.1%	-

3.3.14 OTHER (CRF 1.A.5)

CRF category 1.A.5 Other includes stationary and mobile emissions sources not included elsewhere. The energy balance reports data under category 'Not elsewhere specified (other)' only for 1988 and 1989, which is mostly natural gas. Table 105 presents the reported emissions from other stationary sources (CRF category 1.A.5.a).

Table 105 GHG emissions in CRF 1.A.5.a. Other Stationary

GHG (Gg)	TJ	CO_2	CH_4	N_2O
1988	75 318.93	5 108.42	0.1926	0.0329
1989	78 237.91	5 243.72	0.1895	0.0322
1990	NO	NO	NO	NO
1995	NO	NO	NO	NO
2000	NO	NO	NO	NO
2005	NO	NO	NO	NO
2010	NO	NO	NO	NO
2011	NO	NO	NO	NO
2012	NO	NO	NO	NO
2013	NO	NO	NO	NO
2014	NO	NO	NO	NO
2015	NO	NO	NO	NO
2016	NO	NO	NO	NO
2017	NO	NO	NO	NO
2018	NO	NO	NO	NO
2019	NO	NO	NO	NO
Decrease 1988-2019	-	-	-	-
Decrease 1990-2019	-	-	-	-
Decrease 2018-2019	-	-	-	-

For the 2021 submission, emissions from military aviation were reallocated from CRF subcategory 1.A.3.a Civil Aviation to 1.A.5.b Other mobile. As the precise quantities of fuel consumed for military aviation is confidential data, it has been calculated as the difference between the total domestic consumption of jet kerosene and the jet kerosene consumed for domestic aviation based on data provided by Eurocontrol.

Table 106 GHG emissions in CRF 1.A.5.b. Other Mobile

GHG (Gg)	TJ	CO_2	CH_4	N_2O
1988	1 854.22	133.71	0.0009	0.0037
1990	1 199.00	86.46	0.0006	0.0024
1995	898.10	64.76	0.0004	0.0018
2000	648.11	46.73	0.0003	0.0013
2005	326.17	23.52	0.0002	0.0007
2010	344.98	24.88	0.0002	0.0007
2011	536.81	38.71	0.0003	0.0011
2012	132.03	9.52	0.0001	0.0003
2013	244.50	17.63	0.0001	0.0005
2014	129.98	9.37	0.0001	0.0003
2015	295.63	21.32	0.0001	0.0006
2016	594.03	42.83	0.0003	0.0012
2017	563.31	40.62	0.0003	0.0011
2018	431.84	31.14	0.0002	0.0009
2019	189.29	13.65	0.0001	0.0004
Decrease 1988-2019	89.8%	89.8%	89.8%	89.8%
Decrease 1990-2019	84.2%	84.2%	84.2%	84.2%
Decrease 2018-2019	56.2%	56.2%	56.2%	56.2%

3.4 FUGITIVE EMISSIONS FROM SOLID FUELS AND OIL AND NATURAL GAS (CRF 1.B)

Fugitive emissions from fuels are responsible for 3.4% of total GHG emissions for 2019. The fugitive emissions from gas and oil have a share of approx. 1.9% of total GHG emissions, whereas the fugitive emissions of solid fuels are approx. 1.5% of total GHG emissions.

3.4.1 COAL MINING AND HANDLING (CRF 1.B.1)

This category includes methane and carbon dioxide fugitive emissions from coal mining and handling activities in underground and surface mines as well as emissions from solid fuel transformation.
Coal mining in Bulgaria is being carried out mostly through surface mining, although some underground mining still exists. The main domestic solid fuels are lignite and sub-bituminous coal and they are mined mostly by surface mining in the Maritza Iztok mining complex. At the beginning of the time series the quantities of coal produced through underground mining were equal to about 12% of the total production of coal, but since many of the mines were subsequently closed down, the percentage dropped down to less than 0.2% in 2018. In 2019 the last underground mine was closed down and therefore from the annual production amounts to 28.0 million tons in 2019, none were produced through underground mining.
Solid fuel transformation is also a source of fugitive emissions from coke and charcoal production, even though the 2006 IPCC guidelines are not very explicit regarding this subcategory. Updated methodologies and emission factors are provided in the 2019 Refinement to the 2006 IPCC Guidelines.
Until 2008 the operation of coke ovens in Bulgaria was a source of fugitive emissions, whereas the annual amount of coking coal was varying between 1.4 Mt at the beginning of the time series and 434 kt at the end.
Charcoal production is an additional source of fugitive emissions which are estimated for the entire time series. The indigenous production of charcoal decreases from 17 kt at the beginning of the time series to 2.1 kt in 2019. The activity data and the emission estimates are presented in Table 99.
Under this category are also included fugitive emissions from abandoned underground mines. Emissions from abandoned underground mines have been estimated based on national data,

implementing a Tier 3 approach. Detailed information on the past and current state of all abandoned mines is presented in Table 95. The information has been collected, including type and historic quantities of coal mined, mine depth, estimate of the average emissions prior of closure, year of closure, method of closure and current state (flooded or non-flooded). From the 21 mines closed in the period 1942–2017, 19 were found to be non-flooded and thus a source of fugitive emissions. Based on the type of coal mined and year of closure, for each individual mine was calculated an annual emission factor according to Equation 4.1.12 and parameters from Table 4.1.9 of 2019 Refinement to the 2006 IPCC Guidelines. The annual emission factor is presented in Table 107 below. Emission rate at closure was calculated based on mined quantities, type and rank of coal, as well as historic information on mine gassiness.

Table 107 Information about Abandoned underground mines by region

Coal region	Year of closure	Coal rank	Gassy/non-gassy	Flooded/non-flooded	Mine depth (m)	Average emissions prior of closure (Gg)
Lignite coal						
Kaninski region	1996		non-gassy	flooded	30-100	0.023
Kyustendilski region	1998	Category I - up to 5 m3/t		flooded	100-180	0.462
Zapadno-Marishki region	2003	Assumed 2.5 m3/t	non-gassy		30-250	3.044
Brown / Sub-bituminous						
Oranovo-Simitliiski region	2019	Category I - up to 5 m3/t			0-470	0.549
Pirinski region	2003	Category I - up to 5 m3/t			60-340	1.662
Chernomorski / Burgaski region	1942-2003	Assumed 2.5 m3/t	non-gassy		140-320	0.375
Pernishki region	2002	Category I - up to 5 m3/t			50-150	8.854
Bobov dolski region	2017	Category I - up to 5 m3/t			350-400	7.863
Babino	2016	Super category - over 15 m3/t				3.605
Black / Other bituminous coal						
Vidinski region	1969	Assumed 10 m3/t	gassy		unknown	0.157
Balkanski region	2015	Super category - over 15 m3/t			0-300	2.646
Anthracite coal						
Svogenski region	2005	Assumed 2.5 m3/t	non-gassy		30-200	0.177

Table 108 Applied coefficients according to Table 4.1.9 of the 2019 Refinement to the 2006 IPCC Guideline

Coal Rank	a	b
Anthracite	1.72	-0.58
Bituminous	3.72	-0.42
Sub-bituminous	0.27	-1.00

Table 109 Calculated emission factors according to equation 4.1.12 of the 2019 Refinement to the 2006 IPCC Guideline

Years since closure	Anthracite	Bituminous	Sub-bituminous
1	0.560	0.521	0.787
2	0.421	0.408	0.649
3	0.348	0.350	0.552
4	0.302	0.313	0.481
5	0.269	0.287	0.426

Years since closure	Anthracite	Bituminous	Sub-bituminous
6	0.245	0.266	0.382
7	0.225	0.250	0.346
8	0.210	0.237	0.316
9	0.197	0.226	0.292
10	0.186	0.217	0.270
11	0.176	0.208	0.252
12	0.168	0.201	0.236
13	0.161	0.194	0.222
14	0.154	0.189	0.209
15	0.148	0.183	0.198
16	0.143	0.178	0.188
17	0.138	0.174	0.179
18	0.134	0.170	0.171
19	0.130	0.166	0.163
20	0.126	0.163	0.156
21	0.123	0.159	0.150
22	0.120	0.156	0.144
23	0.117	0.154	0.139
24	0.114	0.151	0.134
25	0.111	0.148	0.129
26	0.109	0.146	0.125
27	0.107	0.144	0.121
28	0.104	0.142	0.117
29	0.102	0.139	0.113
30	0.100	0.138	0.110
31	0.099	0.136	0.107
32	0.097	0.134	0.104
33	0.095	0.132	0.101
34	0.094	0.131	0.098
35	0.092	0.129	0.096
36	0.091	0.127	0.093
37	0.089	0.126	0.091
38	0.088	0.125	0.089
39	0.086	0.123	0.087
40	0.085	0.122	0.085
41	0.084	0.121	0.083
42	0.083	0.120	0.081
43	0.082	0.118	0.079
44	0.081	0.117	0.078
45	0.080	0.116	0.076
46	0.079	0.115	0.075
47	0.078	0.114	0.073
48	0.077	0.113	0.072
49	0.076	0.112	0.070
50	0.075	0.111	0.069
51	0.074	0.110	0.068
52	0.073	0.109	0.066
53	0.073	0.108	0.065
54	0.072	0.108	0.064
55	0.071	0.107	0.063
56	0.070	0.106	0.062
57	0.070	0.105	0.061
58	0.069	0.104	0.060
59	0.068	0.104	0.059
60	0.068	0.103	0.058
61	0.067	0.102	0.057
62	0.066	0.102	0.056
63	0.066	0.101	0.056
64	0.065	0.100	0.055
65	0.065	0.100	0.054

Years since closure	Anthracite	Bituminous	Sub-bituminous
66	0.064	0.099	0.053
67	0.063	0.098	0.052
68	0.063	0.098	0.052
69	0.062	0.097	0.051
70	0.062	0.097	0.050
71	0.061	0.096	0.050
72	0.061	0.095	0.049
73	0.060	0.095	0.048
74	0.060	0.094	0.048
75	0.059	0.094	0.047
76	0.059	0.093	0.046
77	0.059	0.093	0.046
78	0.058	0.092	0.045
79	0.058	0.092	0.045
80	0.057	0.091	0.044

3.4.2 EXTRACTION, REFINING, TRANSPORTATION AND DISTRIBUTION OF OIL AND NATURAL GAS (CRF 1.B.2)

Unlike fugitive emissions from coal mining, the emissions from Oil and Gas are a lot more complex because of the various sources involved and the various types of activity data. The emission estimates for this category cover methane, carbon dioxide and nitrous oxide fugitive emissions from exploration, production and processing, refining and storage, transport, transmission and distribution of oil and natural gas.

The trends for methane fugitive emissions from oil and gas systems are presented in Table 111 and Table 112.

The current natural gas consumption is about half of what it was in the base year, due to the collapse of the industrial sector (mainly in fertilizer production and iron & steel industries), which decline had not been compensated by the increasing gas consumption of commercial and residential sectors in the latest years.

Natural gas production in Bulgaria peaked in the period 2005-2006, following the development of a new field (Galata), which was depleted in 2009. Since 2011 there have been several new fields that have been developed (Kaliakra and Kavarna). These fields have also led to a limited increase in the domestic production of natural gas, but have not altered the overall decline observed since 2012. As a requirement from the National Statistics Institute and due to the limited number of oil and natural gas production companies in the country, the domestic production data is notated as confidential and not presented in this report.

The CH_4 and CO_2 fugitive emissions from the transmission and distribution gas networks are estimated based on the length of transmission and distribution networks, as per advice given by the 2019 Refinement to the 2006 IPCC Guidelines.

The production of crude oil in Bulgaria is in very limited amounts equal to 0.4% of the total consumption in 2019, with only one production company operating. Generally, there is a decreasing trend in the local production of crude oil.

Table 110 Activity data and CH_4 emissions from CRF 1.B.1 Coal mining and Handling

Year	1.B.1.a Coal Mining and Handling							1.B.1.b Solid Fuel Transformation			
	i. Underground Mines				ii. Surface Mines			Coking coal		Charcoal	
	AD	Post-mining emissions	Mining emissions	Abandoned underground mines	AD	Post-mining emissions	Mining emissions	AD	Emissions	AD	Emissions
	kt	Gg	Gg	Gg	kt	Gg	Gg	kt	Gg	kt	Gg
1988	4098	6.86	49.42	0.18	30049	2.01	24.16	1400	0.0686	18	0.4796
1990	3848	6.45	46.41	0.15	27827	1.86	22.37	1854	0.0908	20	0.5203
1995	3381	5.66	40.77	0.11	27449	1.84	22.07	1693	0.0830	20	0.5177
2000	1621	2.72	19.55	0.17	24811	1.66	19.95	1325	0.0649	8	0.2080
2005	585	0.98	7.06	8.65	24110	1.62	19.38	1051	0.0515	24	0.6240
2010	744	1.25	8.97	5.23	28649	1.92	23.03	0	0.0000	17	0.4420
2011	872	1.46	10.52	4.84	36250	2.43	29.15	0	0.0000	16	0.4160
2012	688	1.15	8.30	4.50	32732	2.19	26.32	0	0.0000	4	0.1040
2013	550	0.92	6.63	4.21	28071	1.88	22.57	0	0.0000	5	0.1300
2014	472	0.79	5.69	3.96	30796	2.06	24.76	0	0.0000	6	0.1560
2015	447	0.75	5.39	5.11	35412	2.37	28.47	0	0.0000	6	0.1560
2016	270	0.45	3.26	7.45	30961	2.07	24.89	0	0.0000	4	0.1040
2017	134	0.23	1.62	10.33	34143	2.29	27.45	0	0.0000	2	0.0635
2018	51	0.09	0.61	9.07	30212	2.02	24.29	0	0.0000	2	0.0530
2019	0	0.00	0.00	8.14	28001	1.88	22.51	0	0.0000	2	0.0547

Table 111 Activity data from oil and gas

Year	1. B. 2. a. Oil		1. B. 2. b. Natural Gas				1. B. 2. c. Venting and Flaring			
							1. B. 2. c. 1 Venting		1. B. 2. c. 2 Flaring	
	1. Exploration 2. Production 3. Transport	4. Refining / Storage	1. Exploration 2. Production 3. Processing	4. Transmission	4. Storage	5. Distribution	i. Oil	ii. Gas	i. Oil	ii. Gas
	10^3m^3	10^3m^3	10^6m^3	km	10^6m^3	km	10^3m^3	10^6m^3	TJ	
1988	C	15319.3	C	1234	291.8	50	IE	IE	0.0	IE
1990	C	9666.7	C	1469	219.5	50	IE	IE	0.0	IE
1995	C	9314.7	C	2044	285.4	50	IE	IE	908.1	IE
2000	C	6193.5	C	2645	351.6	300	IE	IE	859.5	IE
2005	C	7207.5	C	2645	263.3	1577	IE	IE	871.2	IE

2010	C	6381.1	C	2645	299.9	3493	IE	IE	1422.9	IE
2011	C	5924.2	C	2645	367.7	3656	IE	IE	1438.2	IE
2012	C	6869.5	C	2645	346.8	3873	IE	IE	1334.7	IE
2013	C	6552.4	C	2645	238.5	4035	IE	IE	1384.2	IE
2014	C	6007.0	C	2645	273.2	4224	IE	IE	1380.6	IE
2015	C	7036.1	C	2765	291.2	4334	IE	IE	4857.3	IE
2016	C	7293.7	C	2765	342.2	4444	IE	IE	8301.6	IE
2017	C	7907.2	C	2765	325.1	4724	IE	IE	9191.2	IE
2018	C	6852.9	C	2788	324.3	4916	IE	IE	7443.6	IE
2019	C	7977.5	C	2800	358.4	5157	IE	IE	8941.4	IE

Table 112 CH_4 fugitive emissions from oil and gas (Gg)

Year	1. B. 2. a. Oil				1. B. 2. b. Natural Gas						1. B. 2. c. Venting and Flaring			
	1. Exploration	2. Production	3. Transport	4. Refining / Storage	1. Exploration	2. Production	3. Processing	4. Transmission	4. Storage	5. Distribution	1. B. 2. c. 1 Venting		1. B. 2. c. 2 Flaring	
											i. Oil	ii. Gas	i. Oil	ii. Gas
1988	0.0019	0.2713	0.0023	0.4596	0.0006	0.0598	0.0059	2.5667	0.0846	0.0115	IE	IE	0.0000	IE
1990	0.0014	0.2035	0.0017	0.2900	0.0008	0.0804	0.0080	3.0555	0.0637	0.0115	IE	IE	0.0000	IE
1995	0.0010	0.1458	0.0013	0.2794	0.0030	0.2870	0.0285	4.2515	0.0828	0.0115	IE	IE	0.0009	IE
2000	0.0010	0.1424	0.0012	0.1858	0.0009	0.0861	0.0086	5.5016	0.1020	0.0690	IE	IE	0.0009	IE
2005	0.0007	0.1017	0.0009	0.2162	0.0316	1.3744	0.2998	5.5016	0.0763	0.3627	IE	IE	0.0009	IE
2010	0.0005	0.0780	0.0007	0.1986	0.0044	0.2069	0.0416	5.5016	0.0870	0.8034	IE	IE	0.0014	IE
2011	0.0005	0.0746	0.0006	0.1854	0.0262	1.1260	0.2485	5.5016	0.1066	0.8409	IE	IE	0.0014	IE
2012	0.0006	0.0814	0.0007	0.2134	0.0230	0.9915	0.2183	5.5016	0.1006	0.8908	IE	IE	0.0013	IE
2013	0.0007	0.0950	0.0008	0.2050	0.0174	0.7945	0.1653	5.5016	0.0692	0.9281	IE	IE	0.0014	IE
2014	0.0006	0.0882	0.0008	0.1877	0.0118	0.5827	0.1123	5.5016	0.0792	0.9715	IE	IE	0.0014	IE
2015	0.0006	0.0848	0.0007	0.2191	0.0062	0.3538	0.0587	5.7512	0.0845	0.9968	IE	IE	0.0049	IE
2016	0.0006	0.0814	0.0007	0.2276	0.0056	0.3179	0.0530	5.7512	0.0992	1.0221	IE	IE	0.0083	IE
2017	0.0006	0.0811	0.0007	0.2464	0.0048	0.3064	0.0457	5.7512	0.0943	1.0865	IE	IE	0.0092	IE
2018	0.0005	0.0762	0.0007	0.2130	0.0020	0.1727	0.0188	5.7990	0.0941	1.1307	IE	IE	0.0074	IE
2019	0.0005	0.0740	0.0006	0.2476	0.0023	0.1812	0.0222	5.8240	0.1039	1.1861	IE	IE	0.0089	IE

3.4.3 METHODOLOGICAL ISSUES

Fugitive emissions from coal mining were estimated by Tier 1 method.
Equations 4.1.1 and 4.1.7 from 2019 Refinement to the 2006 IPCC Guidelines, Vol. 2, Ch. 4 have been applied:

Emissions = Raw coal production ● Emission Factor ● Units conversion factor

Relevant values of emission factors from 2019 Refinement to the 2006 IPCC Guidelines were selected, considering that underground mines have an average depth of not more than 400 m, and the surface mines for lignite coal are over 25 m deep.
The estimate of the CO_2, CH_4 and N_2O fugitive emissions from gas and oil systems was conducted by Tier 1 methodology applying Equation 4.2.1 from the 2019 Refinement to the 2006 IPCC Guidelines, Vol. 2, Ch. 4.

$$Emissions_{gas,\ industry\ segment} = Activity\ data_{industry\ segment} \cdot EF_{gas,\ industry\ segment}$$

The appropriate EFs from 2019 Refinement to the 2006 IPCC Guidelines, Vol. 2, Ch. 4.2.2.3, Table 4.2.4 were applied:

1. B. 2. a. Oil			
i. Exploration		**iii. Transport**	
AD	National Energy Balance	AD	National Energy Balance
EF	CH_4: 0.00002 Gg/10^3m^3 CO_2: 0.0044 Gg/10^3m^3 N_2O: 3.20E-09 Gg/10^3m^3 2019 Refinement to the 2006 IPCC Guidelines	EF	CH_4: 0.000025 Gg/10^3m^3 CO_2: 0.0000023 Gg/10^3m^3 2019 Refinement to the 2006 IPCC Guidelines
ii. Production		**iv. Refining / Storage**	
AD	National Energy Balance	AD	National Energy Balance
EF	CH_4: 0.00291 Gg/10^3m^3 CO_2: 0.04499 Gg/10^3m^3 N_2O: 0.00000067 Gg/10^3m^3 2019 Refinement to the 2006 IPCC Guidelines	EF	CH_4: 0.00003 Gg/10^3m^3 CO_2: 0.00585 Gg/10^3m^3 N_2O: 8.77E-08 Gg/10^3m^3 2019 Refinement to the 2006 IPCC Guidelines

1. B. 2. b. Natural Gas			
i. Exploration		**iv. Transmission**	
AD	National Energy Balance	AD	Energy and Water Regulatory Commission
EF	CH_4: 0.00006 Gg/10^6m^3 CO_2: 0.00005 Gg/10^6m^3 N_2O: 3.6E-10 Gg/10^6m^3 2019 Refinement to the 2006 IPCC Guidelines	EF	CH_4: 0.00208 Gg/km/yr CO_2: 0.00025 Gg/km/yr 2019 Refinement to the 2006 IPCC Guidelines
ii. Production		**iv. Storage**	
AD	National Energy Balance	AD	Bulgartransgaz
EF	CH_4: 0.00254 Gg/10^6m^3 CO_2: 0.0036 Gg/10^6m^3 N_2O: 0.000000061 Gg/10^6m^3 2019 Refinement to the 2006 IPCC Guidelines	EF	CH_4: 0.00029 Gg/10^6m^3 CO_2: 0.00004 Gg/10^6m^3 2019 Refinement to the 2006 IPCC Guidelines
iii. Processing		**v. Distribution**	
AD	National Energy Balance	AD	Energy and Water Regulatory Commission
EF	CH_4: 0.00057 Gg/10^6m^3 CO_2: 0.00721 Gg/10^6m^3 N_2O: 0.000000079 Gg/10^6m^3 2019 Refinement to the 2006 IPCC Guidelines	EF	CH_4: 0.00023 Gg/km/yr CO_2: 0.00001 Gg/km/yr 2019 Refinement to the 2006 IPCC Guidelines
vi. Other leakage - Natural gas-fuelled vehicles		**vi. Other leakage - Appliances**	
AD	Ministry of Interior	AD	Energy and Water Regulatory Commission
EF	CH_4: 0.0000003 Gg/car/y CO_2: 2.300E-09 Gg/car/y 2019 Refinement to the 2006 IPCC Guidelines	EF	CH_4: 0.000004 Gg/appliance/y CO_2: 0.000000033 Gg/appliance/y 2019 Refinement to the 2006 IPCC Guidelines

vi. Other leakage – Industrial plants			
AD	National Energy Balance		
EF	CH_4: 0.0004 Gg/10^6m^3 CO_2: 0.0000033 Gg/10^6m^3 2019 Refinement to the 2006 IPCC Guidelines		

1. B. 2. c. Venting and Flaring			
1. B. 2. c. 1 Venting		1. B. 2. c. 2 Flaring	
i. Oil		i. Oil	
AD	IE	AD	IE
EF	IE According to page 4.47, Vol. 2, Ch. 4 of 2019 Refinement to the 2006 IPCC Guidelines	EF	IE According to page 4.47, Vol. 2, Ch. 4 of 2019 Refinement to the 2006 IPCC Guidelines
ii. Gas		ii. Gas	
AD	IE	AD	IE
EF	IE According to page 4.47, Vol. 2, Ch. 4 of 2019 Refinement to the 2006 IPCC Guidelines	EF	IE According to page 4.47, Vol. 2, Ch. 4 of 2019 Refinement to the 2006 IPCC Guidelines

1.B.1.a Coal Mining and Handling	
i. Underground Mines	
AD	National Energy Balance
EF	Mining CH_4: 18 m^3/t Mining CO_2: 5.9 m^3/t Post-Mining CH_4: 2.5 m^3/t 2019 Refinement to the 2006 IPCC Guidelines
ii. Surface Mines	
AD	National Energy Balance
EF	Mining CH_4: 1.2 m^3/t Mining CO_2: 0.44 m^3/t Post-Mining CH_4: 0.1 m^3/t 2019 Refinement to the 2006 IPCC Guidelines
1.B.1.b Solid Fuel Transformation	
AD	National Energy Balance, FAO (Charcoal)
EF	Coking coal CH_4: 0.049 kg/t Charcoal CH_4: 1 t/TJ 2019 Refinement to the 2006 IPCC Guidelines

Activity data for crude oil and natural gas has been sourced from the Energy balances, Bulgartransgaz and Energy and Water Regulatory Commission.
Emissions from venting and flaring have been included in the estimates for oil and gas exploration, production and processing, as the updated Tier 1 emission factors are aggregates of venting, flaring, and leak emissions (page 4.47, Vol. 2, Ch. 4 of 2019 Refinement to the 2006 IPCC Guidelines). There is one exception related to emissions from natural gas used for hydrogen production in oil refineries, which have been reported under CRF category 1.B.2.c.2.i as per ERT recommendation E.9 from FCCC/ARR/2016/BGR. The activity data used for this category is the quantity of natural gas used for hydrogen production in refineries. The EFs applied are the same as for stationary combustion (55-56 t CO_2/TJ – country-specific, 1 kg CH_4/TJ - default, 0.1 kg N_2O/TJ- default).

3.4.4 UNCERTAINTIES

The uncertainty of this emission source category was estimated as follows:

- 200% for coal mining;

- 50% for oil and natural gas systems.

3.4.5 SOURCE-SPECIFIC QA/QC AND VERIFICATION

All activities regarding QC as described in QA/QC System have been undertaken.

3.4.6 SOURCE-SPECIFIC RECALCULATIONS, INCLUDING CHANGES MADE IN RESPONSE TO THE REVIEW PROCESS

For category 1.B.1.a.2.1 Fugitive emissions from surface mines, the previous emission factor of 1.2 m^3/t was changed to 1.5 m^3/t (IPCC GPG 2000, p.2.75), following a recommendation of the ERT during the Centralized review in 2012. For the 2014 submission the EF was changed back to 1.2 m^3/t following the adoption of the 2006 IPCC Guidelines.

For category 1.B.2.b.4 Fugitive emissions from gas transmission, the previous emission factor of 1340 kgCH_4/km was changed to 2500 kgCH_4/km (IPCC GPG 2000, Table 2.16, p.2.86), following a recommendation of the ERT during the Centralized review in 2012. For the latest submission the calculation approach was changed to rely on transited gas quantities following the adoption of the 2006 IPCC Guidelines.

As a result of ERT recommendation during the 2013 review cycle, the emission inventory was improved by adding emission estimates for category 1.B.2.a.iii. Oil transport.

A new category was included in the 2016 emission estimates following the previous review recommendations – Abandoned underground mines. As historical data and current state of the abandoned underground mines is not available for Bulgaria (e.g. whether these mines are now completely flooded or if they had been gassy at the time of operation), proxy data from Hungary is utilized for the emission estimates, as advised during the ESD review in 2016. This assumption rests on the similarity of mining activity between the two countries and extent to which the historical relationship between underground mining emissions and abandoned underground mine emissions reflects past mining activity and mitigation actions. In short, Hungary and Bulgaria had reasonably similar levels of emissions from underground mines operation between 1990 and 2000. Available data on total coal production from 1981 for the two countries is also reasonably similar as is the data for consumption since 1965. Given the specific methodology for this category, it is considered inappropriate to further adjust the emission estimates of Hungary with other factors (e.g. GDP, population, etc). Therefore, the Hungarian estimates were applied directly in this submission.

Another new category was included in the emission inventory as a result of the 2016 review cycle ERT recommendations from – Storage of natural gas. Data from the Ministry of Energy and Bulgartransgaz (the operator of the Chiren natural gas storage facility) regarding the quantities of natural gas extracted, has been used for the emission estimates for the entire time series. The default EFs from Table 4.2.4 of the 2006 IPCC Guidelines (volume 2, chapter 4) have been applied.

In order to address ERT recommendation FCCC/ARR/2016/BGR E.12, we have contacted several of the biggest mines in order to investigate whether there is a difference between the mined raw coal and the saleable coal. It was confirmed, that that lignite, the main type of coal produced in Bulgaria, is not upgraded. Some of the other mines, that we contacted, have explained that there were some coal upgrade facilities in the past, which were closed more than a decade ago. We've also contacted the Ministry of Energy in order to obtain past data provided by coal mining companies in Bulgaria for the beginning of the timeseries, but it was not available for such a distant period in the past. We have concluded, that there might be a possible underestimation for the base year, since coal upgrade facilities existed in the past, but currently the emissions should not be underestimated, as the amount of raw coal is equal to the saleable coal, used for the emission estimates.

Following recommendations FCCC/ARR/2016/BGR E.8 and FCCC/ARR/2016/BGR E.9 were introduced several changes in the 2019 submission. As petroleum coke is combusted in order to restore the catalyst's activity and not for energy purposes, all GHG emissions from petroleum coke, which were previously reported under CRF subcategory 1.A.1.b were reallocated under CRF subcategory 1.B.2.a.4. This subcategory contains other fugitive emissions from oil refining, estimated based on the total quantity of refinery intakes. The refinery intake is reported as activity data for this subcategory, which leads to inconsistent implied emission factor due to the inclusion of GHG emissions from petroleum coke. Similarly, the GHG emissions from hydrogen production, which were previously reported under CRF subcategory 1.A.1.b were reallocated under CRF subcategory

1.B.2.c.2.i. This subcategory also contains other fugitive emissions from oil refining, estimated based on the indigenous production of oil. The indigenous production is reported as activity data for this subcategory, which leads to inconsistent implied emission factor due to the inclusion of GHG emissions from natural gas used for hydrogen production. The emission trend in this subcategory is rather unstable. A sharp growth can be observed after 2008 when the emissions increase 5 times within one year. In the period 2009-2019, an upward trend can be noticed with a historical high in 2017, due to the increase of the total quantity of refinery intake. For the 2021 submission the Fugitive emission sector the updated methodologies and the default emission factors from 2019 Refinement to the 2006 IPCC Guidelines were applied. The recalculation includes an estimate of the fugitive emissions from abandoned underground mines (1.B.1.a.1.iii) based on detailed national data. Before the 2020 submission emissions from abandoned underground mines have been reported based on proxy data from Hungary.

3.4.7 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

No specific improvements for this subcategory are planned. We are currently applying a Tier 1 method for the estimation of emissions from category 1.B.1.a. Coal mining and handling. In order to implement a Tier 2/3 approach, the IPCC guidelines propose to examine measurement data from a number of underground coal mines and to measure the in-situ gas content of coal samples. Currently, no such data is available for Bulgaria. At present, there is no coal production in Bulgaria derived from underground mines. Moreover, mostly lignite coal is produced in Bulgaria, which has lower EF than higher coal ranks, such as bituminous. Currently, the use of global average emission factors does not lead to underestimation of the emissions from this category. The financial costs related to the required laboratory measurements necessary to derive a country-specific emission factor were estimated to be very high. For those reasons we consider the implementation of a Tier 2 approach to be unreasonable.

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF SECTOR 2)

4.1 OVERVIEW OF SECTOR

This chapter includes information on and descriptions of methodologies used for estimating greenhouse gas emissions as well as references for activity data and emission factors reported under IPCC Category 2 Industrial Processes and Product Use (IPPU) for the period from 1988 to 2019.

Emissions from this category comprise emissions from the following sub categories:

- 2.A Mineral Industry
- 2.B Chemical Industry
- 2.C Metal Industry
- 2.D Non-energy Products from Fuels and Solvent Use
- 2.E Electronics Industry
- 2.F Product Uses as Substitutes for ODS
- 2.G Other Product Manufacture and Use
- 2.H Other

Only process related emissions are considered in this sector.

Emission Trends

This section briefly describes the emission trends from 1988 to 2019 for each of the IPCC Categories under CRF Sector 2 for which GHG emissions are reported.

Industrial process emissions include emissions from industrial installations, consumption of Solvent Use and halocarbons and SF6 (the fluorinated gases or F-gases).

The trends in the sector can be followed in the following table. There are some country specific issues which are described in each subsector where big fluctuations occur.

The results from the evaluations are presented in the following table:

Table 113 GHG Emission trends in CRF 2 IPPU, 1988 – 2019

IPCC category	Emissions [Gg CO_2 eq]		Share [%]		Trend 1988 – 2019 [%]
	Base year*	2019	Base year*	2019	
2 Industrial processes	13480.60	6359.87	100.00	100.00	-52.8
2.A Mineral Industry	3739.87	2325.24	27.74	36.6	-37.8
2.B Chemical Industry	5422.48	1899.68	40.22	29.9	-64.9
2.C Metal Industry	4024.37	160.7	29.85	2.5	-96.0
2.D Non-energy Products from Fuels and Solvent Use	229.17	100.55	1.70	1.6	-56.1
2.E Electronics Industry	NO	NO	NO	NO	NO
2.F Product Uses as Substitutes for ODS	NO	1818.55	0.00	28.6	0
2.G Other Product Manufacture and Use	64.70	55.15	0.48	0.9	-14.8
2.H Other	NO	NO	NO	NO	NO

* Base year 1988

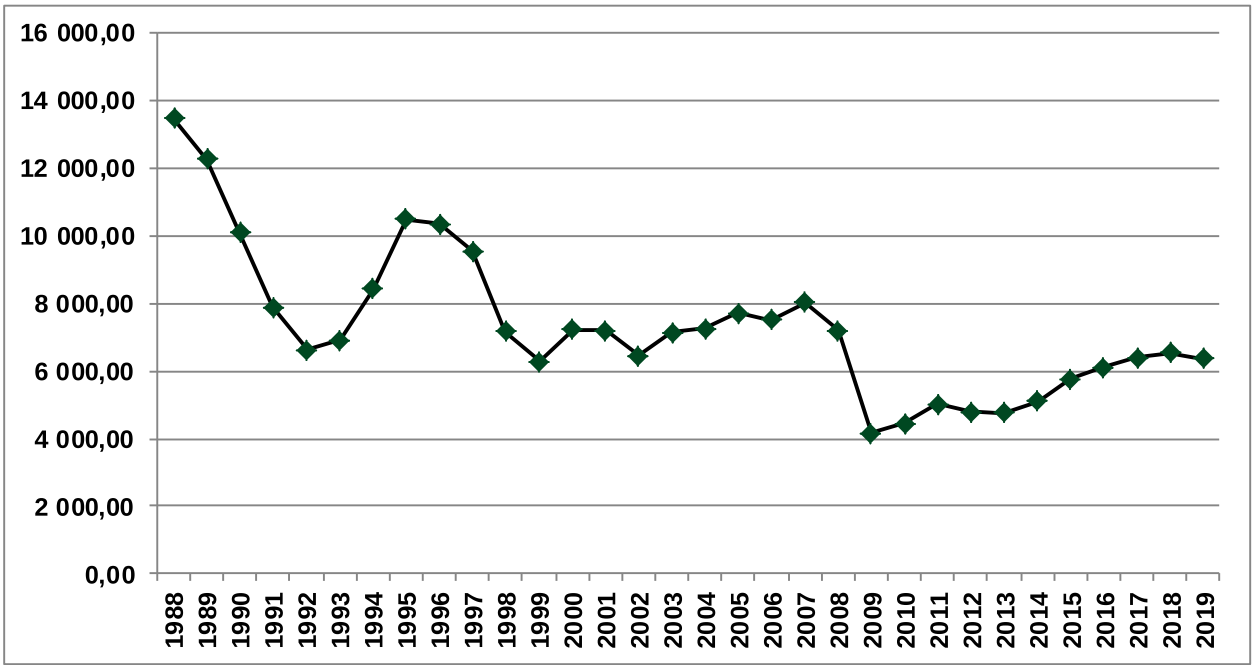

Figure 51 CO2 Emission trends for CRF Sector 2 IPPU for 1988-2019

The general reduction in the emissions in the later years of the time period is influenced by the introduction of better technologies in some plants or due to plant closures.

Emission trends by gas

The following table presents greenhouse gas emissions of the IPPU sector as well as their share in total greenhouse gas emissions from that sector in the base year and in 2019.

Table 114 GHG emissions from CRF 2 IPPU by gas in 1988 and 2019

GHG	Base year*	2019	Base year*	2019
	CO_2 equivalent [Gg CO_2 eq]		[%]	
Total	13480.60	6359.87	100.00	100.00
CO_2	11460.54	3730.99	85.02	58.66
CH_4	52.13	0.00	0.39	0.0
N_2O	1964.63	2.66	14.57	0.004
HFCs	0.00	1818.55	0.00	0.29
PFCs	0.00	0.012	0.00	<0.1
SF_6	3.30	18.26	0.02	0.02

**1988 for: CO_2, CH_4, N_2O and SF_6.*
**1995 for: HFCs and PFCs.*

Table 115 GHG Emissions from CRF 2 IPPU by gases 1988 – 2019

GHG emissions [Gg CO_2 eq]							
Year	Total	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
1988	13480.60	11460.54	52.132	6.59	0.00	0.000	3.30
1989	12261.64	10455.57	51.775	6.59	0.00	0.000	3.49
1990	10084.04	8360.44	39.914	5.64	0.00	0.000	3.69
1991	7876.68	6677.27	30.565	3.91	0.00	0.000	3.91
1992	6629.67	5610.08	28.519	3.31	0.01	0.000	4.13
1993	6920.97	6010.10	32.897	2.93	0.02	0.000	4.37
1994	8442.82	7450.98	44.718	3.16	1.10	0.000	4.63
1995	10485.91	9045.56	48.967	4.64	3.33	0.000	4.90
1996	10347.01	8864.56	48.194	4.78	5.84	0.000	5.18
1997	9560.74	8421.44	51.480	3.60	9.28	0.000	5.48
1998	7159.79	6433.58	44.296	2.22	15.07	0.000	5.80
1999	6282.96	5665.64	37.079	1.85	21.59	0.000	6.14
2000	7230.48	6334.26	37.616	2.75	33.02	0.000	6.49
2001	7186.49	6274.30	37.926	2.76	45.67	0.000	6.87

GHG emissions [Gg CO_2 eq]							
Year	**Total**	**CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**
2002	6464.14	5678.17	33.940	2.29	61.30	0.000	7.27
2003	7131.12	6288.04	42.282	2.38	83.74	0.000	7.69
2004	7240.12	6234.18	36.398	2.82	119.92	0.000	8.13
2005	7712.06	6568.82	35.122	3.04	195.16	0.000	8.16
2006	7504.14	6666.01	36.044	1.67	297.11	0.000	8.48
2007	8018.06	6981.89	34.914	2.04	385.79	0.000	8.81
2008	7191.80	5954.30	19.412	1.96	625.89	0.021	9.16
2009	4156.86	3218.61	4.871	0.96	639.11	0.056	9.52
2010	4441.44	3473.34	0.016	0.96	663.05	0.064	18.76
2011	5016.99	3995.18	0.005	0.85	752.68	0.055	16.97
2012	4780.17	3786.91	0.001	0.52	823.14	0.046	16.10
2013	4754.73	3627.94	0.001	0.46	968.38	0.039	20.42
2014	5115.24	3850.47	0.001	0.47	1107.96	0.033	16.88
2015	5764.40	4383.58	0.000	0.47	1222.08	0.028	18.07
2016	6051.32	4506.52	0.000	0.43	1399.33	0.023	18.75
2017	6407.65	4467.95	0.000	0.35	1816.64	0.031	17.51
2018	6525.73	4127.59	0.000	0.43	2252.53	0.014	17.99
2019	6359.87	3731.00	0.000	2.66	1818.55	0.012	18.26

The emission trends of the three GHG – CO_2, CH_4 and N_2O, are presented on the following figure.

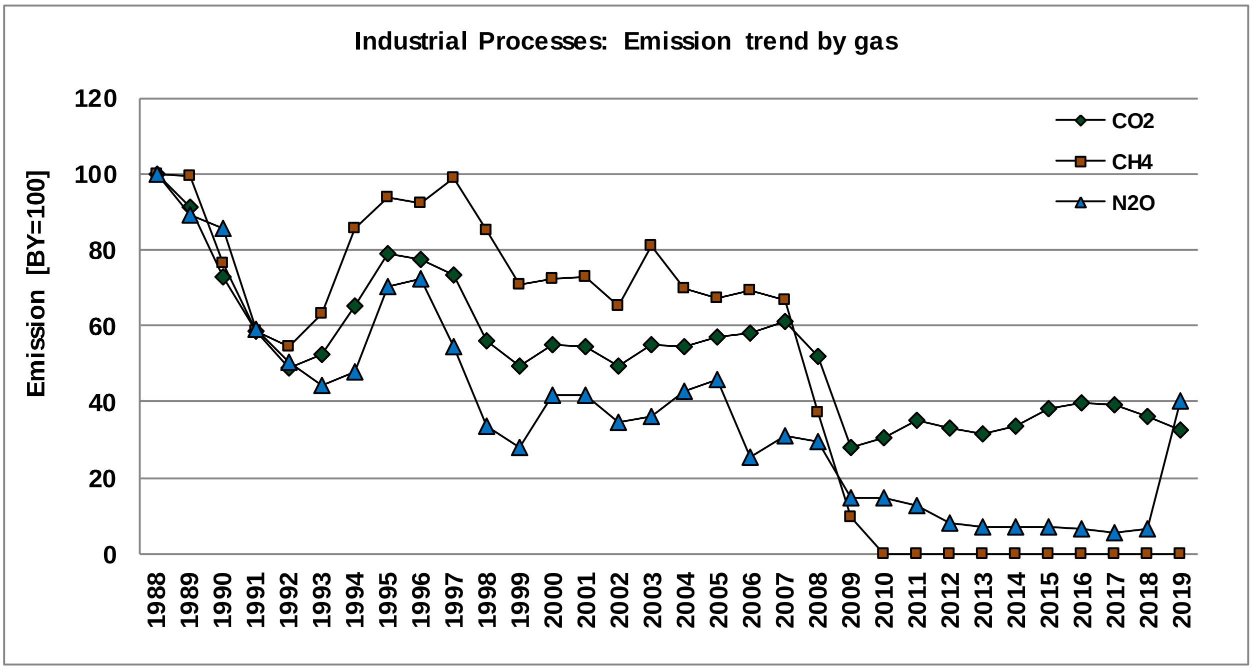

Figure 52 IPPU: Emission trend by gas – CO_2, N_2O, CH_4

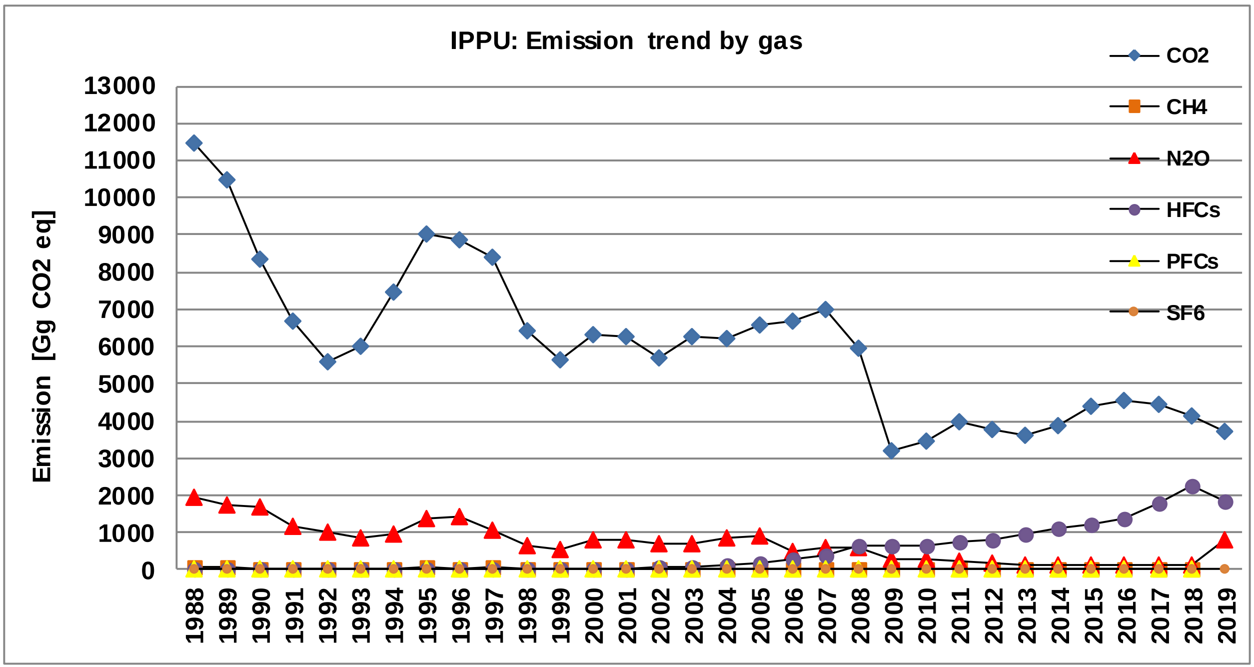

Figure 53 IPPU: Emission trend by gas – CO_2, N_2O, CH_4, HFCs PFCs and SF_6

Emission trends by sources

The main sources of greenhouse gas emissions in the IPPU sector can be followed by the tables and graphics (sector 2.F).

Table 116 GHG Emissions from CRF 2 IPPU by sector 1988 to 2019

GHG emissions [Gg CO_2 eq]							
Year	**2.A Mineral Industry**	**2.B Chemical Industry**	**2.C Metal Industry**	**2.D Non-energy Products from Fuels and Solvent Use**	**2.F Product Uses as Substitutes for ODS**	**2.G Other Product Manufacture and Use**	**2.H Other**
1988	3739.87	5422.48	4024.37	229.17	0.00	64.70	0.00
1989	3556.28	5190.91	3248.14	202.02	0.00	64.29	0.00
1990	3277.86	4943.27	1629.35	169.34	0.00	64.23	0.00
1991	2065.61	3912.54	1710.80	123.48	0.00	64.24	0.00
1992	1746.74	3097.65	1591.97	129.13	0.01	64.17	0.00
1993	1769.82	2856.54	2084.69	147.93	0.02	61.96	0.00
1994	2096.87	3209.15	2939.41	106.48	1.10	89.82	0.00
1995	2731.32	4206.76	3360.40	103.19	3.33	80.91	0.00
1996	2689.69	4397.46	3061.41	108.86	5.84	83.75	0.00
1997	2117.07	3692.04	3580.32	82.27	9.28	79.75	0.00
1998	1548.53	2457.03	2962.70	106.23	15.07	70.23	0.00
1999	1448.47	1896.54	2726.00	123.33	21.59	67.02	0.00
2000	1628.45	2764.01	2631.42	96.61	33.02	76.96	0.00
2001	1654.50	2791.34	2528.25	99.17	45.67	67.55	0.00
2002	1720.66	2209.52	2299.04	101.30	61.30	72.33	0.00
2003	1758.53	2285.62	2827.93	108.82	83.74	66.47	0.00
2004	1989.29	2615.79	2342.86	109.40	119.92	62.86	0.00
2005	2196.40	2784.70	2370.52	105.74	195.16	59.54	0.00
2006	2330.46	2154.13	2556.15	106.54	297.11	59.74	0.00
2007	2825.39	2377.75	2266.69	102.59	385.79	59.85	0.00
2008	2814.61	2314.70	1279.45	95.64	625.91	61.50	0.00
2009	1746.34	1311.03	308.16	93.09	639.17	59.07	0.00
2010	1811.79	1501.86	288.66	100.45	663.11	75.57	0.00

GHG emissions [Gg CO_2 eq]							
Year	2.A Mineral Industry	2.B Chemical Industry	2.C Metal Industry	2.D Non-energy Products from Fuels and Solvent Use	2.F Product Uses as Substitutes for ODS	2.G Other Product Manufacture and Use	2.H Other
2011	1953.77	1826.29	315.88	98.82	752.74	69.50	0.00
2012	2056.84	1444.80	290.17	94.55	823.19	70.62	0.00
2013	1941.35	1473.39	221.79	90.95	968.41	58.84	0.00
2014	2005.29	1604.66	249.29	91.36	1107.99	56.66	0.00
2015	2385.67	1790.30	224.06	84.83	1222.10	57.43	0.00
2016	2445.49	1837.89	223.42	89.21	1399.35	55.96	0.00
2017	2521.48	1746.22	183.09	86.59	1816.67	53.60	0.00
2018	2478.52	1455.57	186.20	98.67	2252.54	54.22	0.00
2019	2325.24	1899.68	160.70	100.55	1818.55	55.15	0.00

The following figure presents greenhouse gas emissions from IPCC Category 2 IPPU by sub category for the years 1988 to 2019.

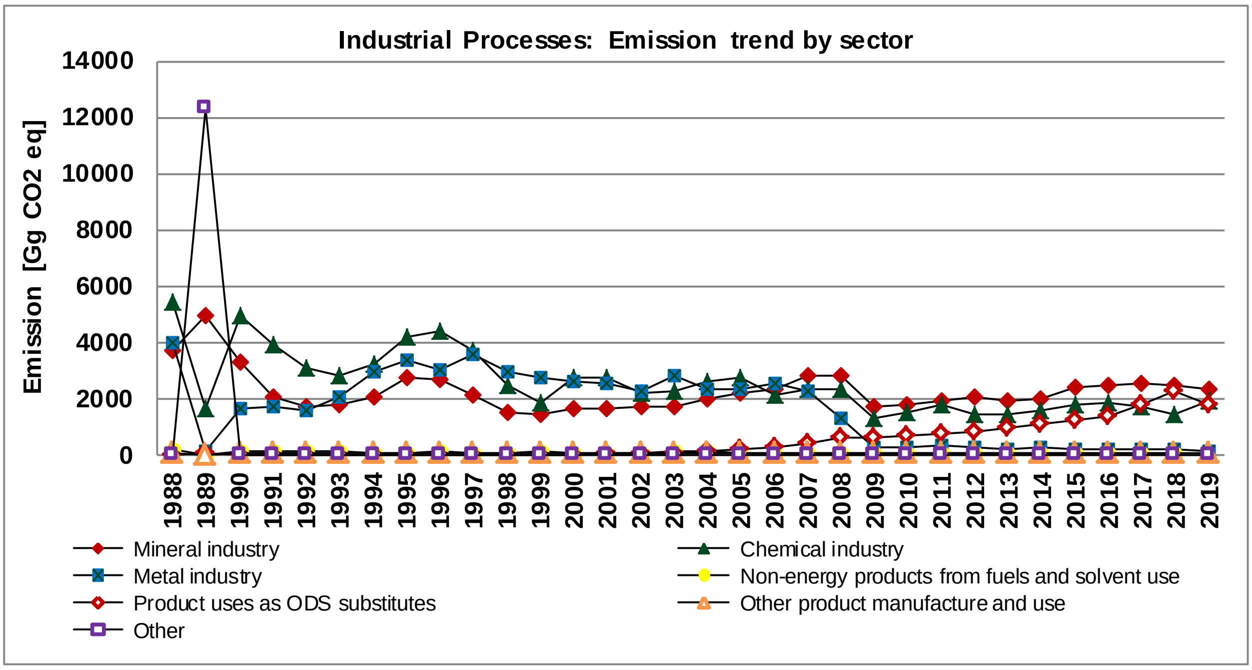

Figure 54 CRF 2 IPPU: Emission trend by sector – [Gg CO2 eq]

The emissions reduction during the whole time period from 1988 to 2019 is due to mainly economic reasons (economic crisis). There are a two similar periods – around 1989 - 1991 and 1997 – 1999. The period around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase of the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.
The general reduction in the emissions in the later years of the time period is influenced also by the starting introduction of better technologies on plant level or plant closures.
Greenhouse gas emissions from the IPPU sector fluctuate during the period and reach a minimum in 2009.
One of the most important factors leading to emission reduction in Metal Industry sector is that the biggest plant from this sector (which share in the steel production before 2008 was more than 50%) ceased operation of its pig iron and the following steel making in BOF in November 2008. The total reduction in the sector production comparing the years of 2008 and 2019 is more than 50%.
Ceased operation of existing ammonia and nitric acid plants is the main reason for the emission reduction in Chemical Industry category, too. That led to a reduction of the emissions in the period 1999/2002 for the Chemical Industry as a whole. After that 2010 the market was recovered.

In 2018 a slight increase in emissions is observed for the entire IPPU sector. This is mainly due to increase in Product uses as ODS substitutes (Consumption of Halocarbons) category.

Methodology

The general method for estimating emissions for the IPPU sector, as recommended by the 2006 IPCC Guidelines, involves multiplying production data for each process by an emission factor per unit of production. For some sub-sectors (for example ammonia production, nitric acid production, etc.) higher tier, i.e. tier 2 or tier 3, are used.
In some categories emission and production data were reported directly by industry or EU ETS, IPPC and/or E-PRTR reports thus represent plant and country specific data. Methodologies are described for all IPCC categories.
Detailed information on the methodology can be found in the corresponding subchapters.

Emission data reported under the European Emission Trading Scheme - EU ETS

Verified CO_2 emissions reported under the EU ETS were available for the years 2007-2019. These emissions have been incorporated in the inventory as far as possible (see respective subchapters for more information). Furthermore the background data for the emission calculations under the EU ETS were used for further QA/QC checks.

Uncertainty Assessment

For the sector IPPU uncertainties are estimated taking into account the recommendations of the 2006 IPCC Guidelines.
For all the sub-sectors uncertainties for the emission factors and activity data as well as combined uncertainty are estimated. When doing so the methods for obtaining the activity data and estimating the emission factors (plant specific, country specific, national statistics) were considered.

Quality Assurance and Quality Control (QA/ QC)

Emission estimations as well as activity data and emission factors are compared with the verified EU ETS emission reports, IPPC reports as well as E-PRTR reports where available.
The availability of quality management systems, such as ISO 9001, ISO 14001 and EMAS, are available for is also taken into account that.
Monitoring data are used in some emissions estimation.

Planned Improvements

All planned improvements (described in the following sub-chapters) have been implemented in this sector.

4.2 MINERAL INDUSTRY (CRF 2.A)

4.2.1 CEMENT PRODUCTION (CRF 2.A.1)

4.2.1.1 Source category description

In the period 1988 - 2019 there are 6 existing/operational cement plants in Bulgaria. One of these six installations was operational from 1988 till 1996 and decommissioned finally during that last year. One from the five left/operational installation had substantial decrease in production during 2010. In 2011 this factory completely ceased operation and all equipment was decommissioned. In 2013 one more installation ceased operation and all the equipment was decommissioned. At present there are only 3 operating plants. All 3 plants are covered by the EU ETS and the IPPC Directive and have been modernized during the last 10 years. In addition all plant are certified at present according to ISO 9001 and 14 001 standards.
Additional information on the above installations (operators) may be obtained through the Bulgarian Association of Cement Industry (BACI) at www.bacibg.org and/or their own internet sites.

4.2.1.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begun which leaded to decrease in the plants' production. This process was followed by reconstruction and modernization of the plants and in the same time some of the companies cease their operation.

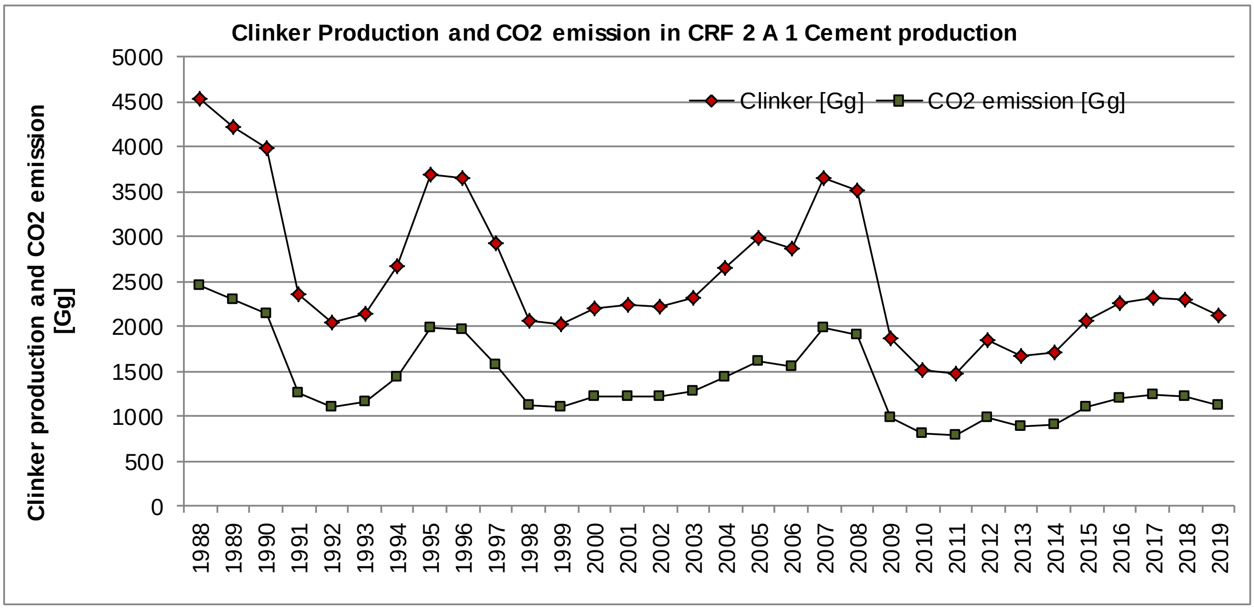

Figure 55 Clinker Production and CO2 emission in CRF 2 A 1 Cement production

4.2.1.3 Methodological issues

4.2.1.3.1 Method

The GHG emissions from the sector are calculated by using a clinker production data and a country specific method, similar to a Tier 2 Method according to item 2.2.1.1 from the 2006 IPCC GL. The aggregated national clinker production (CP) data in t/y are provided by the NSI. Clinker production data was taken from the annual reports under the IPPC permits. In addition, information on the content of calcium and magnesium oxide in the clinker is required from the plants.
The emission calculations and the applied emission factor are respectively according to equation 2.2 on pages 2.9 from item 2.2.1.1 (2006 IPCC GL):

$$\textbf{Emissions} = \mathbf{EF_{clinker} \bullet CP \bullet CKD\ Correction\ Factor}$$

$$\mathbf{EF_{clinker} = \sum M \bullet C_{(MeO)}}$$

$$\mathbf{C_{(MeO)} = ((\sum Cn_{(MeO)}) \bullet CPn) / CP)/100}$$

Where:
CKD Correction Factor = 1.00 for the period 2009-2018, and 1.02 for the period 1988-2008
M - Molecular Weight CO_2/ Molecular Weight Me-oxide
$C_{(MeO)}$ – Content (Weight Fraction) in Clinker [%]
CP – clinker production [Gg]
Me – Ca, Mg, other
n – Cement plants (1-5)

The above assumption (for the period 2009-2018) for the CKD Correction Factor is based on the modern status of cement plants and the total (100%) recycling of their CKD as a raw material.

4.2.1.3.2 Emission factor

In addition, the above calculations are based on the conservative assumption that all of the lime (MeO) comes from a carbonate sources (e.g. limestone/$MeCO_3$) in the lack of reliable data on the use

of non-carbonate sources, i.e. assuming 100% calcinations of the carbonate sources present in the raw materials mixture.
Taking into account the above, the final equation is as follows:

Emissions = 0.530• CP (for 2019)

The CO_2 emissions for 2019 are taken from the operators EU ETS reports. In their reports $CaCO_3$, $MgCO_3$ and other carbonates content in the raw materials used is taken into account.

4.2.1.3.3 Activity data

The aggregated national clinker production (CP) data provided by the NSI and plants cover the period from 1988 to 2019. They are presented in the table below together with the relevant coefficients and the calculated CO_2 emissions:

Table 117 Clinker production, weight fraction and CO2 emission

Clinker Production Data		IEF [kt CO2/ kt production]	CO2 Emissions [kt]
Year	[kt/y]		
1988	4535.24	0.541	2454.46
1989	4232.71	0.541	2290.73
1990	3986.62	0.537	2142.42
1991	2354.10	0.537	1264.77
1992	2041.10	0.538	1097.10
1993	2143.81	0.538	1153.80
1994	2680.61	0.537	1440.69
1995	3700.60	0.538	1992.66
1996	3645.10	0.538	1960.52
1997	2921.99	0.538	1573.01
1998	2063.45	0.542	1118.43
1999	2018.72	0.548	1106.45
2000	2211.23	0.548	1211.57
2001	2239.65	0.548	1228.41
2002	2222.32	0.547	1214.71
2003	2327.30	0.547	1272.52
2004	2644.37	0.546	1444.25
2005	2981.62	0.543	1618.09
2006	2859.79	0.542	1549.68
2007	3644.85	0.543	1979.36
2008	3509.82	0.541	1899.69
2010	1514.55	0.533	807.29
2015	2073.69	0.533	1105.43
2016	2257.05	0.529	1194.11
2017	2326.86	0.533	1239.30
2018	2297.48	0.533	1223.50
2019	2127.51	0.530	1127.10

4.2.1.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.
AD = 1-2 %
CaO Weight Fraction = 1-2 %
MgO Weight Fraction = 1-2 %
Quantitative uncertainty estimates are provided in Annex 2.

Combined uncertainty	2,12 %
AD	1,5%
EF	1,5%

4.2.1.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.
As a part from the QA activities the aggregated national clinker production data provided by the NSI were compared with the production data reported by the cement plants in the annual reports for compliance with their IPPC permits (EPRTR data), as well as in their verified EU ETS emission reports.
All verification EU ETS reports are public available at: http://eea.government.bg/bg/r-r/r-te/verifitsirani-dokladi-19

4.2.1.6 Source specific recalculations

Following a recommendation from FCCC/ARR/2018/BGR I.4 the CKD correction factor has been changed from value of 1,00 to defaut value of 1.02 (according to 2006 IPCC Guidelines) for the years 1988 to 2008 that lead to recalculations of CO_2 emissions and IEF. From 2009 onwards, the CKD correction factor is equal to 1,00 because data used for the estimations are taken from the EU ETS reports.
Recalculations have been performed, based on provided data for CaO and MgO content in clinker from companies for the years 2016 and 2017.

4.2.1.7 Source specific planned improvements

Improvements in this category are not planned.

4.2.2 LIME PRODUCTION (CRF 2.A.2)

4.2.2.1 Source category description

The production of lime involves a series of steps similar to those in the production of Portland cement clinker. These include quarrying the raw materials, crushing and sizing, calcining (i.e., high temperature heat processing ~ 1100°C) the raw materials to produce lime, hydrating the lime to calcium hydroxide followed by miscellaneous transfer, storage and handling operations.
Calcium oxide (CaO or quicklime) is formed by heating limestone to decompose the carbonates. This is usually done in shaft or rotary kilns at high temperatures and the process releases CO_2. Depending on the product requirements (e.g., metallurgy, pulp and paper, construction materials, effluent treatment, water softening, pH control, and soil stabilisation), primarily high calcium limestone (calcite) is utilized in accordance with the following reaction (2006 IPCC Guidelines):

$CaCO_3$ (high-purity limestone) + heat = CaO (quicklime) + CO_2

Currently there are 5 lime producing plants in Bulgaria which fall under the IPPC and the EU ETS. They produce high calcium quicklime. After the largest metallurgic plant ceases operation in 2008 there is virtually no production of dolomitic lime. In 2013 letters were sent to all quicklime producing plants (including the ones producing quicklimes for their own needs) and all of them declared that they do not produce dolomitic lime.

4.2.2.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.
The reduction in 2009 is ceased operation (in November 2008) of one of the lime producers (integrated steel making plant), reduction in the construction works and other quicklime consuming production processes and world economic crises.

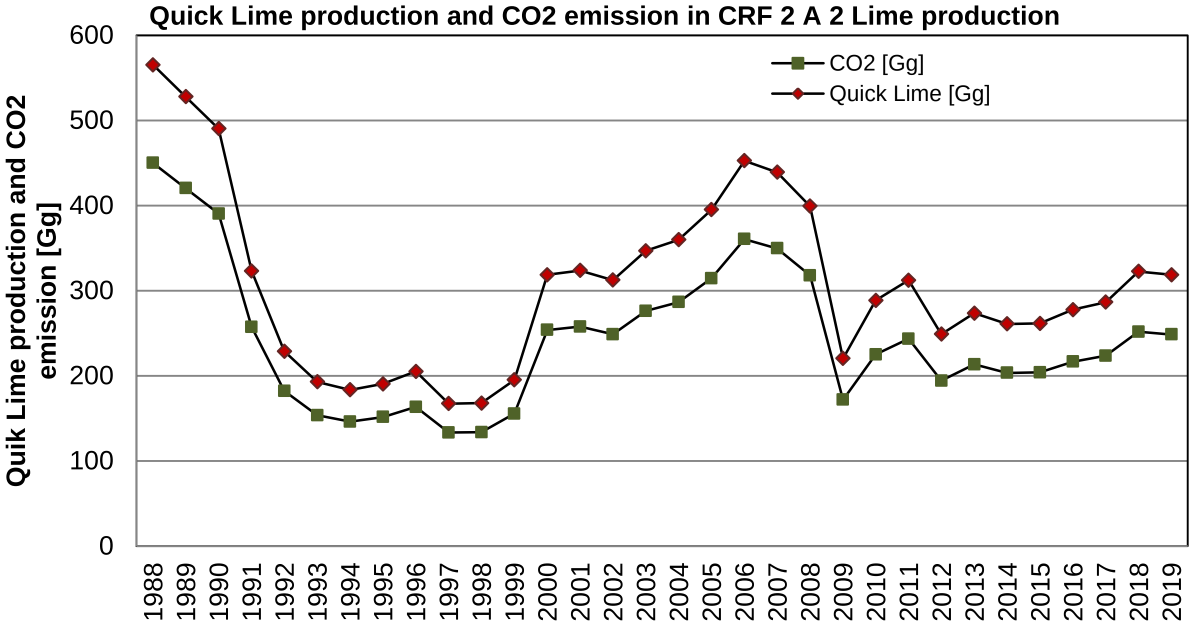

Figure 56 Lime Production and CO_2 emission in CRF 2.A.2 Lime production

4.2.2.3 Methodological issues

4.2.2.3.1 Method

The emissions from the sector are calculated using country specific data on the total amount of lime produced provided by NSI. Default emission factor is applied.
The emissions are estimated following the general approach and using the following equation similar to equation 2.6, p.2.21 (2006 IPCC Guidelines):

$$\mathbf{CO_2\ Emissions = \sum (EF_{Lime,i} \bullet M_{Lime,i} \bullet CF_{LKD,I})}$$

Where:
CO_2 Emissions = emissions of CO_2 from lime production, tonnes
$EF_{Lime,i}$ = emission factor for lime of type i, tonnes CO_2/tonne lime
$M_{Lime,i}$ = lime production of type i, tonnes
$CF_{LKD,I}$ = correction factor for LKD for lime of type i, dimensionless = 1.02
The following is taken into account:
2006 IPCC Guidelines (Table 2.4, p. 2.22) recommend a default emission factor of 0.785 tonnes CO_2/tonne quicklime produced and 0.913 tonnes CO_2/tonne dolomitic lime produced.
It is assumed that the whole quantity of $CaCO_3$, $MgCO_3$, и $CaMg(CO_3)_2$ is carbonised to CaO и MgO – 100% and the ratio of high-calcium lime to Dolomitic lime is: 85% High-calcium lime to 15% Dolomitic lime.
$M_{Lime} = 0.85 \bullet M_{high\ calciumlime} + 0.15 \bullet M_{dolomitic\ lime}$
Thus an approach in line with Tier 2 method (2006 IPCC Guidelines, p.2.21) is used to estimate CO_2 emissions from lime production.

4.2.2.3.2 Emission factor

To estimate the emission factors are used the following equations:

EQUATION 3.5A

$EF_{high\ calciumlime}$ = Stoichiometric ratio (CO_2 /CaO) • CaO content + Stoichiometric ratio (CO_2 /MgO) • MgO content

Where: $EF_{high\ calciumlime}$ = emission factor for quicklime

EQUATION 3.5B

$EF_{dolomitic\ lime}$ = Stoichiometric ratio (CO_2/ CaO·MgO) • (CaO·MgO) content (Stoichiometric ratio (CO_2 /CaO) • CaO content + Stoichiometric ratio (CO_2 /MgO) • MgO content)

Where: $EF_{dolomitic\ lime}$ = emission factor for dolomitic quicklime

The above equations are used to estimate the emission factor.

4.2.2.3.3 Activity data

Country specific data on the total lime production (quicklime) are provided by NSI.
The following is taken into consideration: It is good practice to assess the available national statistics for completeness, and for the ratio of limestone to dolomite used in lime production (2006 IPCC Guidelines).
Thus statistical data on total amount of lime produced are used to estimate the emissions of CO_2 from lime production.

Issues of double counting:

CO_2 emissions from Lime production are reported in this chapter and are not included in Limestone and dolomite use chapter.

Table 118 Lime production and CO2 emissions

Year	Lime Production [kt/y]	IEF (with LKD) [kt CO_2/ kt production]	CO_2 Emissions [kt CO_2]
1988	565.21	0.796	450.07
1990	490.39	0.796	390.49
1995	190.48	0.796	151.67
2000	318.70	0.796	253.78
2005	395.12	0.796	314.63
2010	288.60	0.780	225.13
2015	261.59	0.780	204.06
2016	277.69	0.780	216.61
2017	286.55	0.780	223.53
2018	322.69	0.780	251.72
2019	318.73	0.780	248.63

4.2.2.3.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	2,83 %
AD	2%
EF	2%

Uncertainty for AD:

The following is taken into account (2006 IPCC GL, p. 2.25, see also Table 2.5):
The uncertainty for the activity data is likely to be much higher than for the emission factors, based on experience in gathering lime data.

Uncertainty for EF:

The following is taken into account (2006 IPCC GL, p. 2.25, see also Table 2.5):
In Tier 2 and Tier 1, the stoichiometric ratio is an exact number and therefore the uncertainty of the emission factor is the uncertainty of lime composition.
There is uncertainty associated with determining the CaO content and/or the CaO•MgO content of the lime produced.
Quantitative uncertainty estimates are provided in Annex 2.

4.2.2.4 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.

4.2.2.5 Source specific recalculations

There are no source specific recalculations for this category.

4.2.2.6 Source specific planned improvements

No source specific improvements are planned.

4.2.3 GLASS PRODUCTION (CRF 2.A.3)

4.2.3.1 Source category description

Currently there are six glass plants in Bulgaria mainly producing flat, container and domestic glass. All of them fall under the IPPCD and the EU ETS.
According to the information given in the Reference Document on Best Available Techniques in the Glass Manufacturing Industry, December 2001, the general description of the main types of glass produced in the country are:

Container glass

The forming process is carried out in two stages, the initial forming of the blank either by pressing with a plunger, or by blowing with compressed air, and the final moulding operation by blowing to obtain the finished hollow shape. These two processes are thus respectively termed "press and blow" and "blow and blow". Container production is almost exclusively by IS (Individual Section) machines.

Flat glass

Flat glass is produced almost exclusively with cross-fired regenerative furnaces. The basic principle of the float process is to pour the molten glass onto a bath of molten tin, and to form a ribbon with the upper and lower surfaces becoming parallel under the influence of gravity and surface tension. From the exit of the float bath the glass ribbon is passed through the annealing lehr, gradually cooling the glass to reduce residual stresses. On-line coatings can be applied to improve the performance of the product (e.g. low emissivity glazing).

Domestic glass

Domestic glass is a diverse sector involving a wide range of products and processes. Ranging from intricate handmade lead crystal, to high volume, mechanised methods used for mass produced tableware.
The forming processes are automatic processing, hand made or semi-automatic processing, and following production the basic items can be subjected to cold finishing operations (e.g. lead crystal is often cut and polished).

4.2.3.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.
One of the glass producing plants is new and has started working in the period 2005/2006. Another one had reduced capacity, operational time, during 2008 – 2009 and had stopped in 2010.

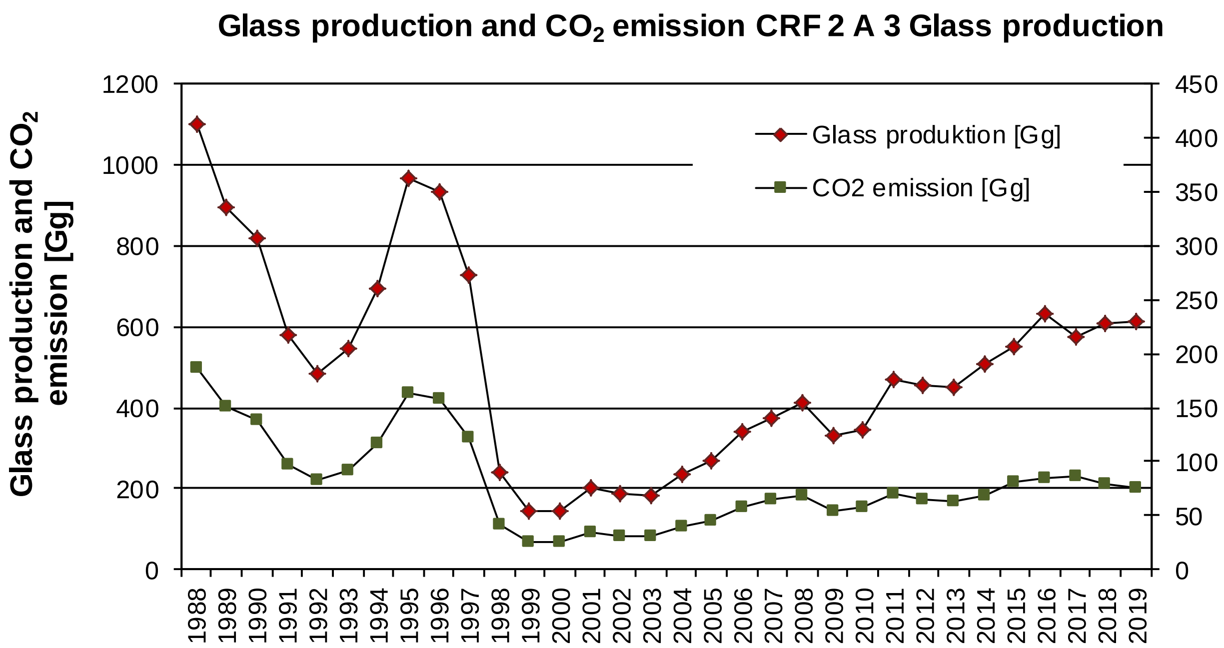

Figure 57 Glass Production and CO_2 emission in CRF 2.A.3 Glass production

4.2.3.3 Methodological issues

4.2.3.3.1 Method

Emissions are estimated based on the carbonate used from data presented in verified reports, it is similar to equation 2.12, page 2.28, 2006 IPCC GL. This section does not report emissions from soda ash use, they are reported in the sub-sector 2A4b Other uses of Soda Ash.
The emissions were estimated using the following equation:

Emissions CO_2 = Emission factor • Glass production

For the period 2007 - 2018 plant specific emissions and production data were used based on the data reported by operators under the EU ETS (except one plant) and the IPPC. Thus plants specific emission factors were obtained which from an implied emission factor was delivered.

4.2.3.3.2 CO_2 Emission factor

For the period 2007 - 2008 plant specific (for five plants) emission factors were calculated on the basis of data from the IPPCD and the EU ETS reports (see Table 119). These emission factors were used to calculate an implied emission factor which was further used to recalculate the emissions for the rest of the time series.

4.2.3.3.3 Activity data

Plant specific data from the IPPCD and the EU ETS reports are available for the years 2007 - 2019. For the time series 1988 – 2019 statistical activity data were used. The quantity of glass produced was recalculated by NSI in tones due to differences in the measurement units reported.
Issue of double counting:
Only the emissions from the use of lime stone in the glass production process are estimated in this category. The quantities of soda ash and fuel used are reported under Soda ash use and Energy Chapter respectively.

Table 119 Glass production and CO2 emission in CRF 2.A.3 Glass production

Year	Glass Production (GP) [kt/y]	Emission Factor (EF CO_2) [kt CO_2/kt GP]	CO_2 Emissions [kt CO_2]
1988	1102.09	0.169	186.24
1990	818.04	0.169	138.24

Year	Glass Production (GP) [kt/y]	Emission Factor (EF CO_2) [kt CO_2/kt GP]	CO_2 Emissions [kt CO_2]
1995	968.79	0.169	163.72
2000	146.66	0.169	24.78
2005	267.94	0.169	45.28
2010	344.16	0.166	57.11
2015	550.91	0.146	80.41
2016	631.60	0.133	84.01
2017	575.64	0.149	85.78
2018	607.47	0.131	79.40
2019	612.27	0.124	76.06

4.2.3.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	14,14 %
AD	±10 %
EF	10%

Uncertainty for AD:

"Glass production data are typically measured fairly accurately (+/-5 percent) for Tier 1 and Tier 2. As mentioned above, inventory compilers should be cautious where activity data are not originally available in mass, but rather as a unit (e.g., bottle) or area (e.g., m2). If activity data have to be converted to mass, this may result in additional uncertainty." (2006 IPCC GL, p. 2.31)
Taking the above into account the uncertainty of the emission factor was assumed as ±6 %.

Uncertainty for EF:

Uncertainty associated with use of the Tier 1 emission factor and cullet ratio is significantly higher, and may be on the order of +/- 60 percent.
Quantitative uncertainty estimates are provided in Annex 2.

4.2.3.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.
Revision of the activity data by using IPPCD and EU ETS reports as well as statistical data.
Development of country specific emission factor for glass production based on IPPCD and EU ETS data.
ISO 9001 and 14 001 standards.

4.2.3.6 Source specific recalculations

There are no source specific recalculations for this category.

4.2.3.7 Source specific planned improvements

No source specific improvements are planned.

4.2.4 OTHER PROCESS USES OF CARBONATES (CRF 2.A.4): CERAMICS PRODUCTION (CRF 2.A.4.A)

4.2.4.1 Source category description

According to the Reference Document on Best Available Techniques in the Ceramic Manufacturing Industry, August 2007, the fundamental methods and steps in the production processes hardly differ

in the manufacture of the various ceramic products, besides the fact that, for the manufacture of, e.g. wall and floor tiles, table - and ornamentalware (household ceramics), sanitaryware and also technical ceramics, often a multiple stage firing process is used.
The manufacture of ceramic products takes place in different types of kilns, with a wide range of raw materials and in numerous shapes, sizes and colours. The general process of manufacturing ceramic products, however, is rather uniform, besides the fact that, for the manufacture of wall and floor tiles, table- and ornamentalware (household ceramics), sanitaryware and also technical ceramics, often a multiple stage firing process is used. In general, raw materials are mixed and cast, pressed or extruded into shape. Water is regularly used for a thorough mixing and shaping. This water is evaporated in dryers and the products are either placed by hand in the kiln (especially in the case of periodically operated kilns) or placed onto carriages that are transferred through continuously operated kilns. In most cases, the kilns are heated with natural gas, but liquefied petroleum gas, fuel oil, coal, petroleum coke, biogas/biomass or electricity are also used.
The currently operating ceramic plants in Bulgaria are producing mostly bricks, roof and wall tiles and other ceramic products. Those of them which cover the capacity criteria according to the IPPC Directive have IPPC permits as well as ETS permits.

4.2.4.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.
A relatively stable production amount is observed for the period after the world economic crisis. This level is stable but significantly lower than the previous years. The production in this sector is highly dependent on the construction business. As this business flourishes in 2004-2005 there is also a great increase in the production of ceramics. After 2009 the demand is considerably lower and the market is oversaturated with goods which brings the production of a collapse in 2009.

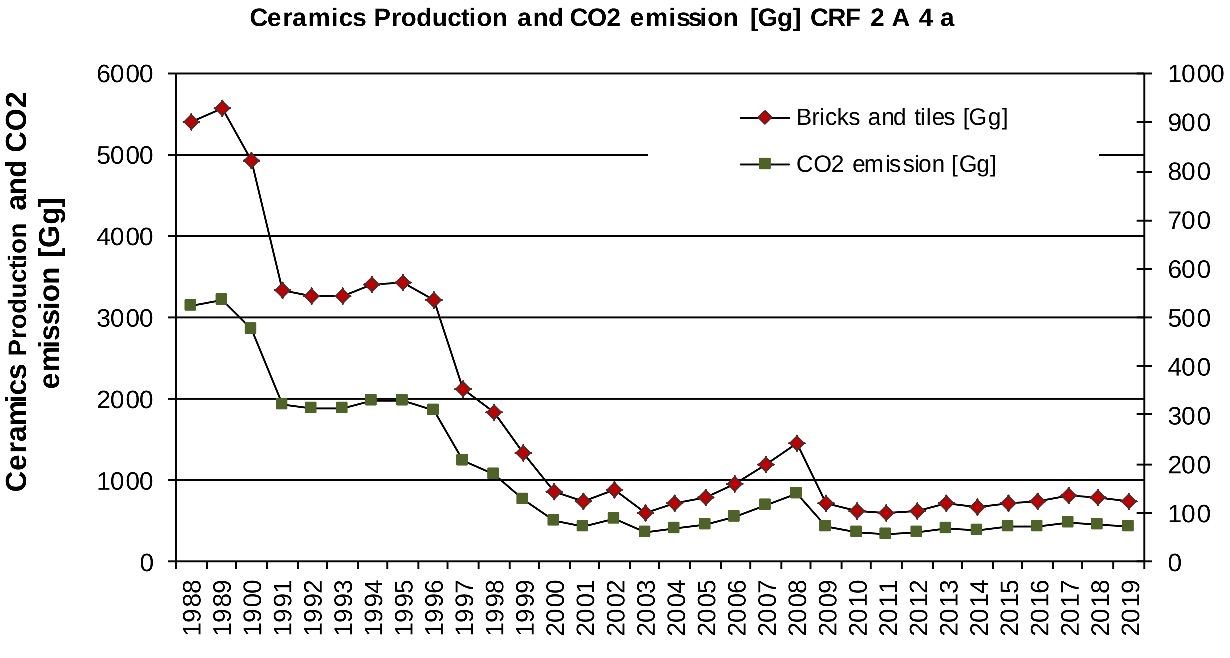

Figure 58 Ceramics Production and CO_2 emission in 2A4a "Other Process Uses of Carbonates"

4.2.4.3 Methodological issues

4.2.4.3.1 Method

The emissions estimation is according to the definitions in the 2006 IPCC Guidelines and default emission factor.
In emissions estimations the general approach described in the 2006 IPCC Guidelines is applied using the following equation:

$$TOTAL\ CO_2 = (AD \cdot EF)$$

where:
TOTAL CO_2 = the process emission (tonnes) of CO_2
AD = production of ceramics production (tonnes/yr)
EF = the emission factor for CO_2 for ceramics produced.

4.2.4.3.2 CO_2 Emission factor

A default emission factor is used according to:
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 - ANNEX IV Activity-specific monitoring methodologies related to installations (Article 20(2)) 12. Manufacture of ceramic products as listed in Annex I to Directive 2003/87/EC - Method B (Output based) Tier 1: A conservative value of 0,123 tonnes of CaO (corresponding to 0,09642 tonnes of CO_2) per tonne of product shall be applied for the calculation of the emission factor instead of the results of analyses.

4.2.4.3.3 Activity data

Statistical data on production are used for the whole time series. Conversion of the production data (from m^3 and units) was performed in order to obtain them in tones.

Issue of double counting:

In order to avoid double counting, the quantity fuel used is reported under Energy Chapter respectively.
Emissions from this category in 2019 are estimated to 71.88 kt and the production is 745.44 kt and the IEF is 0.096 kt/production, respectively data for the base year (1988) are estimated to 522.51 kt and the production is 5419.1 kt and the IEF is 0.096 kt/production.

Table 120 Ceramic production and CO2 emission in CRF 2.A.4.a

Year	Ceramic Production (CP) [kt/y]	Emission Factor [kt CO_2/kt CP]	CO_2 Emissions [kt CO_2]
1988	5419.1	0.096	522.51
1990	4929.8	0.096	475.33
1995	3428.1	0.096	330.53
2000	859.7	0.096	82.89
2005	790.0	0.096	76.17
2010	621.63	0.096	59.94
2015	723.89	0.096	69.80
2016	728.17	0.096	70.21
2017	804.92	0.096	77.61
2018	785.91	0.096	75.78
2019	745.44	0.096	71.88

** Ceramic Production = Bricks and Tiles*

4.2.4.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	5.83 %
AD	3%
EF	5%

Uncertainty for AD:

The following is relevant (2006 IPCC GL, p. 2.39)
Assuming that carbonate consumption is allocated to the appropriate consuming sectors/industries, the uncertainty associated with weighing or proportioning the carbonates for any given industry is 1-3

percent. The uncertainty of the overall chemical analysis pertaining to carbonate content and identity also is 1-3 percent.

Uncertainty for EF:

The following is relevant (2006 IPCC GL, p. 2.39)
Assuming that the activity data are collected correctly, and thus the correct emission factor is applied, there is negligible uncertainty associated with the emission factor. There may be some uncertainty associated with assuming a fractional purity of limestone and dolomite in cases where only carbonate rock data are available (+/- 1-5 percent).

Quantitative uncertainty estimates are provided in Annex 2.

4.2.4.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.
Check with IPPC reports on the activity data used.

4.2.4.6 Source specific recalculations

There are no source specific recalculations for this category.

4.2.4.7 Source specific planned improvements

No source specific improvements are planned.

4.2.5 OTHER PROCESS USES OF CARBONATES (CRF 2.A.4): SODA ASH USE (CRF 2.A.4.B)

4.2.5.1 Source category description

In this category CO_2 emissions from soda ash use in glass production and non-ferrous metal processing are considered and other industries.

4.2.5.2 Trend description

The use of soda ash depends mainly on production where it is used, as most strongly is influenced by the glass industry (glass production), because there is used about 80-90% of the total quantity use in the country.
The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production. Third period with major fluctuations is worldwide economic crisis in 2009-2010.
There was a peak in 2006 which is due to approach to calculate the amounts of soda ash used in the country as = production + export – import, and not on the actual use amounts. This approach is assumed in order to avoid underestimation of emissions, because all enterprises using soda ash in manufacturing processes cannot be covered (approximately 5-6% lower than reported). This peak is due to approximately 100 000 t less quantities exported than previous years, approximately the same amount of output and about 2000 t more imported quantity compared to 2005.

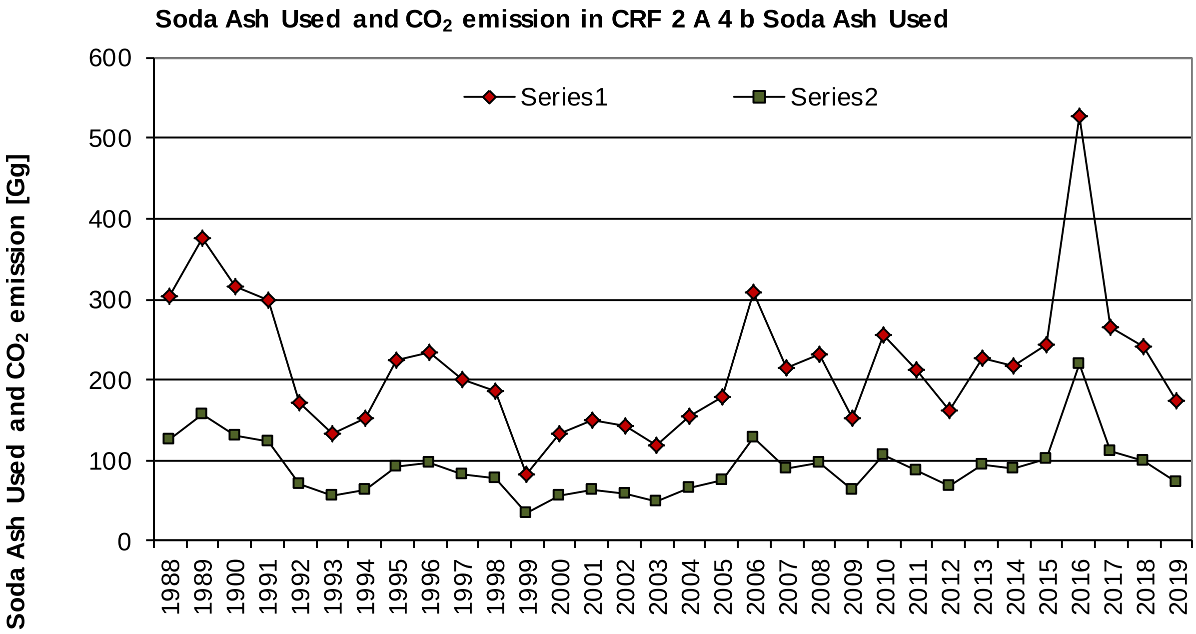

Figure 59 Soda ash used and CO_2 emission in CRF 2.A.4.b "Other Process Uses of Carbonates"

4.2.5.3 Methodological issues

For the period 1988 - 2009 a recalculation of the emissions from soda ash use is made. The following is taken into account: Statistics on soda ash production, imports and exports are obtained from NSI. Based on that a balance is made to obtain the quantity of soda ash used. This quantity is further used as AD for the calculations of the emissions from category 2.A.4.b. The EF for these recalculations is estimated stoichiometrically from Na_2CO_3.
In order to avoid double counting emissions from soda ash used in Glass productions are reported only here under 2.A.4.b and are not considered under Glass production (2.A.3).

4.2.5.3.1 Method

Emissions of CO_2 from Soda ash use are estimated using the methodology described in recommendations of the 2006 IPCC Guidelines and a default emission factor from the same guidelines (415.229 kg CO_2/t soda). Plant specific and country specific data were used to estimate CO_2 emissions from Soda ash use.
In emissions estimations the general approach is applied using the following equation:

$$\textbf{TOTAL } CO_2 = AD \bullet EF$$

where:
TOTAL = the process emission (tonnes) of CO_2
AD = soda ash used (tonnes/yr) – it is assumed that the pure substance is 100% (in fact it is in the range of 99.75-99.85%, a slight overestimation of emissions by 0.2%)
EF = the emission factor for CO_2 (EF = 415.229 kg CO_2/t soda)

4.2.5.3.2 CO_2 Emission factor

Default emission factor (stoichiometry) of 415.229 kg CO_2/t soda ash used for the whole time series was used as described in the 2006 IPCC Guidelines

4.2.5.3.3 Activity data

The activity data is calculated based on the material balance for the production, import and export of soda ash in the country, according to the recommendation of the ERT during 2012.

Emissions from this category in 2019 are estimated to 72.39 kt and the soda ash used is 174.3 kt and the IEF is 0.415 kt/production, respectively data for the base year (1988) are estimated to 126.58 kt and the soda ash used is 304.86 kt and the IEF is 0.415 kt/production

Table 121 Soda ash used and CO2 emission in CRF 2.A.4 b

Year	Soda ash used [kt/y]	CO_2 EF [t CO_2/kt soda]	CO_2 Emissions [Gg CO_2]
1988	304.86	415.229	126.58
1990	316.39	415.229	131.37
1995	223.34	415.229	92.74
2000	133.50	415.229	55.43
2005	179.07	415.229	74.35
2010	254.42	415.229	105.64
2015	242.46	415.229	100.68
2016	376.99	415.229	156.54
2017	264.95	415.229	110.01
2018	240.60	415.229	99.91
2019	174.3	415.229	72.39

4.2.5.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	2.24 %
AD	2 %
EF	+/-1 %

Uncertainty for AD:

The two following aspects are relevant (2006 IPCC GL, Chapter 2.5.2)
Assuming that carbonate consumption is allocated to the appropriate consuming sectors/industries, the uncertainty associated with weighing or proportioning the carbonates for any given industry is 1-3 percent.
The uncertainty of the overall chemical analysis pertaining to carbonate content and identity also is 1-3 percent.
Taking the above into account as well as that for the part of the time series statistical (and not plant specific) data were used an uncertainty of 2 % for activity data is assumed.

Uncertainty for EF:

The following is taken into account:
In theory the uncertainty associated with the emission factor for this source category should be relatively low, as the emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon calcination of the carbonate. In practice, there are uncertainties due, in part, to variations in the chemical composition of the limestone and other carbonates. For example, in addition to calcium carbonate, limestone may contain smaller amounts of magnesia, silica and sulphur. Assuming that the activity data are collected correctly, and thus the correct emission factor is applied, there is negligible uncertainty associated with the emission factor. There may be some uncertainty associated with assuming a fractional purity of limestone and dolomite in cases where only carbonate rock data are available (+/- 1-5 percent) (2006 IPCC GL, Chapter 2.5.2).
On the basis of the above as well as taking into account that for the part of the time series statistical (and not plant specific) data were used the emission factor uncertainty is assumed as ± 1 % - stoichiometric ratio.
Quantitative uncertainty estimates are provided in Annex 2.

4.2.5.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.
Revised the emission estimation method, by using soda ash mass balance

ISO 9001 and 14 001 standards.

EU ETS reports - emission from soda ash used in glass production (calculated by plants in the reports) and using the mass balance approach are compared.

4.2.5.6 Source specific recalculations

There are no source specific recalculations for this category.

4.2.5.7 Source specific planned improvements

No source specific improvements are planned.

4.2.6 OTHER PROCESS USES OF CARBONATES (CRF 2.A.4): DESULPHURISATION CRF 2.A.4.D

4.2.6.1 Source category description

Flue gas desulphurization (FGD) is a technology used to remove sulphur dioxide (SO_2) from the exhaust flue gas if fossil fuels power plants. Fossil fuels such as coal, peat and oil contain varying amounts of sulphur. To avoid high emissions of sulphur dioxide to the atmosphere, large combustion plants (in particular plants over 100 MWth) are usually equipped with FGD.

Nowadays there are many different ways of reducing the SO_2 emissions generated by the combustion of fossil fuels. In Bulgaria two following desulphurization techniques are applied:

Use of adsorbents in fluidised bed combustion systems

This is a primary measure to reduce the sulphur oxide emissions. The use of adsorbents in fluidised bed combustion systems are integrated desulphurisation systems. This limits the combustion temperature to about 850°C. The adsorbent utilised is typically CaO, $Ca(OH)_2$ or $CaCO_3$. The reaction needs a surplus of adsorbent with a stoichiometric ratio (fuel/adsorbent) of 1.5 to 7 depending on the fuel. Due to chlorine corrosion effects, the desulphurisation rate is limited by 75%. This technique is mainly utilised in coalfired LCPs and is described in Chapter 4. (LCP BREF, p. 65).

Wet scrubbers

This is a secondary measure to reduce sulphur oxide emissions. Wet scrubbers, especially the limestone-gypsum processes, are the leading FGD technologies. They are used in large utility boilers. This is due to their high SO_2 removal efficiency and their high reliability. Limestone is used in most cases as the sorbent, as it is available in large amounts in many countries and is cheaper to process than other sorbents. By-products are either gypsum or a mixture of calcium sulphate/sulphite, depending on the oxidation mode. (LCP BREF, p. 66 - 67).

Limestone and quicklime are used for desulphurisation in the large combustion plants (LCP) in Bulgaria. CO_2 emissions in this sector are estimated only for these LCP's which use limestone for desulphurisation. Currently there are five LCP in Bulgaria applying desulphurization for the flue gas cleaning with lime stone. Four of them have desulphurization installations applying wet scrubbing process and the fifth one is using fluidized bed combustion system where the desulphurisation is incorporated into the combustion process.

4.2.6.2 Trend description

The first desulphurization installation started its operation in 2002. The next desulphurization installations started operation in 2006 - 2012.

In 2005 there was only one plant with such installations and during that year its boilers with desulphurization installations had reduced capacity.

There is a reduced demand for electrical energy in 2012 compared to 2011, due to which the emissions are lower despite the fact that one of the installations switched from quick lime to limestone.

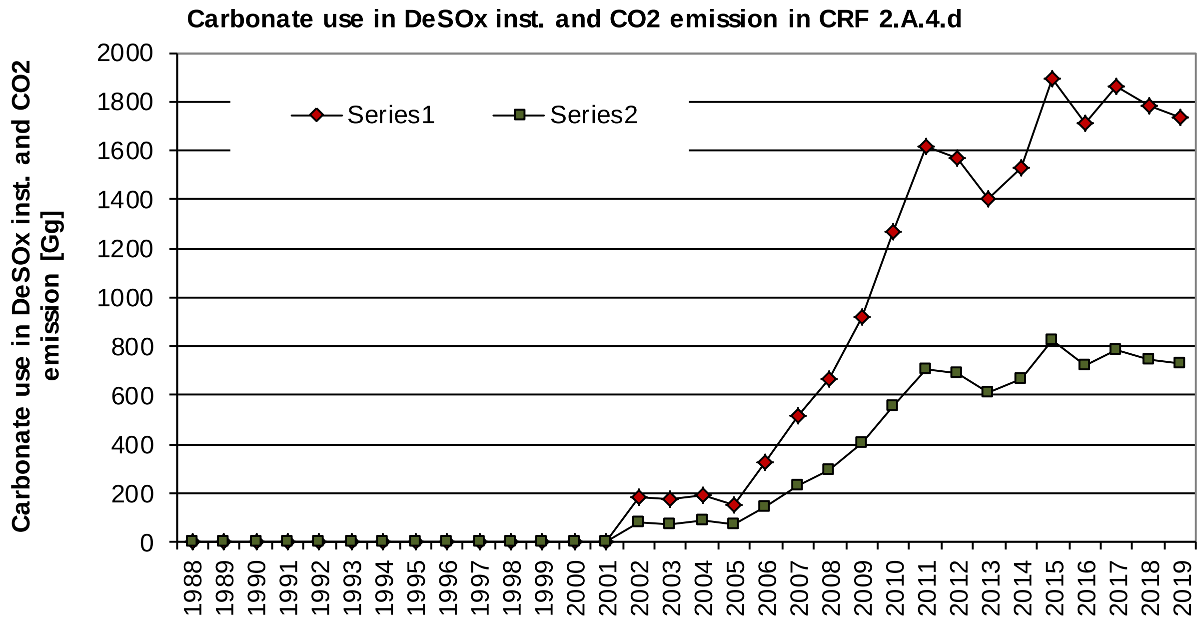

Figure 60 CaCO3, MgCO3 use and CO2 emission in CRF 2.A.4.d "Other Process Uses of Carbonates"

4.2.6.3 Methodological issues

Tier 2 method for the CO_2 emissions estimation is used. The CO_2 emissions estimated using the above equation are taken from the LCP operators the EU ETS reports. The quantities of calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$) used for the estimations are also taken form the EU ETS reports thus allowing to take into account the pure carbonates used in the process.

4.2.6.3.1 Method

Tier 2 method for the CO_2 emissions estimation is used. Under Tier 2, the amount of CO_2 emitted from the use of limestone and dolomite is estimated from a consideration of consumption and the stoichiometry of the chemical processes.
The equation used to estimate the emissions is as follows:

$$\mathbf{CO_2\ Emissions = (M_{Ca} \bullet EF_{Ca}) + (M_{Mg} \bullet EF_{Mg})}$$

Where:
CO_2 Emissions = emissions of CO_2 from other process uses of carbonates - desulphurisation, tonnes
M_{Ca} or M_{Mg} = mass of Ca Carbonate and Mg Carbonate (consumption), tonnes.
EF_{Ca} or EF_{Mg} = emission factor for Ca Carbonate and Mg Carbonate calcination respectively, tonnes CO_2/tonne carbonate
The CO_2 emissions estimated using the above equation are taken from the operators EU ETS reports.

4.2.6.3.2 CO_2 Emission factor

The emission factor is based on the mass of CO_2 released per mass of carbonate consumed (2006 IPCC GL, p. 2.7).
The EFs used to estimate CO_2 emissions from desulphurization processes are the following:
EF_{CaCO3} = 0.440,
EF_{MgCO3} = 0.522.

4.2.6.3.3 Activity data

Plant specific activity data on the amount of carbonates use are obtained from the EU ETS reports.
Issue of double counting:
The quantity of carbonates used in desulphurization are not considered in CRF 2.A.3 Limestone and dolomite use.

Emissions from this category in 2019 are estimated to 729.18 kt and the carbonate use is 1734.51 kt and the IEF is 0.420 kt/production, respectively data for the base year (1988) are estimated to 0,0 kt and the carbonate use is 0,0 kt.

Table 122 Carbonate use in DeSOx inst.(CaCO3 and MgCO3) use and CO2 emission in CRF 2.A.4.d

Year	Ca Carbonate and Mg Carbonate use [kt/y]	CO_2 EF [kt CO_2/kt Lime]	CO_2 Emissions [Gg CO_2]
1988	0.0	-	0.0
1990	0.0	-	0.0
1995	0.0	-	0.0
2000	0.0	-	0.0
2002	183.58	0.440	80.77
2005	154.26	0.440	67.87
2010	1271.65	0.438	556.68
2015	1892.29	0.436	825.29
2016	1711.54	0.423	724.01
2017	1865.33	0.421	785.25
2018	1780.88	0.420	748.22
2019	1734.51	0.420	729.18

4.2.6.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	2.12 %
AD	±1.5 %
EF	±1.5 %

Uncertainty for AD:

Activity data uncertainties are greater than the uncertainties associated with emission factors. Assuming that carbonate consumption is allocated to the appropriate consuming sectors/industries, the uncertainty associated with weighing or proportioning the carbonates for any given industry is 1-3 percent. The uncertainty of the overall chemical analysis pertaining to carbonate content and identity also is 1-3 percent (2006 IPCC GL, p. 2.39).

Uncertainty for EF:

In theory the uncertainty associated with the emission factor for this source category should be relatively low, as the emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon calcination of the carbonate. In practice, there are uncertainties due, in part, to variations in the chemical composition of the limestone and other carbonates. For example, in addition to calcium carbonate, limestone may contain smaller amounts of magnesia, silica and sulphur. Assuming that the activity data are collected correctly, and thus the correct emission factor is applied, there is negligible uncertainty associated with the emission factor. There may be some uncertainty associated with assuming a fractional purity of limestone and dolomite in cases where only carbonate rock data are available (+/- 1-5 percent) (2006 IPCC GL, p. 2.39).

4.2.6.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.
AD compared with the annual reports under IPPC.
ISO 9001 and 14 001 standards.
EU ETS reports

4.2.6.6 Source specific recalculations

There are no source specific recalculations for this category.

4.2.6.7 Source specific planned improvements

No source specific improvements are planned.

4.3 CHEMICAL INDUSTRY (CRF 2.B)

4.3.1 AMMONIA PRODUCTION (CRF 2.B.1)

4.3.1.1 Source category description

Ammonia is synthesised from nitrogen and hydrogen by the following reaction:

$$N_2 + 3H_2 = 2NH_3.$$

The technological process for Ammonia production in both of the currently operating plants is similar. Ammonia (NH_3) is produced by catalytic steam reforming of natural gas. The feedstock is reformed with steam in a heated primary reformer and subsequently with air in a second reformer in order to produce the synthesis gas.
The reaction taking place during primary reforming is:

$$CH4 + H2O = CO + 3H2$$

$$CO + H2O \rightarrow CO2 + H2$$

The main objective of secondary reforming is to add the nitrogen required for the synthesis and to complete the conversion of the hydrocarbon feed.
The synthesis gas then undergoes processes of heat and CO_2 removal and reaction of methanation due to the fact that small amounts of CO and CO_2, remaining in the synthesis gas, are poisonous for the ammonia synthesis catalyst. The synthesis gas is then compressed in a compressor to the required pressure for Ammonia synthesis.
Currently ammonia is produced in two plants in Bulgaria. Both plants are falling under the IPPC Directive and EU ETS. Until the year of 2002 there were four plants operating.

Urea production

The basic process, developed in 1922, is also called the Bosch–Meiser urea process after its discoverers. The various commercial urea processes are characterized by the conditions under which urea formation takes place and the way in which unconverted reactants are further processed. The process consists of two main equilibrium reactions, with incomplete conversion of the reactants. The first is carbamate formation: the fast exothermic reaction of liquid ammonia with gaseous carbon dioxide (CO2) at high temperature and pressure to form ammonium carbamate (H2N-COONH4):

$$2NH3 + CO2 \rightleftharpoons H2N\text{-}COONH4$$

The second is urea conversion: the slower endothermic decomposition of ammonium carbamate into urea and water:

$$H_2N\text{-}COONH_4 \rightleftharpoons (NH_2)_2CO + H_2O$$

The overall conversion of NH_3 and CO_2 to urea is exothermic, the reaction heat from the first reaction driving the second. Like all chemical equilibria, these reactions behave according to Le Chatelier's principle, and the conditions that most favour carbamate formation have an unfavourable effect on the urea conversion equilibrium. The process conditions are, therefore, a compromise: the ill-effect on the first reaction of the high temperature (around 190°C) needed for the second is compensated for by conducting the process under high pressure (140–175 bar), which favours the first reaction. Although it is necessary to compress gaseous carbon dioxide to this pressure, the ammonia is available from the ammonia plant in liquid form, which can be pumped into the system much more economically. To allow the slow urea formation reaction time to reach equilibrium a large reaction space is needed, so the synthesis reactor in a large urea plant tends to be a massive pressure vessel

4.3.1.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation, which is the case in 1999/2000 and 2002 when two of the ammonia producing plants stopped working.

The emissions decrease with 28% in 2012 compared to those in 2011 is due to the shrinking market of ammonia and nitric acid. Because of the lowest production demand, one of the operators has performed basic capital repairs concerning the optimization of the ammonia manufacturing process.

Urea production is discontinued after 2003 with termination / suspension of operations of two of the four factories for the production of fertilizers in Bulgaria.

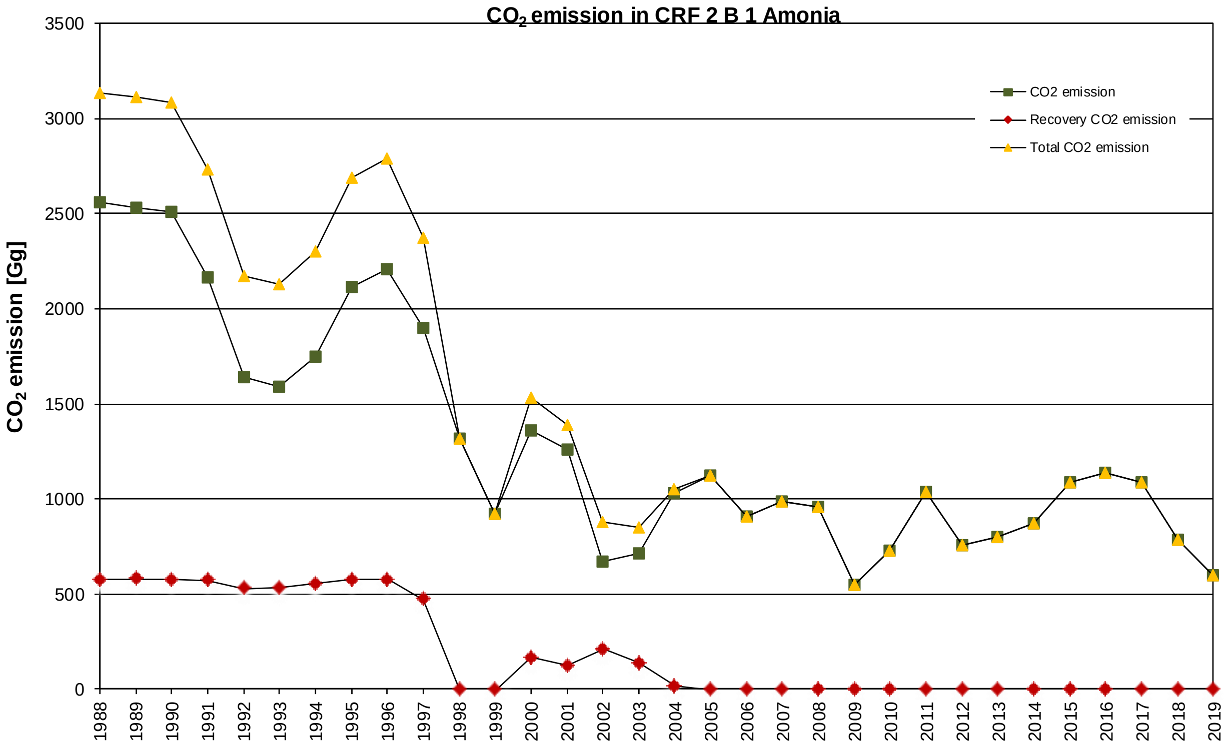

Figure 61 CO2 emission in CRF 2 B 1 Ammonia

4.3.1.3 Methodological issues

4.3.1.3.1 Method

Tier method – Tier 2, is applied using the following equations from the 2006 IPCC Guidelines (Chapter 3: Chemical Industry Emissions, equation 3.2).

TOTAL FUEL REQUIREMENT FOR AMMONIA PRODUCTION – TIER 2

$$TFR_i = \sum_j (AP_{ij} \times FR_{ij})$$

Where:

TFR_i = total fuel requirement for fuel type i, GJ

AP_{ij} = ammonia production using fuel type i in process type j, tonnes

FR_{ij} = fuel requirement per unit of output for fuel type i in process type j, GJ/tonne ammonia produced

CO_2 EMISSIONS FROM AMMONIA PRODUCTION – TIER 2

$$E_{CO_2} = \sum_i \left(TFR_i \times CCF_i \times COF_i \times \frac{44}{12} \right) - R_{CO_2}$$

Where:

E_{CO2} = emissions of CO_2, kg

TFR_i = total fuel requirement for fuel type i, GJ

CCF_i = carbon content factor of the fuel type i, kg C/GJ

COF_i = carbon oxidation factor of the fuel type i, fraction – "1"

R_{CO2} = CO_2 recovered for downstream use (urea production, CO_2)

Data on COF are default (1, fraction) and they are taken from Table 3.1 from the 2006 IPCC Guidelines (Chapter 3, p. 3.15). All other parameter and data are plant specific.

4.3.1.3.2 CO_2 Emission factor

Based on plant specific data of the currently operating plants emission factors for the whole time series are estimated.

An implied emission factor is used to recalculate CO_2 emissions for the rest of the ammonia producing plants.

4.3.1.3.3 Activity data

For the whole time series (where available) plant specific activity data were used. An adjustment with statistical data from NSI has been made for the periods where no activity data for all the ammonia producing plants were available.The following questionnaire is regularly sent to the plant operator:

Table 123 Questionnaire to plant operator of Ammonia production

1	Ammonia production (100%)	t
2	Amount of natural gas per t Ammonia	$Nm^3/t\ NH_3$
3	Amount of natural gas used	Nm^3
4	Natural gas input (Net caloric value)	GJ
5	Amount of natural on the base of the density of natural gas	t
6	Carbon content	t
7	Carbon content	kg/GJ
8	Carbon stored	t

Issue of double counting:

In order to avoid double counting, the quantity of gas used is subtracted from the quantity reported under energy and non-energy use in the Energy Chapter.

Table 124 Ammonia production and CO2 emission in CRF 2.B.1 Ammonia production

Year	Ammonia Production (NH_3) [kt/y]	Ammonia Production (NH_3) [kt/y]	CO_2 IEF [kt CO_2/kt NH_3]	Total CO_2 Emissions [Gg CO_2]	CO_2 Emissions [Gg CO_2]	Recovery CO_2 Emissions [Gg CO_2]
1988	PS data / NSI	C	C	3135.83	2557.48	578.35
1990	PS data / NSI	C	C	3086.75	2507.86	578.89
1995	PS data / NSI	C	C	2690.85	2113.66	577.19
2000	PS data / NSI	C	C	1530.19	1320.60	209.59
2002	PS data / NSI	C	C	876.68	859.89	16.79
2005	PS data	C	C	1119.75	1119.75	0.00
2010	PS data	C	C	726.12	726.12	0.00
2015	PS data	C	C	1084.78	1084.78	0.00
2016	PS data	C	C	1137.61	1137.61	0.00
2017	PS data	C	C	1086.48	1086.48	0.00
2018	PS data	C	C	784.00	784.00	0.00
2019	PS data	C	C	600.79	600.79	0.00

**C - Confidential data*

Confidentiality issue
In accordance with the 'Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. As mentioned in § 27 emissions and removals should be reported at the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information (FCCC/SBSTA/2006/9).

In CRF 2.B.1 Ammonia production the production data and the EF as well as IEF is marked as confidential "C", because these information could lead to the disclosure of confidential information provided by the plant operator.

4.3.1.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	7.28 %
AD	±2,0 %
EF	7%

Uncertainty for AD:

The two following aspects are relevant (2006 IPCC GL, Chapter 3.2.3)
Where activity data are obtained from plants, uncertainty estimates can be obtained from producers. These activity data are likely to be highly accurate (i.e., with uncertainty as low as ±2 percent).
Where uncertainty values are not available from other sources, a default value of ±5 percent can be used.
For two plants, which stopped in 1999/2000 and 2002 respectively, statistical data had to be used. Therefore an uncertainty of 3.5 % for activity data is assumed.

Uncertainty for EF:

The uncertainty for the EF is about 7%. This values is derived from European average values for specific energy consumption (Mix of modern and older plants) Average value – natural gas (2006 IPCC GL, Chapter 3, Table 3.1)
Quantitative uncertainty estimates are provided in Annex 2.

4.3.1.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.
Check if the estimated emission factors are within the range of default emission factors provided for the Tier 1 method.
Check of CO_2 generation rate.
ISO 9001 and 14 001 standards, EMAS.

4.3.1.6 Source specific recalculations

There are no source specific recalculations for this category.

4.3.1.7 Source specific planned improvements

No source specific improvements are planned.

4.3.2 NITRIC ACID PRODUCTION (CRF 2.B.2)

4.3.2.1 Source category description

Currently nitric acid is produced in two plants in Bulgaria. Both plants are falling under the IPPC Directive and ETS. Until 1999/2000 there were three plants operating.
The nitric acid is produced by following general technological steps:
Oxidation of NH_3

NH_3 is reacted with air on a catalyst in the oxidation section. Nitric oxide and water are formed in this process according to the main equation:

$$4 NH_3 + 5 O_2 = 4 NO + 6 H_2O$$

Nitrous oxide, nitrogen and water are formed simultaneously in accordance with the following equations:

$$4 NH3 + 3 O2 = 2 N2 + 6 H2O$$

$$4 NH3 + 4 O2 = 2 N2O + 6 H2O$$

The reaction is carried out in the presence of a catalyst.
Oxidation of NO and absorption in H_2O
Nitric oxide is oxidised to nitrogen dioxide as the combustion gases are cooled, according to the equation:

$$2 NO + O2 = 2 NO2$$

For this purpose, secondary air is added to the gas mixture obtained from the ammonia oxidation. Demineralised water, steam condensate or process condensate is added at the top of the absorption column. The weak acid solution (approximately 43 %) produced in the cooler condenser is also added to the absorption column. The NO_2 in the absorption column is contacted counter currently with flowing H_2O, reacting to give HNO_3 and NO:

$$3 NO2 + H2O = 2 HNO3 + NO$$

The oxidation, absorption of the nitrogen dioxide and its reaction to nitric acid and nitric oxide take place simultaneously in the gaseous and liquid phases. Both reactions (oxidation and HNO_3 formation) depend on pressure and temperature and are favoured by higher pressure and lower temperature.
The most common treatment techniques for tail gases from nitric acid plants are:
SCR (Selective Catalytic Reduction, for NOx abatement)

NSCR (Selective Non-Catalytic Reduction, for NOx and N_2O abatement)

One of the currently operating plants conducts both reactions of oxidation and absorption at normal pressure and the other plant – at high pressure. Both of the plants are using NSCR as emissions abatement technology.

4.3.2.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation, which is the case around 1999/2000 with one of the nitric acid producing plants.
There is 44% reduction of the total emission in the sector in 2012 compared to 2011, which is due to production decrease with 28% in November 2011 as well as utilisation of new treatment facilities in one of the plants to reduce the N_2O emissions the following treatment facilities are utilised after 2005.

- Catalytic converter for N_2O reduction since September 2005 – average efficiency 75%
- Since November 2011 catalyst DN_2O(BASF) – 85% efficiency for N_2O

This is connected with the decrease of the Ammonia production which is performed by the same plants.

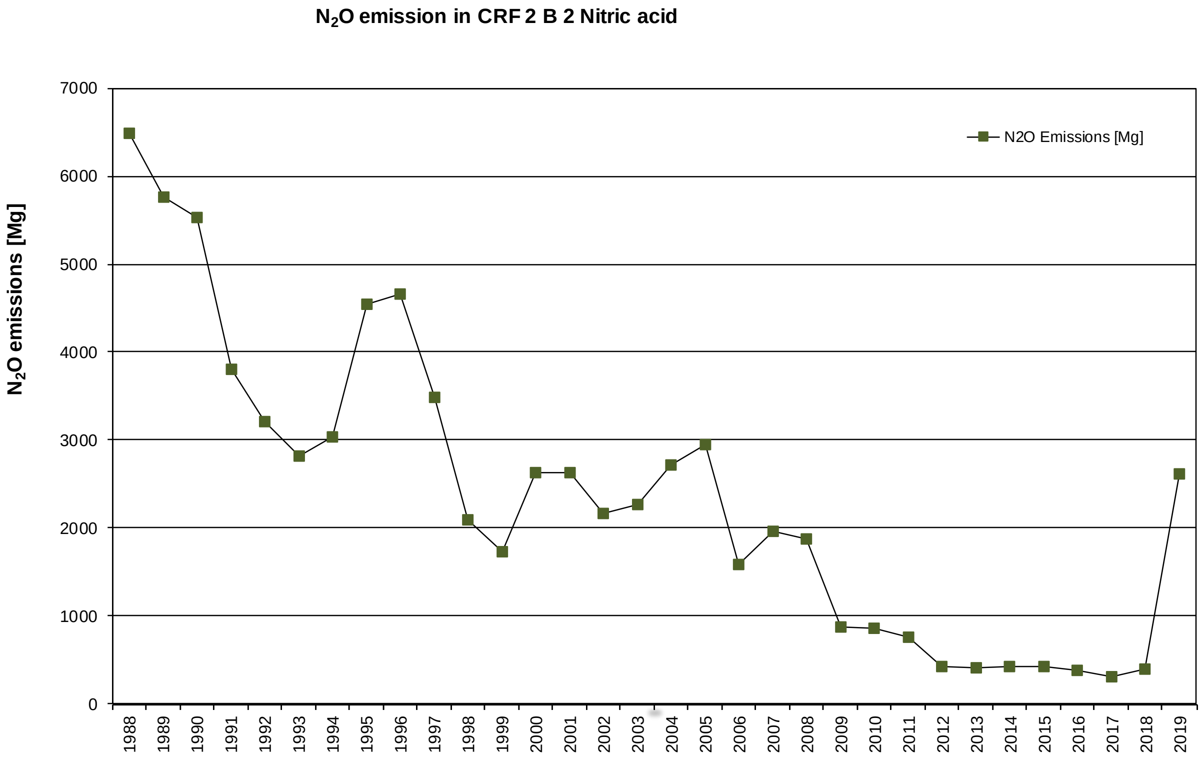

Figure 62 Nitric acid production and N2O emission in CRF 2 B 2 Nitric acid production

4.3.2.3 Methodological issues

4.3.2.3.1 Method

Taking into account the recommendations of the ERT for N_2O emissions from the nitric production, plant specific data are used and a country specific emission factor was developed. Following the Decision tree for N_2O emissions from nitric acid production (IPCC GPG 2000, p. 3.32) plant specific data on N_2O emissions and destruction were obtained. A higher tier method (referred as Tier 3 in 2006 IPCC Guidelines, Chapter 3, p. 3.21) is applied, which means that the N_2O emissions are based on real measurement data.

For completing the time series additional data from NSI were also used. The emissions were recalculated using the following equation:

$$\textbf{Emission } N_2O = IEF * NAP$$

Where:
IEF – Implied emission factor,
NAP – Nitric acid production.

4.3.2.3.2 N_2O Implied Emission factor

For the years 2000 to 2012 a plant specific emission factor was calculated on the basis measured data from plants operators.

For the period 1988 – 2000 the IEF was applied, assuming that technology and abatement types are similar. A default emission factor was applied for the third plant where no information is available and which stopped working in period 1999/2000.

4.3.2.3.3 Activity data

For the 2000 to 2012 emission data from plant operators were available; for the entire time series the production data were available. Following the recommendations of 2006 IPCC GL as a good practice in order to reduce uncertainty all activity data obtained were for 100 % HNO_3.

For the third plant activity data from NSI were used.
The following questionnaire is regularly sent to the plant operator:

Table 125 Questionnaire to plant operator of Ammonia production

1	Nitric acid production (100%)	t
2	N_2O emissions	t/y

Table 126 Nitric acid production and N2O emission

Year	Nitric acid Production (HNO_3) [kt/y]	Nitric acid Production (HNO_3) [kt/y]	Emission Factor [kt N_2O/kt HNO_3]	N_2O Emissions [kt N_2O]
1988	PS data / NSI	C	C	6.48
1990	PS data / NSI	C	C	5.53
1995	PS data / NSI	C	C	4.54
2000	PS data	C	C	2.63
2005	PS data	C	C	2.95
2010	PS data	C	C	0.86
2015	PS data	C	C	0.42
2016	PS data	C	C	0.38
2017	PS data	C	C	0.31
2018	PS data	C	C	0.39
2019	PS data	C	C	2.62

Confidential issue
In accordance with the 'Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. As mentioned in § 27 emissions and removals should be reported at the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information (FCCC/SBSTA/2006/9).
In CRF 2.B.2 Nitric acid production the production data and the EF as well as IEF is marked as confidential "C", because these information could lead to the disclosure of confidential information provided by the plant operator.

4.3.2.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	10.2 %
AD	±2 %
EF	10%

Uncertainty for AD:

The following aspects are relevant
Typical plant-level production data is accurate to ±2% due to the economic value of having accurate information (2000 IPCC GPG, Chapter 3.2).
A properly maintained and calibrated monitoring system can determine emissions within ±5% at the 95% confidence level (2000 IPCC GPG, Chapter 3.2).
Where uncertainty values are not available from other sources, a default value of ±2 percent can be used (2006 IPCC GL, Chapter 3.3.3.2).
Only for one plant, which stopped in 1999 - 2000, statistical data had to be used. Therefore an uncertainty of 3 % for activity data is assumed.

Uncertainty for EF:

The following aspects are relevant
Default EF uncertainty for Plants with NSCRa is ±10% (2000 IPCC GPG, Table 3.8, Chapter 3).

Default EF uncertainties for Plants with NSCRa (all processes) and Atmospheric pressure plants (low pressure) is ±10% (2006 IPCC GL, Chapter 3.3.2.2).
A properly maintained and calibrated monitoring system can determine emissions within ±5% at the 95% confidence level (2000 IPCC GPG, Chapter 3.2).
Only for one plant, which stopped in 1999 - 2000, data on the abatement technology were unavailable. Therefore an EF uncertainty of about 7 % is assumed.
Quantitative uncertainty estimates are provided in Annex 2.

4.3.2.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

Check with the activity data provided by NSI.

Check of AD with IPPC and E-PRTR reports.

ISO 9001 and 14 001 standards, EMAS.

4.3.2.6 Source specific recalculations

There are no source specific recalculations for this category.

4.3.2.7 Source specific planned improvements

No source specific improvements are planned.

4.3.3 ADIPIC ACID PRODUCTION (2.B.3)

Adipic Acid production does not occur in Bulgaria.

4.3.4 CAPROLACTAM, GLYOXAL AND GLYOXYLIC ACID PRODUCTION (2.B.4)

Caprolactam, Glyoxal and Glyoxylic Acid Production production does not occur in Bulgaria.

4.3.5 CARBIDE PRODUCTION AND USE (CRF 2.B.5.B)

4.3.5.1 Source category description

Carbide production
There is one carbide producing plant in Bulgaria. It reports under the EU ETS and has the IPPC permit. The process which is used to produce carbide in it is as follows:
Calcium carbide (CaC_2) is made by reducing calcium oxide CaO with carbon e.g., anthracite coal, in electric arc furnaces. The reaction is:

$$\mathbf{CaO + 3C \rightarrow CaC_2 + CO\ (+\ ½\ O_2 \rightarrow CO_2)}$$

The CaO used for carbide production is produced by the same plant from limestone. This limestone usage is included in CRF 2.A.2 Lime production in order to avoid double counting with the quicklime production.
The most important application of calcium carbide is producing acetylene (C_2H_2) by reacting CaC_2 with water. A substantial use of acetylene is welding applications
Production and use of acetylene for welding applications is summarised by reaction:

$$\mathbf{CaC2 + 2H2O \rightarrow Ca(OH)2 + C2H2\ (+\ 2.5O2 \rightarrow 2CO2 + H2O)}$$

4.3.5.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

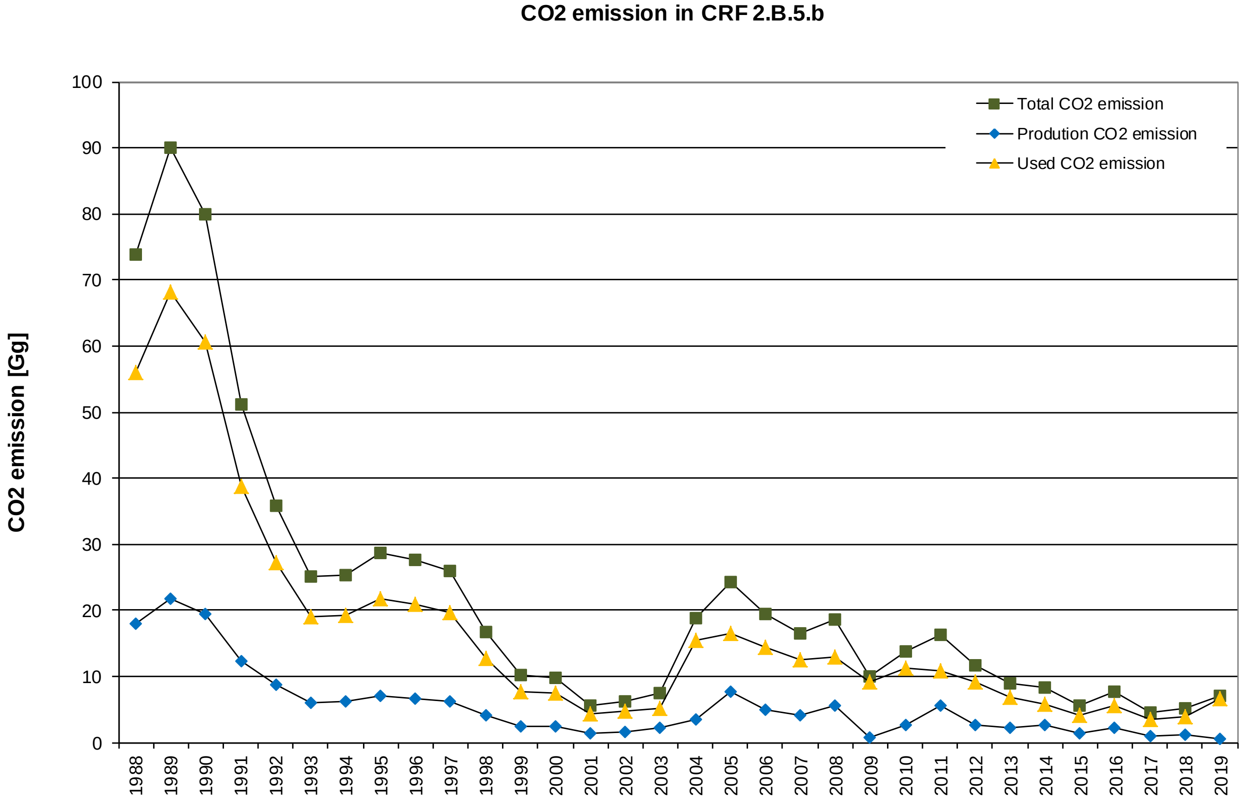

Figure 63 CO_2 emission of Carbide production and use in CRF 2.B.5.b

4.3.5.3 Methodological issues

Tier 3 has been applied from the 2006 IPCC Guidelines, Chapter 3, p. 3.42, additional data are required by the factory for the consumed quantities of coal and graphite electrodes. Data for the period 2003-2013 have been provided. The average ratio for that period has been determined and it is applied for the period 1988-2002.
For calcium carbide use is applied approach that the whole amount of calcium carbide is consumed for the acetylene production, which is used for welding / cutting of scrap metal.
To estimate CO_2 emission is used data from National Statistical Institute and producing factory.

4.3.5.3.1 Method

The emissions of calcium carbide production is calculated using the following equation:

$$E_{CO2} = (ADc \cdot EFc + ADe \cdot EFe - ADp \cdot EFp) \cdot 44/12$$

E_{CO2} - emissions of CO_2, tonnes
ADc - activity data on coal (antratcit) consumption, tonnes
ADe - activity data on graphite electrodes, tonnes
ADp - activity data on calcium carbide, tonnes
EFc - emission factor of carbon content in coals (based on data described in sector Energy - CCF , COF – 100%).
EFe - emission factor of carbon content in graphite electrodes (100%)
EFp- emission factor of carbon content in calcium carbide (based on stoichiometric ratio)

The emissions of calcium carbide use is calculated based on the following equation

$$ECO2 = ADp \cdot EFp \cdot 44/12$$

The recovered carbon from calcium carbide production is reported as 100% used.

4.3.5.3.2 CO_2 Emission factor

For the consumed amount of fuels using the same emission factors as described in Chapter energy. For Graphite electrodes (100% "C" CO_2 / C - 44/12) and calcium carbide ($2CO_2$ / CaC_2 - 1.373 / 2C / Ca - 0,375) have been used the stoichiometric ratios.

4.3.5.3.3 Activity data

Activity data are obtained from producing factory and data from NSI.

Issue of double counting:

The following is considered:
Note that the CaO (lime) might not be produced at the carbide plant. In this case, the emissions from the CaO step should be reported as emissions from lime production and only the emissions from the reduction step and use of the product should reported as emissions from calcium carbide manufacture.
The amount of fuel used is also provided by the NSI in the form of EUROSTAT balance (see sector Energy).

Table 127 CO2 emission of Carbide production and use in CRF 2.B.5.b

Year	Carbide production [kt/y]	CO_2 IEF [kt CO_2/kt CaC_2]	Total CO_2 Emissions [Gg CO_2]	Production CO_2 Emissions [Gg CO_2]	Used CO_2 Emissions [Gg CO_2]
1988	C	C	73.90	73.90	73.90
1990	C	C	79.85	79.85	79.85
1995	C	C	28.64	28.64	28.64
2000	C	C	9.85	9.85	9.85
2005	C	C	24.20	24.20	24.20
2010	C	C	13.70	13.70	13.70
2015	C	C	5.54	5.54	5.54
2016	C	C	7.63	7.63	7.63
2017	C	C	4.46	4.46	4.46
2018	C	C	5.15	5.15	5.15
2019	C	C	7.11	7.11	7.11

Confidential issue
In accordance with the 'Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. As mentioned in § 27 emissions and removals should be reported at the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information (FCCC/SBSTA/2006/9).
In CRF 2.B.5.b Carbide production the production data and the EF as well as IEF is marked as confidential "C", because these information could lead to the disclosure of confidential information provided by the plant operator.

4.3.5.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	11.18 %
AD	±5 %
EF	±10 %

Uncertainty for AD:

The two following aspects are relevant (2006 IPCC GL, p. 3.45)

Where activity data are obtained directly from plants, uncertainty estimates can be obtained from producers. This will include uncertainty estimates for petroleum coke and limestone used and for carbide production data. Data that are obtained from national statistical agencies or from industrial and trade organizations usually do not include uncertainty estimates. It is good practice to consult with national statistical agencies to obtain information on any sampling errors. Where national statistic agencies collect carbide production data from production facilities, uncertainties in national statistics are not expected to differ from uncertainties estimated from plant-level consultations. Where uncertainty values are not available from other sources, a default value of ±5 percent can be used.

Uncertainty for EF:

The following is taken into account:
In general, the default CO_2 emission factors are relatively uncertain because industrial-scale carbide production processes differ from the stoichiometry of theoretical chemical reactions. The uncertainty in the emission factors for CH_4 is due to the possible variations in the hydrogen-containing volatile compounds in the raw material (petroleum coke) that are used by different manufacturers and due to the possible variations in production process parameters. Where uncertainty values are not available from other sources, a default value of ±10 percent can be used.
It is good practice to obtain uncertainty estimates at the plant level which should be lower than uncertainties associated with default values. (2006 IPCC GL, p. 3.45)

4.3.5.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

AD compared with the annual reports under IPPC.

ISO 9001 and 14 001 standards

EU ETS reports

4.3.5.6 Source specific recalculations

There are no source specific recalculations for this category.

4.3.5.7 Source specific planned improvements

No source specific improvements are planned.

4.3.6 TITANIUM DIOXIDE PRODUCTION (CRF 2.B.6)

There is no production of Titanium Dioxide In Bulgaria.

4.3.7 SODA ASH PRODUCTION (CRF 2.B.7)

4.3.7.1 Source category description

There is one soda ash producing plant in Bulgaria. It applies Solvay process which is CO_2-neutral except for coke used for calcination of limestone. This coke used in soda ash production was considered as fuel in the energy sector (subcategory 1.A.2.C).
The concomitant production of quicklime is performed in vertical (shaft) kilns, as the captured flying ash from high-performing filters is fully utilized in the production of soda ash, together with the quantities produced quicklime.

Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production.
Highest drop in 2009 is due to global economic crisis, this trend is observed also in all sectors of the economy in the country.

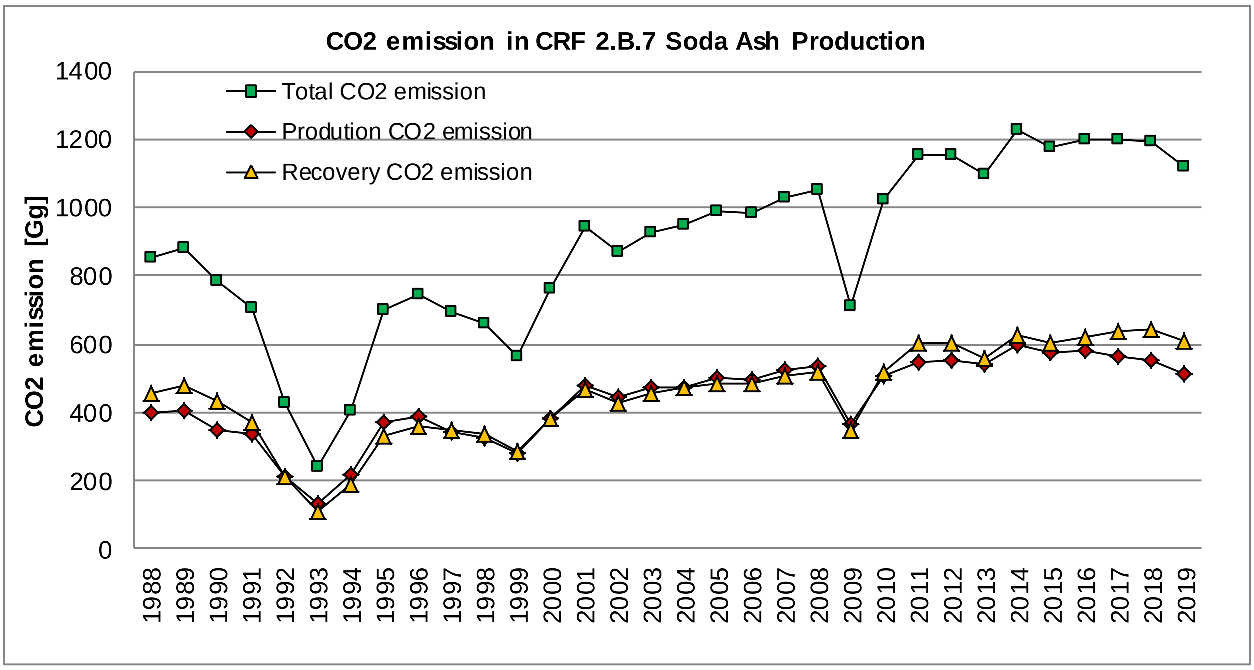

Figure 64 Soda ash production and CO_2 emission in CRF 2.B.7

4.3.7.2 Methodological issues

4.3.7.2.1 Method

Emissions of CO_2 from Soda ash production are estimated using the methodology described in the 2006 IPCC Guidelines. Plant specific and country specific data were used to estimate CO_2 emissions from Soda ash production.
Tier 2 method is applied and data for amount of fuel used and quicklime production was required by the operator. The following equation is used:

$$\mathbf{E_{CO2} = E_{CO2}\ (used\ coal) + E_{CO2}\ (production\ quick\ lime) - Recovery\ E_{CO2}}$$

E_{CO2} (used coal) - Emissions from fuel used are calculated in the manner described in chapter Energy.
E_{CO2} (production quick lime) - Emissions from lime production are calculated using the formula described in Lime production – sector 2.A.2. (without the usage of LKD – 1,02)
Recovery E_{CO2} - Recovery CO_2 emissions are calculated using the formula specified in Sector 2.A.4.b Soda ash use.

4.3.7.2.2 CO_2 Emission factor

Data for the calorific value of fuels and the relevant emission factors, attached in the verified (EU ETS) reports on emissions trading, are used.
EF for the lime production is provided by the enterprise and stoichiometric ratios.
The LKD correction coefficient is not applied as according to the 2006 IPCC Guidelines, p.2.24 – „Vertical shaft kilns generate relatively small amounts of LKD, and it is judged that a correction factor for LKD from vertical shaft kilns would be negligible and do not need to be estimated".
The other reason LKD correction coefficient not to be used is that the captured dust is accounted together with the quicklime and is utilized in the process of soda ash production.
For recovery emissions see sector 2.A.4.b Soda ash use.

4.3.7.2.3 Activity data

Activity data is provided by producing factory and data from NSI.

Issue of double counting:

To avoid double counting of emissions amount of used fuel is removed from the data provided by the NSI in the form Eurostat balance (see the Energy Sector). Also from sector 2.A.2 Lime production, is subtracted the amount of lime produced by the enterprise due to data for sector 2.A.2 provided by the NSI, including data and factory producing soda ash.

Table 128 Soda ash production and CO2 emission in CRF 2.B.7

Year	Soda ash production [kt/y]	CO_2 IEF [t CO_2/kt soda]	Total CO_2 Emissions [Gg CO_2]	Production CO_2 Emissions [Gg CO_2]	Recovery CO2 Emissions [Gg CO2]
1988	C	C	854.42	397.64	456.78
1990	C	C	783.55	349.14	434.41
1995	C	C	701.22	370.68	330.54
2000	C	C	763.55	379.54	384.01
2005	C	C	988.47	503.30	485.17
2010	C	C	1024.44	504.88	519.55
2015	C	C	1176.72	574.38	602.35
2016	C	C	1199.04	579.24	619.79
2017	C	C	1201.30	561.80	639.49
2018	C	C	1192.26	550.78	641.48
2019	C	C	1119.63	512.15	607.48

4.3.7.3 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	2.83 %
AD	2 %
EF	+/-2 %

Uncertainty for AD:

The two following aspects are relevant (2006 IPCC GL, Chapter 2.5.2)

Assuming that carbonate consumption is allocated to the appropriate consuming sectors/industries, the uncertainty associated with weighing or proportioning the carbonates for any given industry is 1-3 percent.

The uncertainty of the overall chemical analysis pertaining to carbonate content and identity also is 1-3 percent.

Taking the above into account as well as that for the part of the time series statistical (and not plant specific) data were used an uncertainty of 2 % for activity data is assumed.

Uncertainty for EF:

The following is taken into account:

In theory the uncertainty associated with the emission factor for this source category should be relatively low, as the emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon calcination of the carbonate. In practice, there are uncertainties due, in part, to variations in the chemical composition of the limestone and other carbonates. For example, in addition to calcium carbonate, limestone may contain smaller amounts of magnesia, silica and sulphur. Assuming that the activity data are collected correctly, and thus the correct emission factor is applied, there is negligible uncertainty associated with the emission factor. There may be some uncertainty associated with assuming a fractional purity of limestone and dolomite in cases where only carbonate rock data are available (+/- 1-5 percent) (2006 IPCC GL, Chapter 2.5.2).

On the basis of the above as well as taking into account that for the part of the time series statistical (and not plant specific) data were used the emission factor uncertainty is assumed as ± 1 % - stoichiometric ratio.

Quantitative uncertainty estimates are provided in Annex 2.

4.3.7.4 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.
Revised the emission estimation method, by using soda ash mass balance
ISO 9001 and 14 001 standards
EU ETS reports - emission from soda ash used in soda ash production (calculated by plants in the reports) and using the mass balance approach are compared.

4.3.7.5 Source specific recalculations

There are no source specific recalculations for this category.

4.3.7.6 Source specific planned improvements

No source specific improvements are planned.

4.3.8 PETROCHEMICAL AND CARBON BLACK PRODUCTION (CRF 2.B.8)

4.3.8.1 Source category description

Methanol (2.B.8.a)

Methanol production does not occur in Bulgaria.

Ethylene (2.B.8.b)

In Bulgaria the production of ethylene had been done in petrochemical plant, where the production stopped in 2009 and has not been reopened.
The technological process of production of ethylene is based on the steam cracking of naphtha.
Ethylene production is a non-key category.

Ethylene Dichloride (2.B.8.c)

A plant for production of ethylene dichloride was opened in 1988 and stopped in 2005, after which the plant is in liquidation.
The technological process of production of ethylene dichloride is based on the direct chlorination process, that involves gas-phase reaction of ethylene with chlorine to produce ethylene dichloride.
Direct chlorination - $\mathbf{C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2}$
Ethylene Dichloride production is a non-key category.

Ethylene Oxide (2.B.8.d)

Production of ethylene oxide does not occur in Bulgaria.

Acrylonitrile (2.B.8.e)

Production of acrylonitrile does not occur in Bulgaria.

Carbon Black (2.B.8.f)

Production of carbon black does not occur in Bulgaria.

4.3.8.2 Trend description

Ethylene (2.B.8.b)

In the period 1990-1995 the country passes through economic and political crisis. After 1996 the privatization of enterprises started and some of them modernize and continue to work while others cease their activities.
After 2009 the production of ethylene was discontinued due to lack of market (the production of ethylene dichloride from the other plant also ceased) and the need for introduction of new treatment facilities that meet the new environmental requirements (emission standards) - lower emissions of harmful substances.

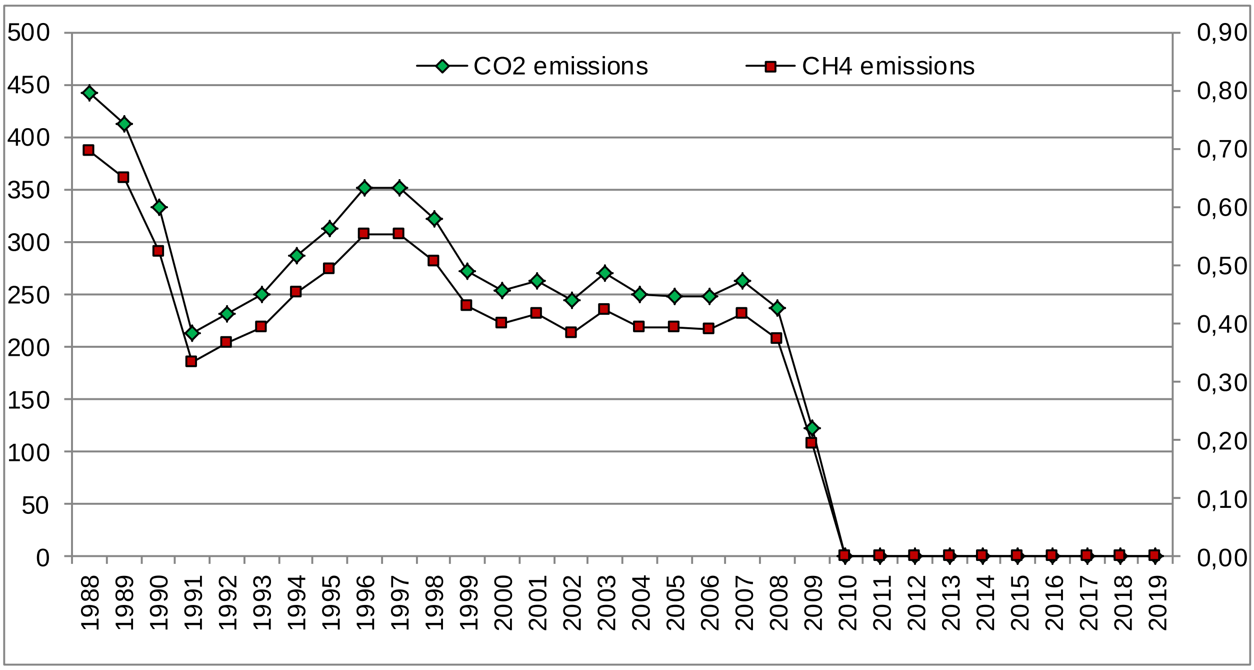

Figure 65 CO2 and CH4 emissions in CRF 2.B.2.b Ethylene production

Ethylene Dichloride (2.B.8.c)

In the period 1990-1995 the country passes through economic and political crisis. After 1996 the privatization of enterprises started and some of them modernize and continue to work while others cease their activities.

After the privatization of the plant around 1999-2000 the production of ethylene dichloride sharply decreases until its final termination in 2005. Since then it has not been restored.

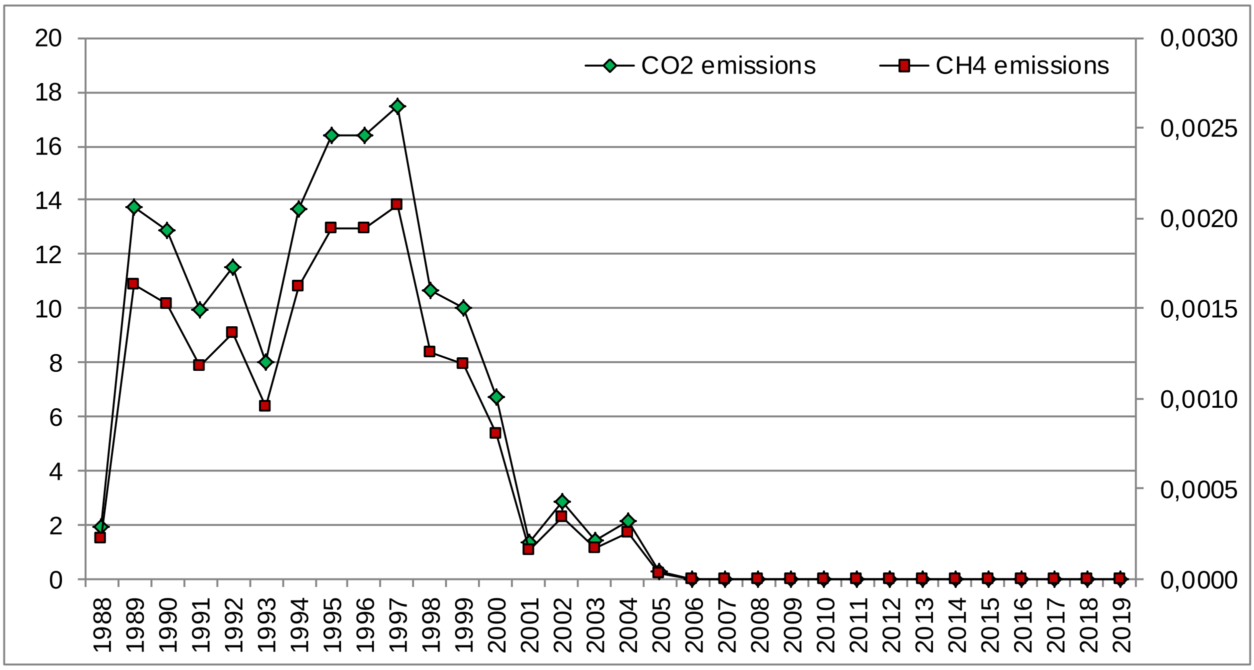

Figure 66 CO2 emissions in CRF 2.B.2.c Ethylene Dichloride production

4.3.8.3 Methodological issues

The Tier 1 method based on default values and national statistics is used.

The ethylene and ethylene dichloride production is taken from NSI. This quantity is used as AD for the calculations of the emissions from categories 2.B.2.b and 2.B.2.c.

4.3.8.4 Method

Ethylene (2.B.8.b)

Emissions of CO_2 and CH_4 from ethylene production is estimated using the methodology described in the 2006 IPCC Guidelines and default emission factor from the same guidelines (table 3.14, p. 3.75 and table 3.16, p. 3.76) with default geographic adjustment factor for Tier 1 CO_2 emission factor for steam cracking ethylene production (table 3.15, p. 3.75 - Eastern Europe).
In emissions estimations the general approach described in the 2006 IPCC Guidelines is applied using the following equation:

$$\textbf{TOTAL } CO_2/CH_4 = \sum(AD \cdot EF \cdot DGAF)$$

where:
TOTAL CO_2 / CH_4= the process emission (tonnes) of CO_2/ CH_4
AD = production of ethylene (tonnes/yr)
EF = the emission factor for CO_2 and CH_4 for ethylene produced.
DGAF = default geographic adjustment factor for Eastern Europe

Ethylene Dichloride (2.B.8.c)

Emissions of CO_2 from ethylene dichloride production is estimated using the methodology described in the 2006 IPCC Guidelines and default emission factor from the same guidelines (table 3.17, p. 3.77).
In emissions estimations the general approach described in the 2006 IPCC Guidelines is applied using the following equation:

$$\textbf{TOTAL } CO_2/CH_4 = \sum(AD \cdot EF)$$

where:
TOTAL CO_2 = the process emission (tonnes) of CO_2
AD = production of ethylene dichloride (tonnes/yr)
EF = the emission factor for CO_2 for ethylene dichloride produced.

4.3.8.4.1 CO_2 and CH_4 Emission factor

Ethylene (2.B.8.b)

The EF for these calculations is taken as default (table 3.14, p. 3.75, table 3.15, p. 3.75 table 3.16, p. 3.76).
Default emission of 1.73 t CO_2/t Ethylene and 3 kg CH_4/t Ethylene applied for the whole time series was used as described in the 2006 IPCC Guidelines. Correction default geographic adjustment factor for Tier 1 CO_2 emission factor for steam cracking ethylene production – 110%

Ethylene Dichloride (2.B.8.c)

The EF for these calculations is taken as default (table 3.17, p. 3.77).
Default emission (Direct Chlorination Process - Total CO_2 Emission Factor) of 0.191 t CO_2/t Ethylene dichloride used for the whole time series was used as described in the 2006 IPCC Guidelines.

4.3.8.4.2 Activity data

Activity data for ethylene and ethylene dichloride are confidential and obtained from NSI for the whole time series.

Ethylene (2.B.8.b)

The quantity of emissions from this activity for the base year (1988) is 442.12 kt CO_2 and 0,70 kt CH_4 (summary 459.5 CO_2 eq) and for the last year of plant exploitation (2009) 121,9 kt CO_2 and 0,20 kt CH_4 (summary 126,9 CO_2 eq.).

Ethylene Dichloride (2.B.8.c)

The quantity of emissions from this activity for the base year (1988) is 1.9 kt CO_2 and 0,0002 kt CH_4 (summary 1.9 CO_2 eq.) and for the last year of plant exploitation (2005) 0.26 kt CO_2 and 0,000003 kt CH_4 (summary 0.26 CO_2 eq.).

4.3.8.5 Uncertainties and time series consistency

Ethylene (2.B.8.b)

	CO_2	CH_4
Combined uncertainty	30.4 %	11.2 %
AD	± 5 %	± 5 %
EF	± 30 %	± 10 %

Ethylene Dichloride (2.B.8.c)

	CO_2
Combined uncertainty	20.6 %
AD	± 5 %
EF	± 20 %

4.3.8.6 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

4.3.8.7 Source specific recalculations

There are no source specific recalculations for this category.

4.3.8.8 Source specific planned improvements

There are no source-specific planned improvements.

4.3.9 FLUOROCHEMICAL PRODUCTION (2.B.9)

Fluorochemical production does not occur in Bulgaria.

4.4 METAL INDUSTRY (CRF 2.C)

4.4.1 IRON AND STEEL PRODUCTION (CRF 2.C.1.A)

4.4.1.1 Source category description

According to the information given in Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001, p. 16, four routes are currently used for the production of steel: the classic blast furnace/basic-oxygen furnace route, direct melting of scrap (electric arc furnace), smelting reduction and direct reduction. At present (1998), EU (15) steel production is based on the blast furnace/ basic-oxygen route (approximately 65%) and the electric arc furnace (EAF) route (approximately 35%).[25]
The following steel making processes are present in Bulgaria:

Open hearth furnace (*until *1993)

A type of furnaces where excess carbon and other impurities are burnt out of pig iron to produce steel. Since steel is difficult to manufacture due its high melting point, normal fuels and furnaces are insufficient and the open hearth furnace overcomes this difficulty. Compared to Bessemer steel, which it displaced, its main advantages are that it doesn't expose the steel to excessive nitrogen (which would cause the steel to become brittle), is easier to control, and it permits the melting and refining of large amounts of scrap iron and steel.
The process is far slower than that of Bessemer converter and thus easier to control and take samples for quality control. As the process is slow, it is not necessary to burn all the carbon away as in Bessemer process, but the process can be terminated at given point when desired carbon contents has been achieved.

[25] (ftp://ftp.jrc.es/pub/eippcb/doc/isp_bref_1201.pdf)

Basic oxygen steelmaking (until November 2008)

The objective in oxygen steelmaking is to burn (i.e., oxidise) the undesirable impurities contained in the metallic feedstock. The main elements thus converted into oxides are carbon, silicon, manganese, phosphorus, and sulphur. The purpose of this oxidation process, therefore, is:
to reduce the carbon content to a specified level (from approximately 4% to less than 1%, but often lower)
to adjust the contents of desirable foreign elements
to remove undesirable impurities to the greatest possible extent
The production of steel by the basic oxygen furnace (BOF) process is a discontinuous process which involves the following steps:
transfer and storage of hot metal
pre-treatment of hot metal (desulphurisation)
oxidation in the BOF (decarburisation and oxidation of impurities)
secondary metallurgical treatment
casting (continuous or/and ingot)

Electric steelmaking

The direct smelting of iron-containing materials, such as scrap is usually performed in electric arc furnaces (EAF). The major feed stock for the EAF is ferrous scrap, which may comprise of scrap from inside the steelworks (e.g. offcuts), cut-offs from steel product manufacturers (e.g. vehicle builders) and capital or post-consumer scrap (e.g. end of life products).
With respect to the end-products distinction has to be made between production of ordinary, so called carbon steel as well as low alloyed steel and high alloyed steels/stainless steels. In the EU about 85% of steel production is carbon or low alloyed steel [EC Study, 1996].For the production of carbon steel and low alloyed steels, following main operations are performed:
raw material handling and storage
furnace charging with/without scrap preheating
EAF scrap melting
steel and slag tapping
ladle furnace treatments for quality adjustment
slag handling
continuous casting
For high alloyed and special steels, the operation sequence is more complex and tailor-made for the end-products. In addition to the mentioned operations for carbon steels various ladle treatments (secondary metallurgy) are carried out like
desulphurisation
degassing for the elimination of dissolved gases like nitrogen and hydrogen
decarburisation (AOD=Argon-Oxygen-Decarburisation or VOD=Vacuum-Oxygen-Decarburi-sation)
The steel making plant which produced sinter, pig iron and steel (BOF) ceased operation in November 2008.
Currently in Bulgaria steel is produced only in EAF.

4.4.1.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.
There is general reduction of the total emission in the sector in 2009 compared to 2008. This is mainly due to the world economic crisis in 2009 which lead to a reduction of the production processes rates. The total reduction in the sector production is about 45%.
Another factor leading to this reduction is that the biggest plant from this sector (which share in the steel production before 2008 was more than 50%) ceased operation of its pig iron and the following steel making in BOF in November 2008.
Fluctuations in emissions and production of steel is determined by the largest currently producer in the country and depends on the market for products made from it (the share of other producers is under 5%).

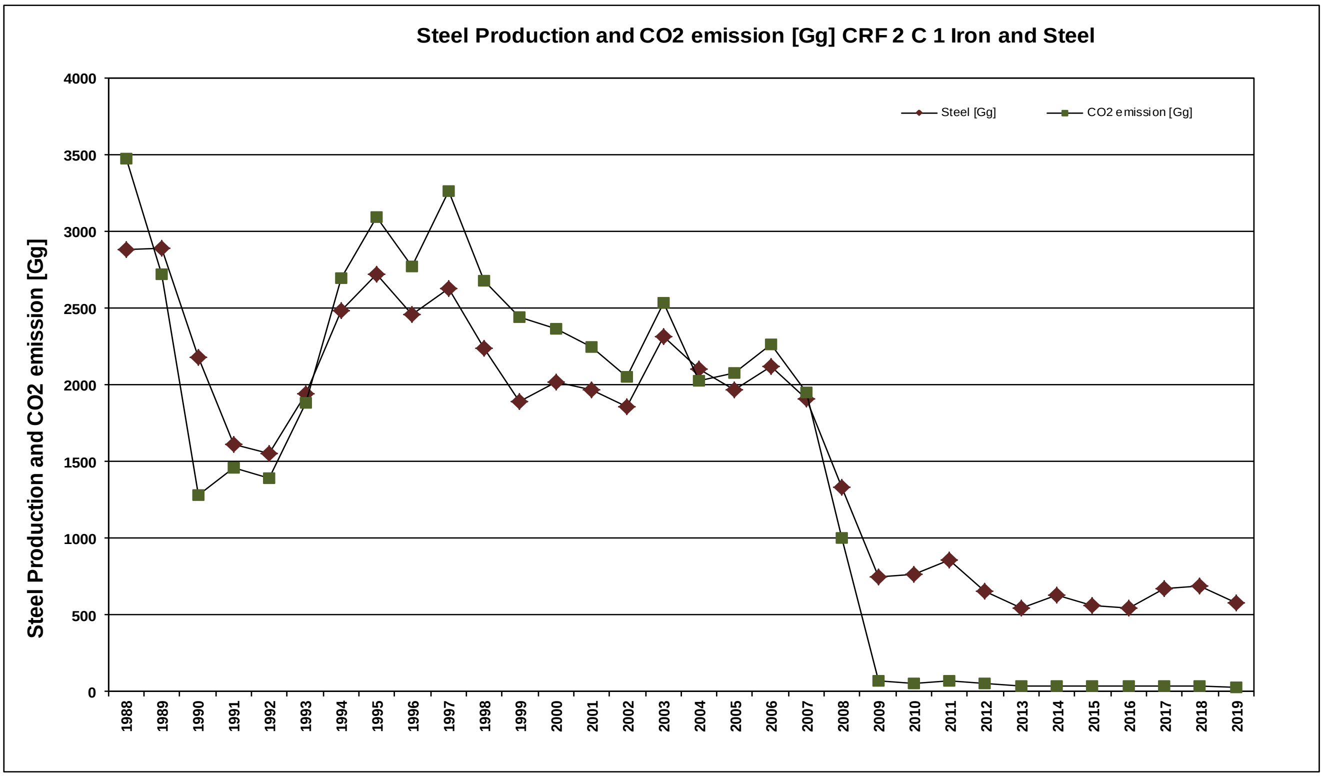

Figure 67 Iron and Steel Production and CO2 emission in CRF 2.C.1.a Iron and Steel production

4.4.1.3 Methodological issues

4.4.1.3.1 Method

Open hearth furnace

To estimate the CO2 emissions for this category Tier 1 method is used because the production of steel with this method terminated in 1993 and no information is available to apply a higher Tier method

Basic oxygen steelmaking

To estimate the CO2 emissions for this category a Tier 2 balance approach is used – carbon contents in the raw materials and the final product. The emissions include the entire production process for this type of steel – including the intermediate pig iron production in the BOF. This method for emissions estimation is implemented during the 2012 ESD review in cooperation with the ESD review experts.

Electric steelmaking

The CO2 emissions from the sector are calculated using country specific data from the EU ETS reports. Data for 2012 from Bulgarian association of metallurgical industry (BAMI, http://www.bcm-bg.com/) as well as data from World Steel Association (WSA, http://worldsteel.org) are used for crosscheck.

Total emissions are the sum of Equation:

$$\textbf{Iron \& Steel: } E_{CO_2,\ non-energy} = BOF \cdot EF_{BOF} + EAF \cdot EF_{EAF} + OHF \cdot EF_{OHF}$$

4.4.1.3.2 Emission factor

Open hearth furnace – default emission factor is used – 1.72 t CO2/t Steel (TABLE 4.1)
TIER 1 DEFAULT CO2 EMISSION FACTORS FOR COKE PRODUCTION AND IRON & STEEL PRODUCTION - 2006 IPCC GL, Chapter 4.2.2.3, p. 4.25)

Basic oxygen steelmaking

A production specific EF is calculated based on the amount of carbon in the raw materials and the final products. The EF varies for the period 1989 – 2009.

Electric steelmaking

Country specific emission factor was developed for the EAF steel based on data from EU ETS reports for the period 2007 - 2016. In the calculation of ETS emissions the operators performed a mass balance of the Carbon content in the raw materials used and the produced end product. Thus CO2 emissions are estimated by an approach similar to the following equation (IPCC GPG 2000, p. 3.25):

EQUATION 3.6B

Emissions crude steel = (Mass of Carbon in the Crude Iron used for Crude Steel Production – Mass of Carbon in the Crude Steel) • 44/12 + Emission FactorEAF • Mass of Steel produced in EAF

4.4.1.3.3 Activity data

Country specific data from the EU ETS reports as well as from BAMI and WSA on total crude steel production were received.
Issue of double accounting:
In order to avoid double counting, the quantity the fuel used is subtracted from the quantity reported under energy and non-energy use in the Energy Chapter.

Table 129 Iron and Steel production and CO2 emission

Year	Steel Production	Steel Production [kt/y]	Emission Factor [kt CO_2/kt Steel]	CO_2 Emissions [kt CO_2]
1988	BAMI / WSA	2880.00	1.209	3481.44
1990	BAMI / WSA	2180.00	0.589	1283.24
1995	BAMI / WSA	2724.00	1.136	3095.68
2000	BAMI / WSA	2022.00	1.171	2368.01
2005	BAMI / WSA / ETS	1969.00	1.055	2078.16
2010	BAMI / WSA / ETS	761.41	0.070	53.47
2013	BAMI / WSA / ETS	541.23	0.060	32.65
2015	BAMI / WSA / ETS	563.76	0.066	37.22
2016	BAMI / WSA / ETS	549.04	0.065	35.86
2017	BAMI / WSA / ETS	669.24	0.053	35.19
2018	BAMI / WSA / ETS	686.91	0.052	35.38
2019	BAMI / WSA / ETS	579.83	0.055	31.63

As can be seen in Table 129 the emission factor for 2008 is lower than the ones for the previous years. This is mainly due to the fact that in 2008 the biggest steel making plant (which is also the only one producing steel in BOF) significantly decreased and subsequently stopped BOF steel production. This leads to a decrease in the production as well as in the CO2 emissions.
For the period 2009-2012, there is no BOF steel production in Bulgaria since the above mentioned steelmaking company stopped its BOF furnaces from operation in November 2008.
Currently the steel in Bulgaria is produced only in EAF hence the IEF takes into account only this type of steel making. In 2008 the IEF includes also BOF steel. Due to the described facts the IEF in 2009-2012 decreases significantly.

4.4.1.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	7.07 %
AD	5 %
EF	5%

Uncertainty for AD:

The two following aspects are relevant
According to IPCC GPG 2000 (Chapter 3, p 3.28):
For both Tier 1 and 2 the most important type of activity data is the amount of reducing agent used for iron production. According to Chapter 2, Energy, energy data have a typical uncertainty of about 5% (about 10% for countries with less developed energy statistics). For calculating the carbon storage term Tier 2 requires additional activity data on amounts of pig iron and net crude steel production that have a typical uncertainty of a few percent. In addition, Tier 2 requires information on the carbon content of pig iron, crude steel, and of iron ore that may have an uncertainty of 5% when plant-specific data are available. Otherwise the uncertainty in the carbon content could be of the order of 25 to 50%. Finally, the uncertainty in the emission factors for the reducing agent (e.g. coke) are generally within 5% (see Section 2.1.1.6, CO2 Emissions from Stationary Combustion, Uncertainty Assessment).
Taking into account that plant specific data from EU ETS reports were used to estimate emissions an uncertainty of 5% is considered.

Uncertainty for EF:

According to Table 4.4 (2006 IPCC GL, Chapter 4.2.3) applying Tier 2 material-specific carbon contents would be expected to have an uncertainty of 10 percent. This uncertainty is considered due to using EU ETS data.
Quantitative uncertainty estimates are provided in Annex 2.

4.4.1.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.
CO2 emissions were taken from ETS reports.
Aggregated national steel production data provided by BAMI and reported by World Steel Association are used for crosscheck.

4.4.1.6 Source specific recalculations

Recalculations have been made due to a technical error in steel production value for the year 2017.

4.4.1.7 Source specific planned improvements

No source specific improvements are planned.

4.4.2 PIG IRON PRODUCTION (CRF 2.C.1.B)

4.4.2.1 Source category description

There is one pig iron production plant in Bulgaria. Currently it has ceased operation (since November 2008).

4.4.2.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.
In particular in pig iron production case the only plant ceased operation in November 2008 (see also "Iron and steel production" chapter).

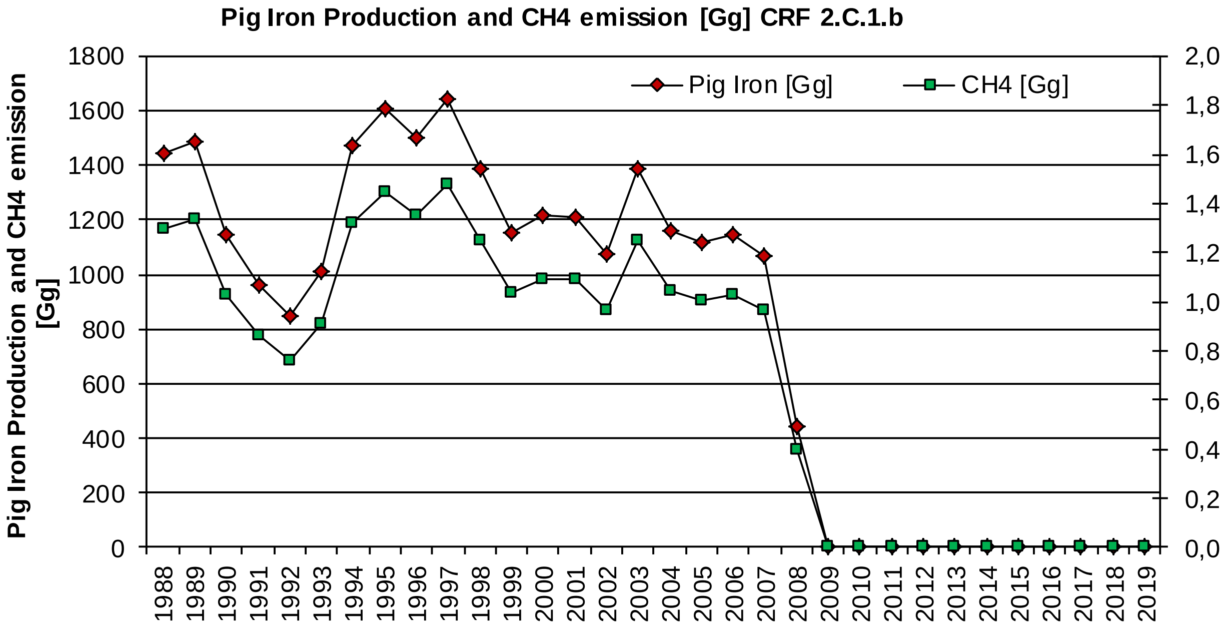

Figure 68 Pig iron Production and CH4 emission in CRF 2.C.1.b Pig iron production

4.4.2.3 Methodological issues

4.4.2.3.1 Method

Tier 1 methodology for CH4 based on emission factors and national production statistics is applied (2006 IPCC GL, p. 4.24).The emissions from the sector are calculated using country specific data on the total amount of pig iron produced taken from WSA Yearbooks. Default emission factor is applied. The emissions are estimated using the following equation (2006 IPCC GL, p. 4.24, equation 4.13).

EQUATION 4.13

CH_4 EMISSIONS FROM BLAST FURNACE PRODUCTION OF PIG IRON (TIER 1)

$$E_{CH4,non-energy} = PI \cdot EF_{PI}$$

Where
ECH4,non−energy – non-energy CH4 emissions from pig iron production
PI – pig iron production (kt)
EFPI – emission factor for pig iron

4.4.2.3.2 Emission factor

The following is taken into account: "The conversion factors provided in Table 4.1 of the IPPC I&S BAT Document are 940 kg pig iron per tonne liquid steel" (2006 IPCC GL, p. 4.25, BAT Reference Document on the Production of Iron and Steel, December 2001).
Thus an emission factor of 0.9 [kg CH4/ton production] is obtained.

4.4.2.3.3 Activity data

Country specific data on the total pig iron production are taken from WSA.
The following is also taken into account (2006 IPCC Guidelines, p. 4.28):
"The Tier 1 method requires only the amount of steel produced in the country by process type, the total amount of pig iron produced that is not processed into steel, and the total amount of coke, direct reduced iron, pellets, and sinter produced; in this case the total amount of coke produced is assume to be produced in integrated coke production facilities. These data may be available from governmental agencies responsible for manufacturing statistics, business or industry trade associations, or individual iron and steel companies."
Issue of double counting:

In order to avoid double counting, the CO_2 emissions from pig iron production are reported under BOF steel production (see *Basic oxygen steelmaking*).

Table 130 Pig iron production and CH4 emission

Year	Pig Iron Production [kt/y]	Emission Factor [t CH_4/ kt production]	CH_4 Emissions [kt CH_4]
1988	1441.00	0.900	1.30
1990	1143.00	0.900	1.03
1995	1607.00	0.900	1.45
2000	1216.00	0.900	1.09
2005	1115.00	0.900	1.00
2008	440.00	0.900	0.40
2010	0.00	0.900	0.00
2015	0.00	0.900	0.00
2016	0.00	0.900	0.00
2017	0.00	0.900	0.00
2018	0.00	0.900	0.00
2019	0.00	0.900	0.00

4.4.2.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	26.9 %
AD	± 10 %
EF	± 25%

Uncertainty for AD:

For Tier 1 the most important type of activity data is the amount of steel produced using each method. National statistics should be available and likely have an uncertainty of ± 10 percent. (2006 IPCC GL, p. 4.30, see also Table 4.4).

Uncertainty for EF:

The default emission factors for coke production and iron and steel production used in Tier 1 may have an uncertainty of ± 25 percent. (2006 IPCC GL, p. 4.30, see also Table 4.4).
Quantitative uncertainty estimates are provided in Annex 6.

4.4.2.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.
Aggregated national pig iron production data and default emission factor are used.
Comparison with NSI and BAMI data on pig iron production.

4.4.2.6 Source specific recalculations

There are no source specific recalculations for this category.

4.4.2.7 Source specific planned improvements

The only pig iron production plant has ceased operation.
No source specific improvements are planned.

4.4.3 DIRECT REDUCED IRON (CRF 2.C.1.C)

There is not direct reduced iron production In Bulgaria.

4.4.4 SINTER (CRF 2.C.1.D)

This is a process of preparation of the ore for its utilization in blast furnaces to produce pig iron. Process represents conversion of fine grain and dust materials (ores and concentrates) into big particles by sintering. The agglomeration takes place in a temperature range bounded by the range of softening and connecting of the separate particles directly or with the aid of easily melting substances that cement the particles. The heat necessary for the functioning of the agglomeration is obtained by fuel (coke) which was added to the batch.
Quantities of fuels used for this process are included in the calculation of emissions from the production of convection steel (BOF).

4.4.5 PELLET (CRF 2.C.1.E)

There is not Pellet production In Bulgaria.

4.4.6 FERROALLOYS PRODUCTION (CRF 2.C.2)

4.4.6.1 Source category description

Ferroalloys production is a non-key category.
Ferroalloys production involves a metallurgical reduction process that results in CO_2 emissions.
This is only a minor source of CO_2 and CH_4 emissions in Bulgaria: in 2015, emissions account for the 0.002% of total emissions from Industrial Processes sector.
There is one ferroalloys producer in Bulgaria. Recovered CO_2 emissions in ferroalloys production are not included. There is not ferroalloys production in Bulgaria for 2019.

4.4.6.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.
There is a significant decrease of the total emission in the sector aftern 2008. This is due to the fact that a steel making plant which produced sinter, pig iron and steel ceased operation in November 2008.

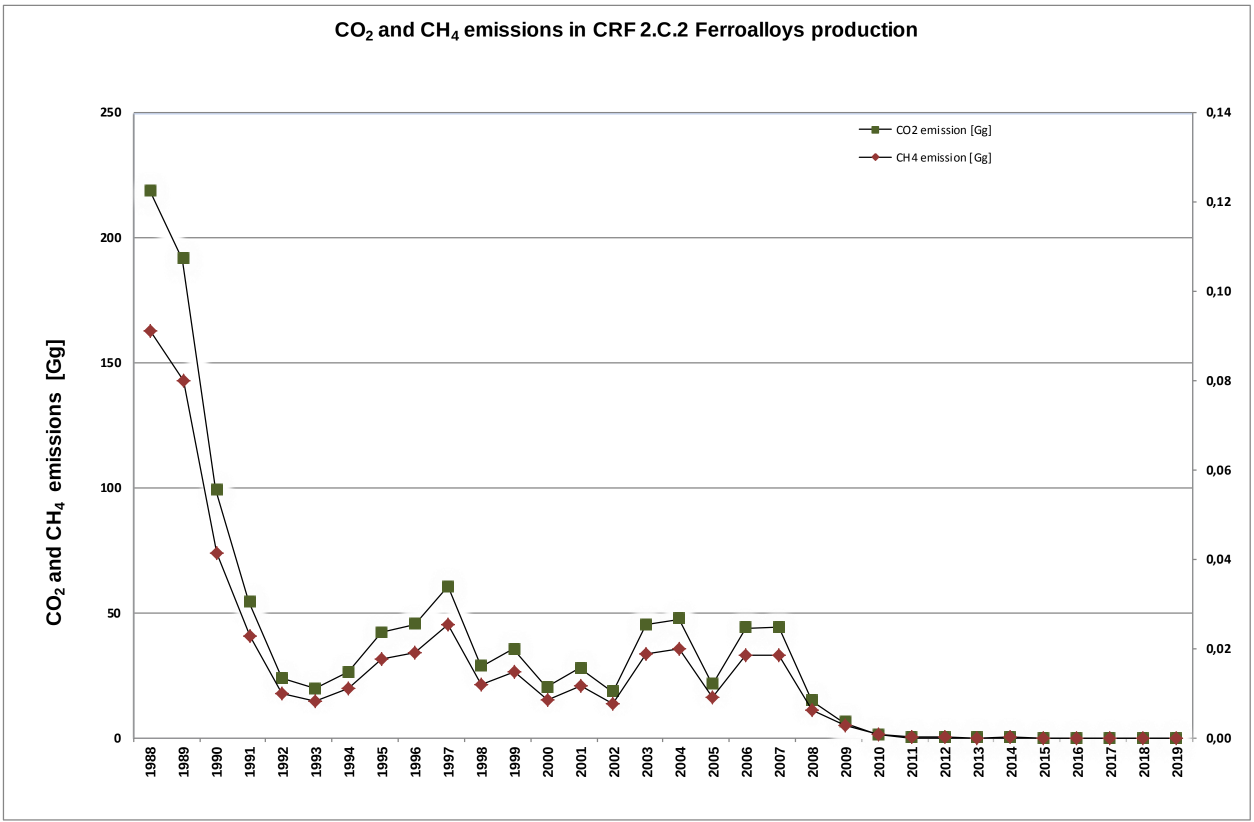

Figure 69 CO_2 and CH_4 emission in CRF 2.C.2 Ferroalloys production

4.4.6.2.1 Methodological issues

The Tier 1 method based on default values and national statistics is used.
The ferroalloys production is taken from NSI. This quantity is used as AD for the calculations of the emissions from category 2.C.2.

4.4.6.2.2 Method

Emissions of CO_2 and CH_4 from ferroalloys production is estimated using the methodology described in the 2006 IPCC Guidelines and an average default emission factor from the same guidelines (table 4.5, p. 4.37 and table 4.7, p. 4.39).
In emissions estimations the general approach described in the 2006 IPCC Guidelines is applied using the following equation:

$$\textbf{TOTAL } CO_2/CH_4 = \sum(AD_i \bullet EF_i)$$

where:
TOTAL CO_2 / CH_4= the process emission (tonnes) of CO_2/ CH_4
AD_i = production of ferroalloy type „I“ (tonnes/yr)
EF_i = the emission factor for CO_2 and CH_4 for ferroalloys produced.

4.4.6.2.3 CO_2 and CH_4 Emission factor

The EF for these calculations is taken as default (table 4.5, p. 4.37 and table 4.7, p. 4.39).
Average EFs are used for CO_2 emissions and they are presented in the table below by the types of available products and an average EF for CH_4 - 1kg /t.

Table 131 CO2 emission factors used for different types of products

Ferroalloy types	IEF [kg CO_2/t. product]
Ferroalloys	2.82
Ferromanganese - natura	1.40
Ferrosilicone - natura	3.73

Ferroalloy types	IEF [kg CO_2/t. product]
Ferrosilicone - 45% Si (natura)	2.50
Ferromanganese, with <2% carbon by weight	1.50
Other Ferroalloys - natura	2.57

4.4.6.2.4 Activity data

Country-specific activity data on the amount of ferroalloys produced and use are obtained from NSI for the whole time period.

Table 132 Ferroalloys production, CO2 and CH4 emission in CRF 2.C.2

Year	Ferroalloys production [kt/y]	CH_4 Emissions [kt CH_4]	CO_2 Emissions [kt CO_2]
1988	C	0.09118	254.94
1990	C	0.04145	129.37
1995	C	0.01766	55.82
2000	C	0.00845	21.88
2005	C	0.00897	20.10
2010	C	0.00065	2.35
2015	C	0.00001	0.04
2016	C	0.00002	0.04
2017	C	0.00001	0.02
2018	C	0.00000	0.00
2019	C	0.00000	0.00

In CRF 2.C.2 Ferroalloys production the production data, because these information could lead to the disclosure of confidential information provided by the plant operator.

4.4.6.3 Uncertainties and time series consistency

Combined uncertainty	25.5 %
AD	± 5 %
EF	± 25 %

4.4.6.4 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

4.4.6.5 Source specific recalculations

There are no source specific recalculations for this category.

4.4.6.6 Source specific planned improvements

There are no source-specific planned improvements.

4.4.7 ALUMINIUM PRODUCTION (CRF 2.C.3)

In Bulgaria primary production of aluminum does not occur. There is secondary production and emissions generated by the quantities of used in the process fuels are reported in sector Energy.

4.4.8 MAGNESIUM PRODUCTION (CRF 2.C.4)

In Bulgaria magnesium production does not occur.

4.4.9 LEAD PRODUCTION (CRF 2.C.5)

4.4.9.1 Source category description

Now there is only one plant for primary lead production in Bulgaria. The production is based on application of modern technology of autogenic melting of lead raw materials to black lead with following scarfing refining.
Until 2011 in Bulgaria there has been two enterprises for primary lead production (from ore). After 2011 one of these enterprises ceases its activity as it is impossible to face the modern requirements in the environmental legislation.
The CO_2 emissions are calculated based on data from reports (EU ETS) of verified emissions of the firms, as well as data from the annual environmental reports.

4.4.9.2 Trend description

As it is in other productions in the country, here are also periods of economic crisis, privatization processes and ceased productions as a consequence of the necessity of large investments for meeting the ecological requirements and not in the last place the influence of the world market.
At the end of 2015, a new plant for the production of lead with a higher efficiency was introduced and by 2016 the production in the old plant was reduced to its full end.

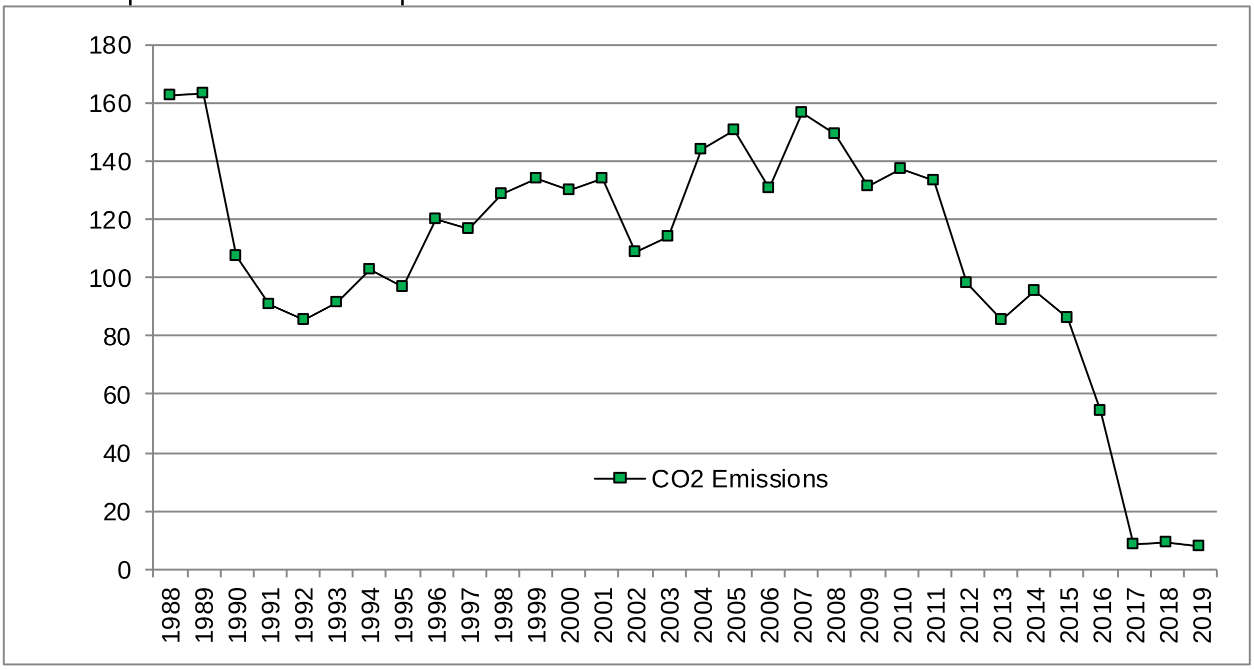

Figure 70 CO2 emissions in CRF 2.C.5 Lead production

4.4.9.3 Methodological issues

The applied data are from the used quantities of solid fuels in the process of lead production from ore (for the period 2005-2015) and also the slag forming materials (mineral flour and other) from verifies reports and annual environmental reports.
The used methodology is analogical to this described in the IPCC Guidelines 2006. For the period 1988-2004 average coefficients are applied for the used quantities of fuels and other materials, based on those averaged for the period 2005-2015 and assigned to the manufactured quantities primary lead.
Data from NSI are also used for the manufactured quantities lead in the country for the whole time period.

4.4.9.3.1 Method

The method is based on the used quantities of solid fuels (reducing agents) in the process of primary lead production in the separate technological processes, the relevant calorific values and the EF for each fuel, as well as the quantities of the used slag forming materials and the relevant analyses of the carbon content in them.

4.4.9.3.2 CO_2 Emission factor

The used emission factors are those described in the verified reports of emissions trading, as some of them are plant-specific, while others are default factors. The applied factors depend on the approved algorithm of the firms throughout the different reporting periods.

4.4.9.3.3 Activity data

For the period 2005-2019 the used data are for the manufactured quantities of primary lead from reports of the firms.
The manufactured quantities of lead for the whole time-series is obtained by NSI and are indicated as confidential.
The quantities of primary manufactured lead for the period 1988-2004 are calculated, based on the calculated average coefficient (2005-2019) from data, obtained by NSI and the enterprises.

4.4.9.4 Uncertainties and time series consistency

Combined uncertainty	15.8 %
AD	± 5 %
EF	± 15 %

4.4.9.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

4.4.9.6 Source specific recalculations

The emissions from this category are described for the first time in the category "Industrial processes". Till now the emissions have been accounted under sector "Energy".
There are no source specific recalculations for this category.

4.4.9.7 Source specific planned improvements

There are no source-specific planned improvements.

4.4.10 ZINC PRODUCTION (CRF 2.C.6)

4.4.10.1 Source category description

Now in Bulgaria there is only one plant for primary zinc production. The production is based on the application of different metallurgical processes, such as roasting, electrolysis and others.
Until 2011 in Bulgaria there has been two enterprises for primary zinc production (from ore). After 2011 one of these enterprises ceases its activity as it is impossible to face the modern requirements in the environmental legislation.
The CO_2 emissions are calculated based on data from reports of verified EU ETS emissions of the plants, as well as data from the annual environmental reports.

4.4.10.2 Trend description

As it is in other productions in the country, here are also observed periods of economic crisis, privatization processes and ceased productions as a consequence of the necessity of large investments for meeting the ecological requirements and not in the last place the influence of the world market.

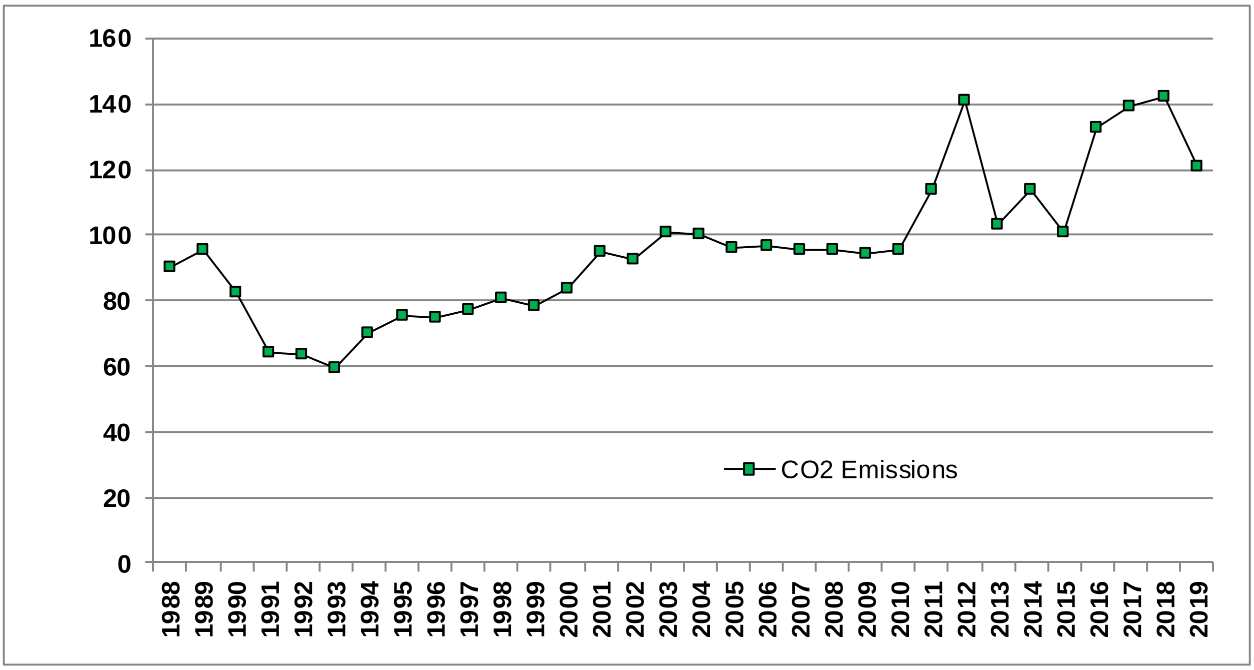

Figure 71 CO2 emissions in CRF 2.C.Zinc production

4.4.10.3 Methodological issues

The applied data are from the used quantities of solid fuels in the process of zinc production from ore (for the period 2005-2015) and also the slag forming materials (mineral flour and other) from verifies EU ETS reports and annual environmental reports.
The used methodology is analogical to this described in the IPCC Guidelines 2006. For the period 1988-2004 average coefficients are applied for the used quantities of fuels and other materials, based on those averaged for the period 2005-2015 and assigned to the manufactured quantities primary zinc.
Data from NSI are also used for the manufactured quantities zinc in the country for the whole time period.

4.4.10.3.1 Method

The method is based on the used quantities of solid fuels (reducing agents) in the process of primary zinc production in the separate technological processes, the relevant calorific values and the EF for each fuel, as well as the quantities of the used slag forming materials and the relevant analyses of the carbon content in them.

4.4.10.3.2 CO_2 Emission factor

The used emission factors are those described in the verified EU ETS reports, as some of them are plant-specific, while others are default factors. The applied factors depend on the approved algorithm of the firms throughout the different reporting periods.

4.4.10.3.3 Activity data

For the period 2005-2019 the used data are for the manufactured quantities of primary zinc from reports of the firms.
The manufactured quantities of zinc for the whole time-series is obtained by NSI and are indicated as confidential.
The quantities of primary manufactured zinc for the period 1988-2004 are calculated, based on the calculated average coefficient (2005-2019) from data, obtained by NSI and the enterprises.

4.4.10.4 Uncertainties and time series consistency

Combined uncertainty	15.8 %
AD	± 5 %
EF	± 15 %

1.1.1.1 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

4.4.10.5 Source specific recalculations

The emissions from this category are described for the first time in the category "Industrial processes". Till now the emissions have been accounted under sector "Energy".
There are no source specific recalculations for this category.

4.4.10.6 Source specific planned improvements

There are no source-specific planned improvements.

4.5 NON-ENERGY PRODUCTS FROM FUELS AND SOLVENT USE (CRF 2.D)

SOURCE CATEGORY DESCRIPTION

This section is established for estimating the emissions from the first use of fossil fuels as a product for primary purposes other than i) combustion for energy purposes and ii) use as feedstock or reducing agent.
The products covered here comprise lubricants, paraffin waxes, bitumen/asphalt, and solvents. Emissions from further uses or disposal of the products after first use (i.e., the combustion of waste oils such as used lubricants) are to be estimated and reported in the Waste Sector when incinerated or in the Energy Sector when energy recovery takes place.
Source category 2D Non-energy products from fuels and solvent use comprises process emissions from lubricant and paraffin wax use, NMVOC emissions from coating applications, degreasing, dry cleaning as well as production and processing of chemical products, precursor emissions from road paving with asphalt and asphalt roofing as well as emissions from urea use in SCR catalysts of diesel engines (heavy motor vehicles).

4.5.1 LUBRICANT USE (CRF 2.D.1)

4.5.1.1 Source category description

Lubricants are mostly used in industrial and transportation applications. Lubricants are produced either at refineries through separation from crude oil or at petrochemical facilities. They can be subdivided into motor oils, industrial oils and greases, which differ in terms of physical characteristics, commercial applications and environmental fate.

4.5.1.2 Trend description

The trend of CO_2 emissions is presented in the following figure.

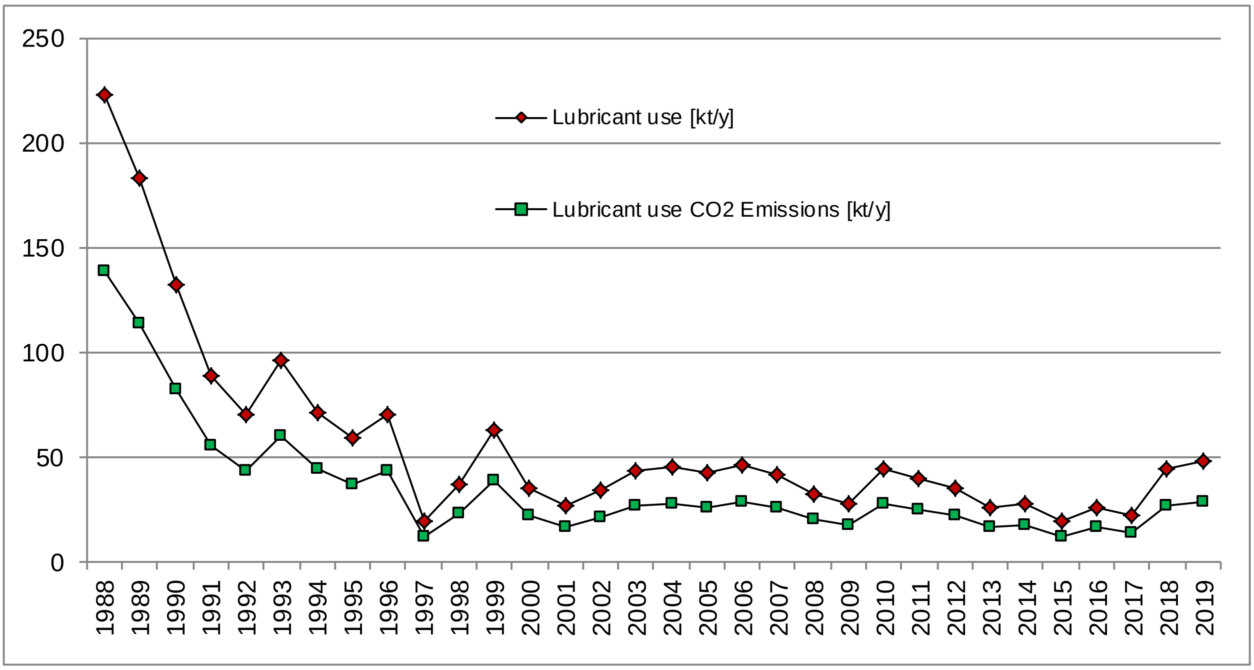

Figure 72 Lubricant use and CO2 emissions in CRF 2.D.1

4.5.1.3 Methodological issues.

4.5.1.3.1 Methods

The use of lubricants in engines is primarily for their lubricating properties and associated CO_2 emissions are therefore considered as non-combustion emissions reported in 2D1 Lubricant use.
For the calculation of CO_2 emissions from oxidation of lubricants a Tier 1 approach according to the 2006 IPCC Guidelines, vol. 3, chap. 5.2 (IPCC 2006) is applied based on the following formulas:

$$\mathbf{CO_2,Emissions = AD \bullet EFlubricant, CO_2}$$

$$\mathbf{EFlubricant, CO2 = NCVlubricant \bullet CClubricant \bullet ODUlubricant \bullet 44/12}$$

Where AD is the activity data, NCV the net calorific value, CC the carbon content and ODU the fraction of lubricants oxidized during use.

4.5.1.3.2 Emission Factors

The emission factor is composed of a specific carbon content factor (tonne C/TJ) multiplied by the ODU factor.
A further multiplication by 44/12 (the mass ratio of CO_2/C) yields the emission factor (expressed as tonne CO_2/TJ). For lubricants the default carbon contents factor is 20.0 kg C/GJ on a Lower Heating Value basis. Tier 1: Having only total consumption data for all lubricants (i.e., no separate data for oil and grease), the weighted average ODU factor for lubricants as a whole is used as default value in the Tier 1 method. Assuming that 90 percent of the mass of lubricants is oil and 10 percent is grease, applying these weights to the ODU factors for oils and greases yields an overall (rounded) ODU factor of 0.2. This ODU factor can then be applied to an overall carbon content factor, which may be country-specific or the default value for lubricants to determine national emission levels from this source when activity data on the consumption of lubricants is known.

4.5.1.4 Activity Data

Data obtained by the NSI and the Eurostat Balances are used.

Table 133 Lubricant use and CO2 emissions in CRF 2.D.1.

CRF 2.D.1 - Lubricant use		
Year	Lubricant use [kt/y]	CO2 Emissions [kt]
1988	223.0	138.35
1990	132.0	81.89

CRF 2.D.1 - Lubricant use		
Year	Lubricant use [kt/y]	CO2 Emissions [kt]
1995	59.0	36.60
2000	35.0	21.71
2005	42.0	26.06
2010	44.0	27.30
2015	19.0	11.79
2016	26.0	16.13
2017	22.20	13.77
2018	44.6	26.3
2019	47.6	27.1

4.5.1.5 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in the following table.
The default ODU factors developed are very uncertain, as they are based on limited knowledge of typical lubricant oxidation rates The carbon content coefficients are based on two studies of the carbon content and heating value of lubricants, from which an uncertainty range of about ±3 percent is estimated.

Table 134 Uncertainty of subcategory 2D1 - Lubricant use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	CO_2	10	30	31.62

4.5.1.6 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Plausibility checks of the results (due to the national statistic and national VOC register);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.5.1.7 Source specific recalculation

No source specific recalculation.

4.5.1.8 Source specific planned improvements

No source specific improvements are planned.

4.5.2 PARAFFIN WAX USE (CRF 2.D.2)

4.5.2.1 Source category description

The category, as defined here, includes such products as petroleum jelly, paraffin waxes and other waxes, including ozokerite (mixtures of saturated hydrocarbons, solid at ambient temperature). Waxes are used in a number of different applications. Paraffin waxes are used in applications such as: candles, corrugated boxes, paper coating, board sizing, food production, wax polishes, surfactants (as used in detergents) and many others. Paraffin waxes are separated from crude oil during the production of light (distillate) lubricating oils. Paraffin waxes are categorized by oil content and the amount of refinement.

4.5.2.2 Trend description

The trend of CO_2 emissions is presented in the following figure.

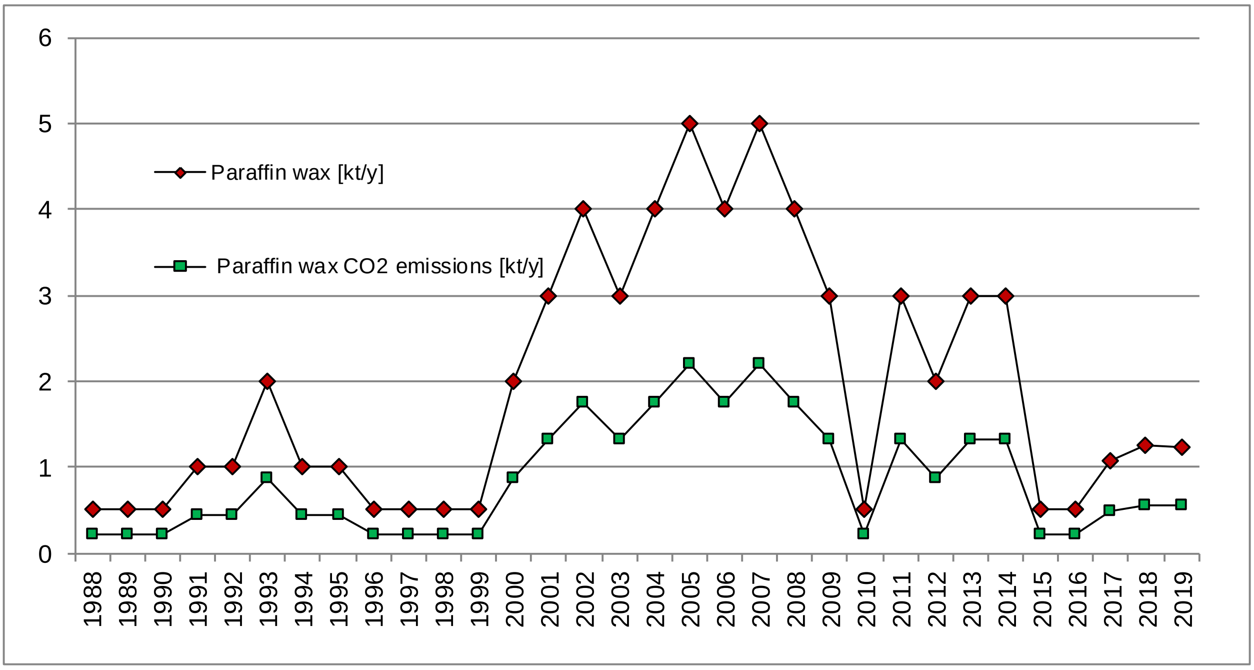

Figure 73 Paraffin wax use and CO2 emissions in CRF 2.D.2.

4.5.2.3 Methodological issues.

4.5.2.3.1 Methods

Waxes are used in a number of different applications. Paraffin waxes are used in applications such as: candles, corrugated boxes, paper coating, board sizing, food production, wax polishes, surfactants (as used in detergents) and many others. Emissions from the use of waxes derive primarily when the waxes or derivatives of paraffinsare combusted during use (e.g., candles), and when they are incinerated with or without heat recovery or inwastewater treatment (for surfactants). In the cases of incineration and wastewater treatment the emissionsshould be reported in the Energy or Waste Sectors.

There are two methodological tiers for determining emissions and storage from paraffin waxes. Both Tier 1 and Tier 2 rely on essentially the same analytical approach, which is to apply emission factors to activity data on the amount of paraffin waxes consumed in a country (in energy units, e.g., TJ). The Tier 2 method relies on determining the actual use of paraffin waxes and applying a country-specific ODU factor to activity data, while the Tier 1 method relies on applying default emission factors to activity data (see decision tree, Figure 5.3).

Tier 1: CO_2 emissions are calculated according to Equation 5.4 with aggregated default data for the limited parameters available:

$$\mathbf{CO_2\ Emissions = PW \bullet CCWax \bullet ODUWax \bullet 44/12}$$

Where:

CO_2 Emissions = CO2 emissions from waxes, tonne CO_2

PW = total wax consumption, TJ

CCWax = carbon content of paraffin wax (default), tonne C/TJ (= kg C/GJ)

ODUWax = ODU factor for paraffin wax, fraction

44/12 = mass ratio of CO_2/C

4.5.2.4 Emission factors

For Tier 1 it can be assumed that 20 percent of paraffin waxes are used in a manner leading to emissions, mainly through the burning of candles, leading to a default ODU factor of 0.2.

4.5.2.4.1 Activity data

Data on the use of paraffin waxes are required to estimate emissions, with activity data expressed in energy units(TJ). To convert consumption data in physical units, e.g., in tonnes, into common energy units, e.g., in TJ (on a Lower Heating Value basis), calorific values are required (for specific guidance see Section 1.4.1.2 of Chapter 1 of Volume 2 on Energy). Basic data on non-energy products used in a country may be available from production, import and export data and on the energy/non-energy use split in national energy statistics.

The activity data for estimation of emissions in subcategory 2.D.2 Paraffin wax use are provided by the NSI in format, obtained by Eurostat Balance.

Table 136: Paraffin wax use and CO2 emissions – CRF 2.D.2 [kt/1000]

CRF 2.D.2 - PARAFFIN WAX USE		
Year	Paraffin wax [kt/year]	CO_2 Emissions [kt/year]
1988	0.5	0.22
1990	0.5	0.22
1995	1	0.44
2000	2	0.88
2005	5	2.20
2010	0.5	0.22
2015	0.5	0.22
2016	0.5	0.22
2017	1.1	0.48
2018	1.3	0.56
2019	1.2	0.55

4.5.2.5 Uncertainties and time series consistency

Much of the uncertainty in emission estimates is related to the difficulty in determining the quantity of nonenergy products used and discarded in individual countries, for which a default of 5 percent may be used in countries with well developed energy statistics and 10-20 percent in other countries, based on expert judgement of the accuracy of energy statistics.
The uncertainty of the GHG emissions is presented in the following table.

Table 135 Uncertainty of subcategory 2.D.2 – Paraffin wax use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	CO_2	10	30	31.62

4.5.2.6 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Plausibility checks of the results (due to the national statistic and national VOC register);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.5.2.7 Source specific recalculation

No source specific recalculation.

4.5.2.8 Source specific planned improvements

No source specific improvements are planned.

4.5.3 OTHER - UREA USE IN SCR CATALYSTS OF DIESEL ENGINES (CRF 2D3D)

4.5.3.1 Source category description

This source category encompasses CO_2 emissions from the use of urea containing AdBlue in diesel engines with SCR-catalysts in road transportation (Euro V/VI).

4.5.3.2 Trend description

The trend of CO2 emissions is presented in the following figure.

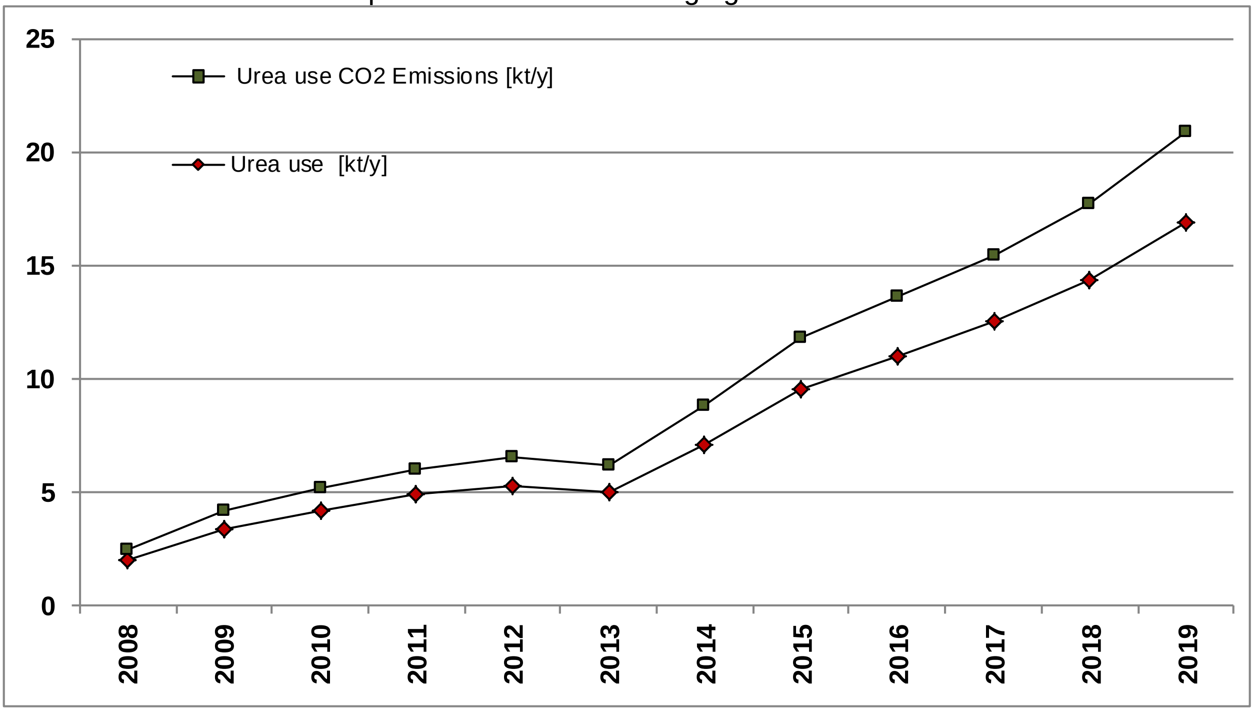

Figure 74 Urea use and CO2 emissions in CRF 2.D.3.d.

4.5.3.3 Methodological issues.

4.5.3.3.1 Methods

For the first time and in accordance with the new 2006 IPCC guidelines the consumption of Ad Blue is reported in this submission following a methodology suggested in the EMEP/EEA guidebook 2013 (EMEP/EEA 2013; part B, chap. 1.A.3.b.i-iv, page 48). A specific percentage of the fuel consumption of SCR-vehicles in road transportation according to their Euro class is applied for Ad Blue consumption estimates. Emissions are calculated according to following formula:

$$\mathbf{CO_2\ Emissions = EF \cdot FC \cdot Share\ of\ SCR\ vehicles\ mileage \cdot Specific\ urea\ share}$$

"FC" - relates to the fuel consumption in [t] of the entire vehicle category
"Share of SCR vehicles mileage" - implies the mileage share of SCR-vehicles in the entire vehicle category
"Specific urea share" - comprises the percentage of fuel consumption which relates to AdBlue (urea solution) consumption.

4.5.3.3.2 Emission factors

The emission factor for CO_2 emissions from urea use in SCR-catalysts in vehicles is a default value (EMEP/EEA 2013) considering the molecular mass conversion of urea into CO_2 during the reaction with water and the content of 32.5% of the aqueous AdBlue urea solution. The EF amounts to 0.238 t per ton of AdBlue.

4.5.3.3.3 Activity Data

The activity data in subcategory 2.D.3.d. are based on the input data in COPERT model used in the road transportation. Please see subcategory Road transport – CRF 1.A.3.b.

Table 136 Urea use and CO2 emissions in CRF 2.D.3.d.

***2D3D* - UREA USE IN SCR CATALYSTS OF DIESEL ENGINES**		
Year	Urea use [kt]	CO_2 Emissions [kt/year]
1988-2007	NO	NO
2008	1.93	0.46
2009	3.34	0.79
2010	4.16	0.99
2011	4.84	1.15
2012	5.26	1.25
2013	5.00	1.19
2014	7.09	1.69
2015	9.53	2.27
2016	10.98	2.61
2017	12.51	2.98
2018	14.32	3.41
2019	16.88	4.02

1.1.1.2 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in the following table.

Table 137 Uncertainty of subcategory 2D3d – Urea use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	CO_2	10	30	31.62

4.5.3.4 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Plausibility checks of the results (due to the national statistic and national VOC register);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.5.3.5 Source specific recalculation

The urea consumption has been recalculated due to the revision of the fuel consumption data and the implementation of an updated COPERT 5.2.2 model, which corrected some errors.

4.5.3.6 Source specific planned improvements

No source specific improvements are planned.

4.5.4 OTHER - SOLVENT USE (CRF 2.D.3.B)

4.5.4.1 Source category description

This chapter describes the methodology used for calculating greenhouse gas emissions from solvent use in Bulgaria. Solvents are chemical compounds, which are used to dissolve substances as paint or for used also for cleaning purposes (degreasing of metals and dry cleaning). Most of the solvents are released into air after application of these substances or other processing. Solvents consist mainly of NMVOC, it is the cause their use is a major source for anthropogenic NMVOC emissions. Once released into the atmosphere NMVOCs react with air molecules (mainly HO-radicals) or high energetic light and generated emission of CO_2.
Sub-category Solvent use 2D3b include paint application, Degreasing and Dry cleaning and Chemical products.

4.5.4.2 Trend description

The trend of the Solvent use and CO2 emissions is presented in following figure.

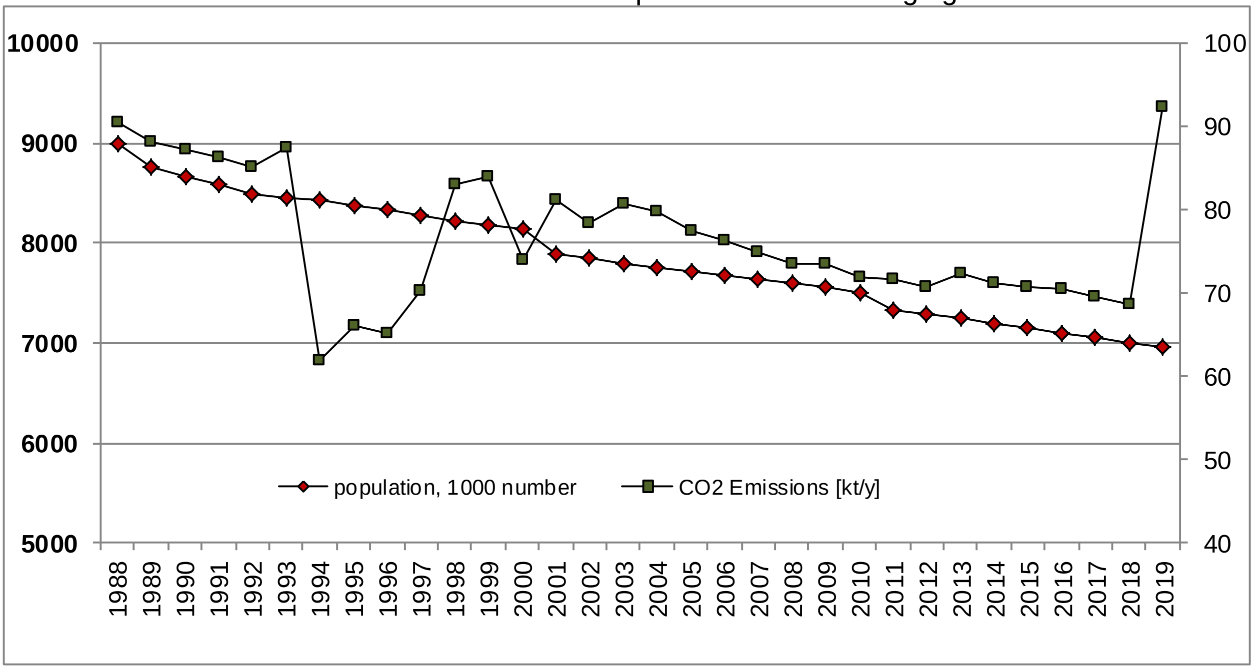

Figure 75 Population and CO2 emissions.

This category covers emissions from following activities.

Paint application

This activity deals with the use of paints within the industrial and domestic sectors.
Decorative coating application, which includes:

- Paint application: construction and buildings (SNAP 060103)
- Paint application: domestic use (SNAP 060104)

Industrial coating application, which includes:

- Paint application: manufacture of automobiles (SNAP 060101)

- Paint application: car repairing (SNAP 060102)
- Paint application: coil coating (SNAP 060105)
- Paint application: boat building (SNAP 060106)
- Paint application: wood (SNAP 060107)
- Other industrial paint application (SNAP 060108)

Other coating application, which includes:
- Other non-industrial paint application (SNAP 060109)

Degreasing and Dry cleaning

This category deals with the following activities:
- Degreasing - process for cleaning products from water-insoluble substances such as grease, fats, oils, waxes, carbon deposits, fluxes and tars. In most cases the process is applied to metal products, but also plastic, fibreglass, printed circuit boards and other products are treated by the same process.
- Dry cleaning - refers to any process to remove contamination from furs, leather, down leathers, textiles or other objects made of fibres using organic solvents.

Chemical products, manufacture and processing

- Chemical products

  This sector covers the emissions from the use of chemical products, use of lacquers and solvents, manufacture and processing (polyester processing, polyvinylchloride processing, polyurethane foam processing, rubber processing, pharmaceutical products manufacturing, paints manufacturing, inks manufacturing, glues manufacturing, asphalt blowing).

The decrease of solvent emissions is due to the positive impact of the enforced regulations in Bulgaria:
- Regulation №7/2003 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations, which replaced a Council Directive 1999/13/EC into national legislation;
- Regulation on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products from 23/02/2007, which replace the Council Directive 2004/42/CE of the European Parliament and of the Council of 21 April 2004.

4.5.4.3 Methodological issues.

4.5.4.3.1 Methods

The method used is the Tier 1 using population on average emission fastor specified below. Thus obtained CO_2 emissions are subtracted emission category 2G4.

<u>CO_2 emissions:</u>

$$\boldsymbol{All\ Emission_{CO2}} = \boldsymbol{AR}_{\textbf{population}} \times \boldsymbol{IEF_{Averdge}}$$

Where:
All EmissionCO_2 = the emission of CO_2
AR population = population of the country)
IEF CO_2 = average CO_2 emission from solvent use per capita value (0.013286 ktCO_2/ population-1000 number).

This equation is applied at national level, using annual national total figures for the activity data.

$$\boldsymbol{2D3b\ Emission_{CO2}} = \boldsymbol{All\ Emission_{CO2}} - \boldsymbol{2G4\ Emission_{CO2}}$$

NMVOC emissions:

Emissions calculation NMVOC is back interlocking system of proportions of calculating CO_2 emissions aan described in the 2006 IPCC Guidelines, Volume 1, Chapter 7.2.1.5 Carbon Emitted in Gases Other than CO_2 from NMVOC:

$$2D3b\ Emissions_{NMVOC} = \left(2D3b\ Emission_{CO2} \times \frac{12}{44}\right)/C$$

Where C is the fraction carbon in NMVOC by mass (default = 0.6)

Reference for default: conversion- factor NMVOC – CO_2, the 2006 IPCC Guidelines, Volume 3, Chapter 5: Industrial Processes and Product Use, page 5.17, 2006 IPCC Guidelines s, Volume 1, Chapter 7: Precursors and Indirect Emissions, page 7.6

4.5.4.3.2 Emission Factor

Used so-called implied emission factor for CO_2 which is based on a simple approach using per capita ratios from a group of 9 Member States (Romania, Hungary, Slovakian republic, Czech republic, Poland, Austria, Italy, Croatia and Bulgaria).
This factor is calculated on the 0.013286 $ktCO_2$/ population-1000 number (average CO_2 emission from solvent use per capita value).

4.5.4.3.3 Activity Data

The activity data for estimation of emissions in subcategory 2D3b Solvent use are provided by the NSI - it's the country's population.

Table 138 Solvent use and CO2 emissions in CRF 2.D.3.b

***2D3b* – Other solvent used**		
Year	**Population [1000 number]**	**CO_2 Emissions [kt CO_2]**
1988	8986.636	90.604
1990	8669.269	87.226
1995	8384.715	66.148
2000	8149.468	74.020
2005	7718.750	77.483
2010	7504.868	71.960
2015	7153.784	70.719
2016	7101.859	70.450
2017	7050.034	69.622
2018	7000.039	68.734
2019	6951.482	92.359

4.5.4.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in the following table.

Table 139 Uncertainty of subcategory 2D3b -Solvents use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	CO_2	10	30	31.62

4.5.4.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);

- Plausibility checks of the results (due to the national statistic and national VOC register);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.5.4.6 Source specific recalculation

No source specific recalculations made in the sector.

4.5.4.7 Source specific planned improvements

No source specific improvements are planned.

4.6 ELECTRONICS INDUSTRY (CRF 2.E)

Research showed that this activity is not applicable for Bulgaria and since no emissions are present and reported.

4.7 PRODUCT USES AS SUBSTITUTES FOR ODS– SECTOR OVERVIEW (CRF 2.F)

The following table and figure summarize the results for CRF Sector 2.F for :

Table 140 Summary of the results for 2019.

Sector	Actual emission	Actual share
	Gg CO_2-eq.	%
Solvents	0,00	0.00%
Aerosols	13,98	0,82%
Foams	4,40	0,26%
Domestic refrigeration	7,25	0,43%
Commercial and industrial refrigeration	163,91	9,66%
Transport refrigeration	2,28	0,13%
Domestic AC	941,89	55,53%
Commercial and industrial AC	57,62	3,40%
Mobile AC	496,31	29,26%
Fire protection	8,54	0,50%
Total	1696,17	100.00%

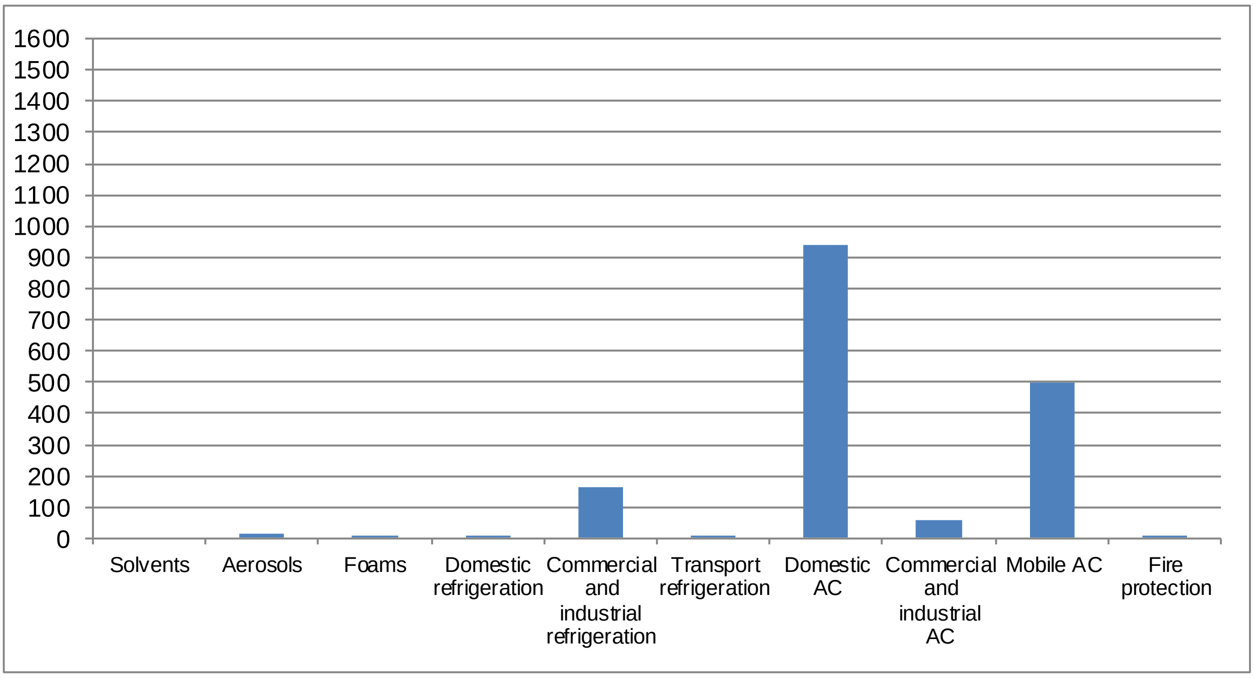

Figure 76 Actual emissions for 2019 [Gg CO2-eq.]

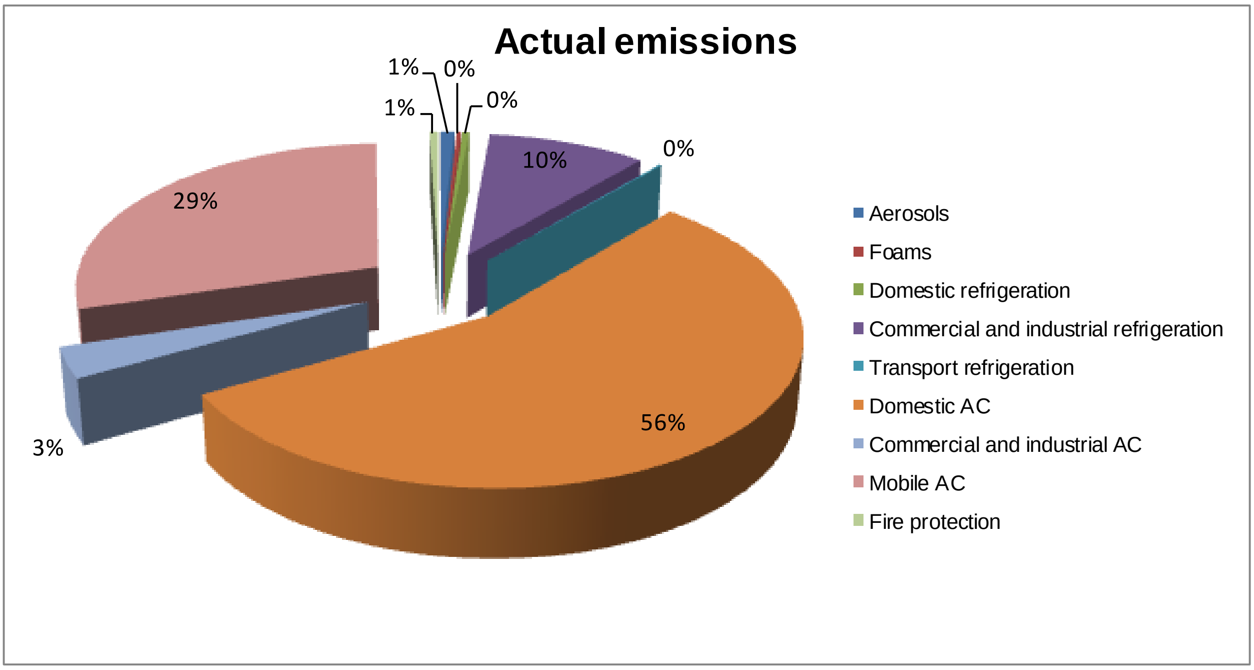

Figure 77 Actual emissions for 2019 [Gg CO2-eq.]

The following table and figure represent the actual emissions for the whole time series:

Table 141 Actual emissions [Gg CO2-eq.]

Year	Solvents	Aerosols	Foams	Domestic Ref	Commercial and Industrial Ref	Transport Ref	Domestic AC	Commercial and industrial AC	Mobil AC	Fire protecion
1988	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	0.00	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	0.01	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	0.02	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	0.04	NO	NO	NO	NO	1.06	NO
1995	NO	NO	NO	0.06	NO	NO	NO	NO	3.26	NO
1996	NO	NO	NO	0.08	NO	0.05	NO	NO	5.71	NO
1997	NO	NO	NO	0.12	NO	0.09	NO	NO	9.08	NO
1998	NO	1.11	NO	0.17	NO	0.14	NO	NO	13.65	NO
1999	NO	1.78	NO	0.23	NO	0.20	NO	NO	19.39	NO
2000	NO	0.76	NO	0.27	5.35	0.33	NO	1.51	24.69	NO
2001	NO	0.33	NO	0.30	9.89	0.50	0.92	2.88	30.34	0.52
2002	NO	0.81	NO	0.33	14.42	0.72	3.30	4.25	36.81	0.65
2003	NO	1.30	NO	0.36	18.96	1.05	10.06	5.62	45.60	0.81
2004	NO	1.88	NO	0.38	23.50	1.41	19.79	6.99	64.96	1.01
2005	NO	2.60	2.93	0.39	28.04	2.33	32.45	8.36	110.19	1.26
2006	NO	7.17	8.53	1.40	32.58	2.84	54.55	9.73	159.43	1.56
2007	NO	9.89	11.55	2.82	37.12	3.10	107.81	11.10	174.31	1.95
2008	NO	10.31	96.67	4.36	41.66	3.28	192.51	12.46	238.18	2.43
2009	NO	11.91	22.35	4.98	46.20	2.87	219.52	13.83	282.61	3.42
2010	NO	10.89	11.98	7.56	50.74	2.53	247.82	15.20	290.54	3.42
2011	NO	10.35	10.33	8.38	72.16	2.37	289.83	19.61	316.34	4.65
2012	NO	9.98	8.71	10.22	77.71	2.32	346.50	24.98	323.00	4.67
2013	NO	10.54	7.41	17.07	88.97	2.34	436.01	30.99	357.47	5.42
2014	NO	9.52	7.55	20.20	96.95	2.57	504.74	36.21	412.07	5.63
2015	NO	11.31	8.35	12.81	100.67	2.44	570.98	42.91	451.87	6.39
2016	NO	14.64	8.17	10.89	100.17	2.37	725.43	42.96	474.58	6.78
2017	NO	13.26	8.47	9.12	104.00	2.45	1146.66	48.01	464.00	7.20
2018	NO	13.46	5.46	9.14	110.62	2.21	1578.31	55.67	461.89	7.84
2019	NO	13,98	4,40	7,25	163,91	2,28	941,89	57,62	496,31	8,54

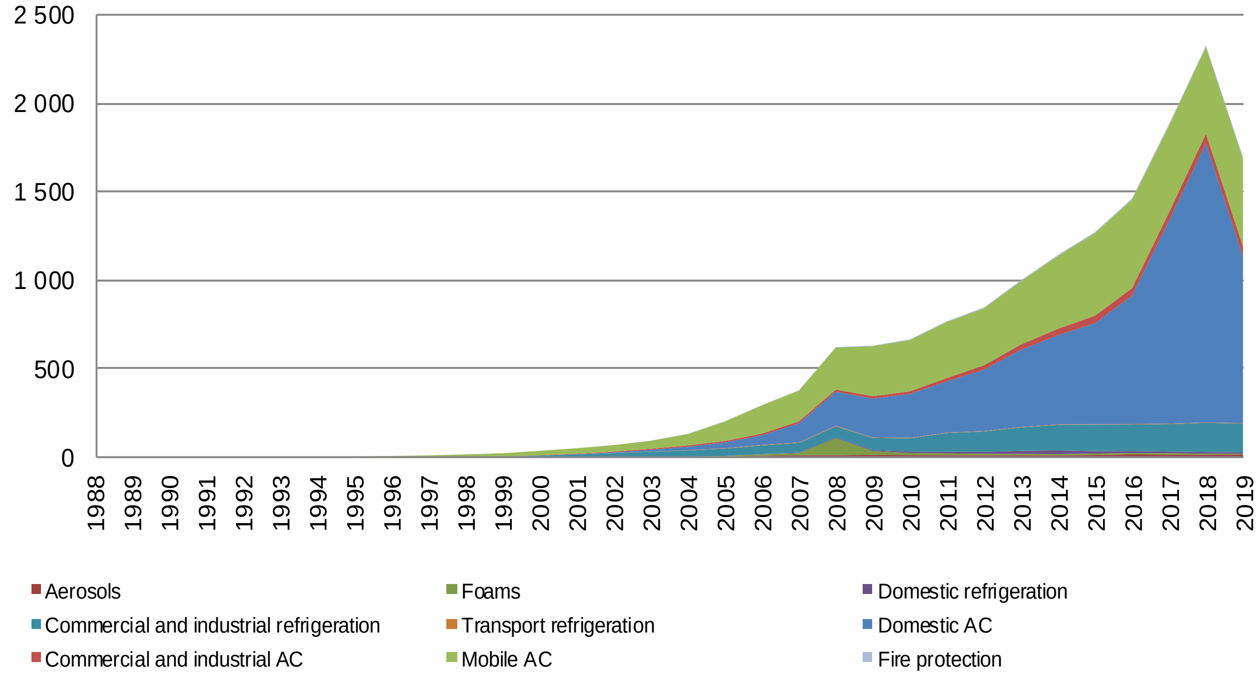

Figure 78 Actual emissions for 1988 - 2019 [Gg CO2-eq.]

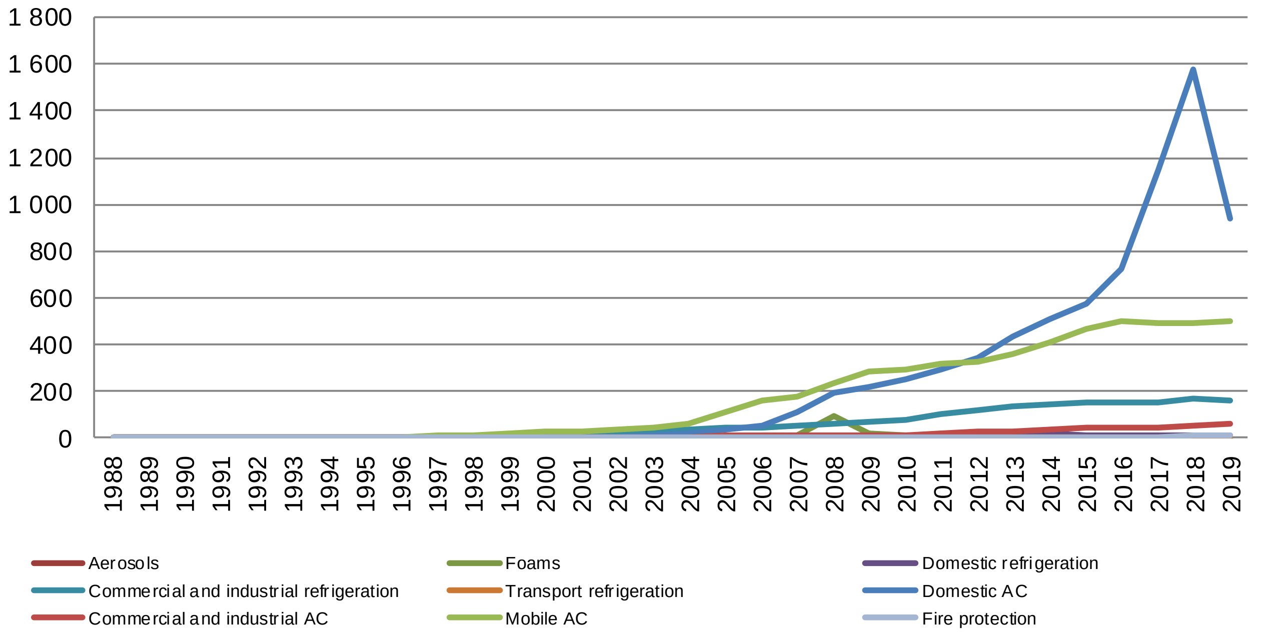

Figure 79 Actual emissions [Gg CO2-eq.]

4.7.1 REFRIGERATION AND AIR CONDITIONING

4.7.1.1 Source Category Description

Depending on the purpose and specifics of the country, the refrigeration and air conditioning equipment can be divided into six major subcategories listed below. It should be noted that according to a recent study, subsector Refrigeration and Air Conditioning employs over 1000 certified technicians and over 70 licensed service companies in the country.

4.7.1.1.1 Commercial and industrial refrigeration (2.F.1.a and 2.F.1.c)

In this subsector emissions from the production of refrigerators, emissions from refrigeration of goods in a supermarket for example, as in other retail outlets are included. The task to determine emissions from this sector is complex because it is more heterogeneous in terms of equipment characteristics: design, size, type of refrigerant, the amount of losses and more. In addition to supermarkets, there is also a wide range of equipment for other types of applications - slaughterhouses, gastronomy, agriculture and others. In contrast to household refrigeration equipment or automotive air conditioning systems, systems that are manufactured in batch production are in smaller quantities than those produced on demand.
Today the most commonly used blend of HFC is R-404A, which becomes even more important than HFC-134a. R-407C also plays an important role. Currently, there are still banked amounts of HCFC-22.
Since the available data does not permit a separate calculation of the banked quantities used in commercial and industrial refrigeration equipment and since the emission factors as recommended by the IPCC Guidelines, are in similar margins, it was decided the two subcategories - commercial and industrial refrigeration - to be grouped and evaluated together.
Even before the entry into force of the Montreal Protocol bans for the use of CFCs and HCFCs (which were subsequently implemented in the European and national legislation), industrial refrigeration equipment was the only sector using alternative cooling agents in significant quantities (mainly ammonia). However, after the ban on the CFC-12 use, imposed by the Montreal Protocol, the main substitute on the market became different types of HFCs. It is also difficult to determine the annual inflow of new refrigerant for this sector due to the its heterogeneity.
The following figure shows the total emissions of HFC (by type) from the sub-sector:

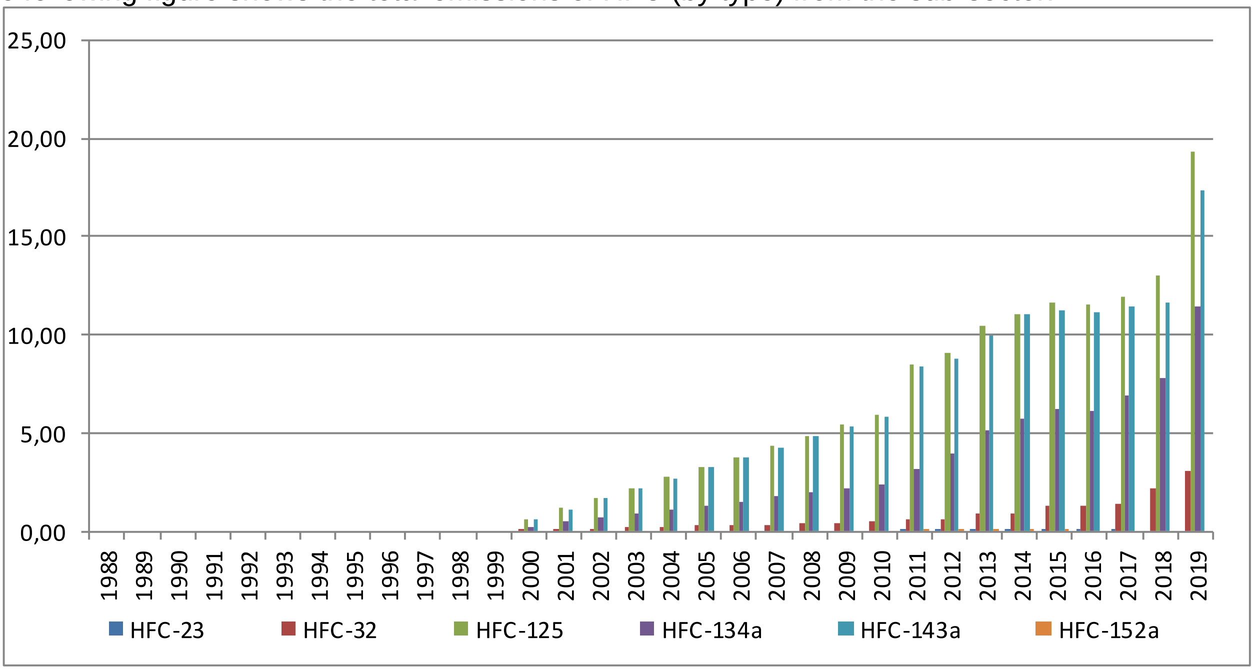

Figure 80 Total emissions by gasses of Commercial and industrial refrigeration in CRF 2.F.1.a and 2.F.1.c

4.7.1.1.2 Domestic refrigeration (2.F.1.b)

There is no production of domestic refrigeration using HFCs in Bulgaria. The producers have switched from CFCs, HFCs, HCFCs and ammonia to other alternatives as i-butane, for example. Therefore, the calculations on this subsector are based on data for imports. The following figure shows the total emissions of HFC (by type) from the sub-sector:

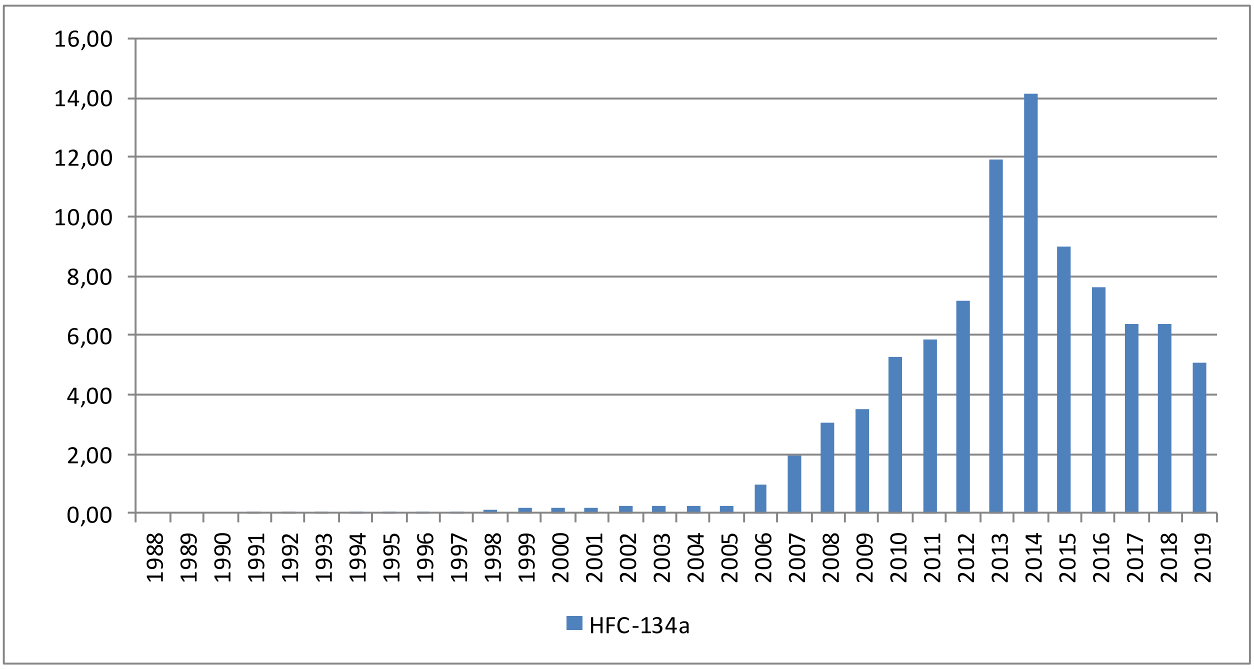

Figure 81 Total emissions by gasses of Domestic refrigeration in CRF 2.F.1.b

4.7.1.1.3 Transport refrigeration (2.F.1.d)

Since the reporting of refrigeration vehicles is not obligated by the legislation, as it is for stationary equipment above 3 kg, there are not many companies, which have submited any data in their annual reports to the RIEW. It is observed that the reports are missing data for years before 2007, and the available for 2007-2013 is scarce, probably inaccurate and it is registered only on the territories of the inspectorates in Sofia, Plovdiv, Varna and Burgas.
Therefore, it was attempted to contact and obtain information directly from some large transport companies, including ones operating outside Bulgaria. Attempt was unsuccessful. As it was not possible to compel the operators to report the data, but apparently, there is data lack in the annual reports of RIEW, estimates are made using one of the largest websites for vehicle resales in Bulgaria. According to statistic extract from the website database, the average number of refrigerated vehicles is taken and after they are classified based on expert judgement and foreign studies' verification and experience (F-gases, Germany, 2005).
The following figure shows the total emissions of HFC (by type) from the sub-sector:

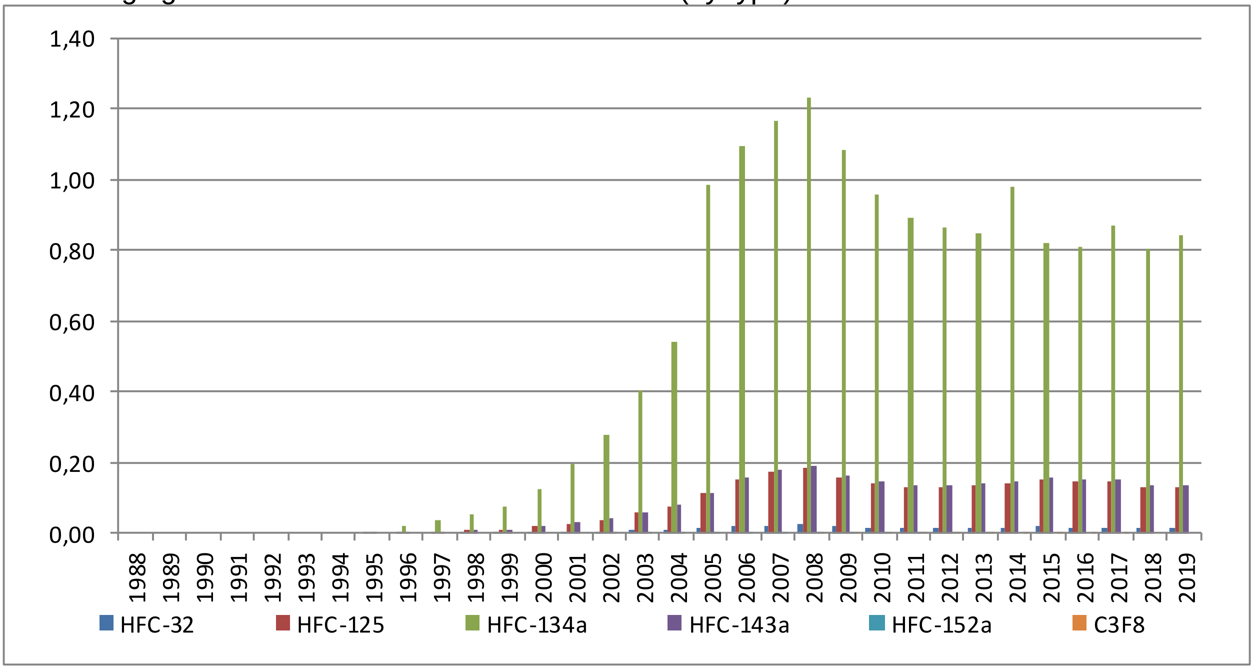

Figure 82 Total emissions by gasses of Transport refrigeration in CRF 2.F.1.d

4.7.1.1.4 Mobile air conditioning (2.F.1.e)

Emissions from mobile air conditioners are summarized in the IPCC manual under the chapter "3.7.5. Mobile air-conditioning sub-source category". There are no special comments, guidelines and methodologies for the separation of air conditioners into different subcategories. However, in this report, mobile air conditioners are divided into four subcategories - for cars, trucks, buses and railway carriages – as each of them has its own specifics that need to be addressed. Production of air conditioners for railway carriages started in 2011.

The following figure shows the total emissions of HFC (by type) from the sub-sector:

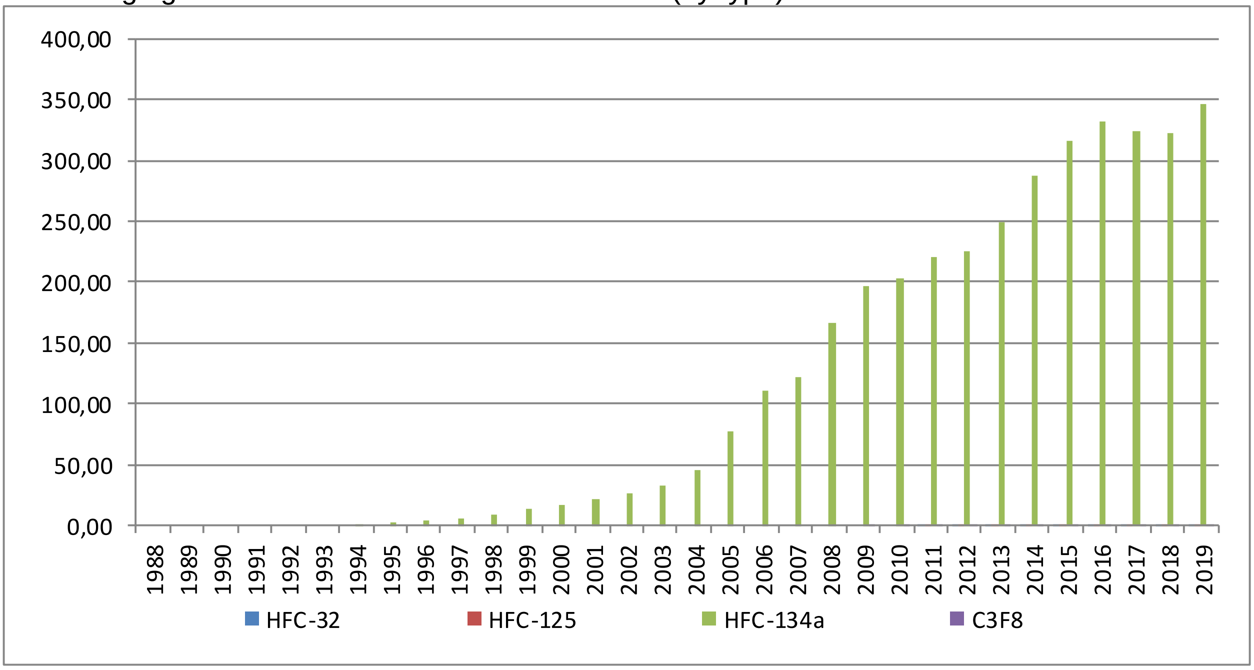

Figure 83 Total emissions by gasses of Mobile air conditioning in CRF 2.F.1.e

4.7.1.1.5 Stationary air conditioning (2.F.1.f)

Stationary air conditioning is divided in domestic and commercial air conditioning systems, respectively divided into more than 20 kW and 20 kW of power. Commercial systems have capacity that is able to provide a comfortable temperature in the whole buildings (central air conditioning systems) or large rooms. In both types of systems, a wide range of HFC is used. Emissions may occur during installation, charging and disposal. Emissions from domestic and commercial air conditioning systems are calculated separately. The following figure shows the total emissions of HFC (by type) from the sub-sector:

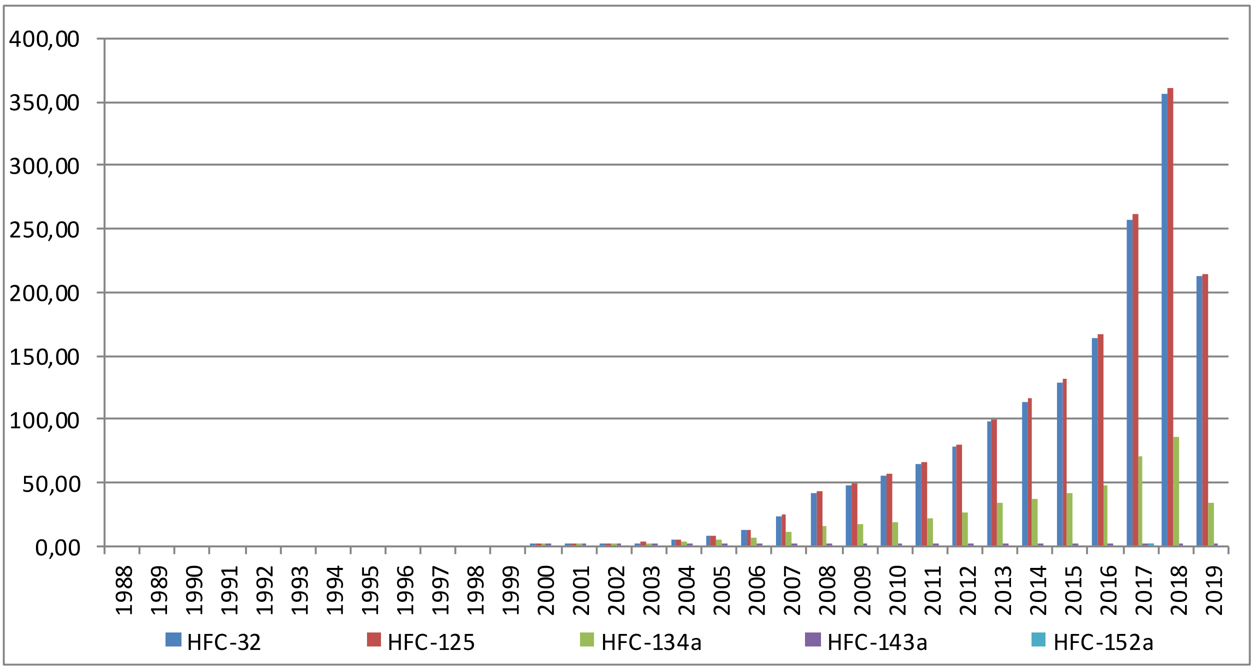

Figure 84 Total emissions by gasses of Stationary air conditioning in CRF 2.F.1.f

4.7.1.2 Methodological Issues

4.7.1.2.1 Commercial and industrial refrigeration (2.F.1.a and 2.F.1.c)

Emission factor of 1.75% was used for the first year and 10% emission factor for emissions from operation (IPCC, 2006). Emissions from disposal of equipment are accounted only if this is explicitly written in the reports of any of the 16 RIEWs, from which the data is taken. The calculations are based on Tier 2a method.

4.7.1.2.2 Domestic refrigeration (2.F.1.b)

A default emission factor of 0.3% per year and average amount of refrigerant in a number of equipment - 0,1 kg was used (IPCC, 2006). In this subsector, emissions from disposal are estimated with lifetime of the equipment set to 15 years (which falls within the boundaries set by IPCC Guidelines, 1996 and 2006).

4.7.1.2.3 Transport refrigeration (2.F.1.d)

The only data that was obtained is used for the amount of refrigerant in the railways from 1998 to 2018. Therefore, their emissions are calculated, even the small amounts of HFC used. Railway carriages were filled with R-12 which is being gradually replaced by HFC-134a, R-401A and R-413A. Tier 2a method, default emission factor for emissions from operation of 20% were used, which fully coincide with the given limits of the Guidelines (IPCC, 2006). This equipment has not been used since 2008 and is kept on storage, but not decommissioned i.e. the equipment is not removed and the cooling agent is not drawn and therefore is being reported.
Concerning the use of refrigeration equipment and cooling agents respectively within the motoring transport, the data concerning the import of heavy and light trucks for the period observed is extracted from statistical databases (NSI, 2018), as well as online database of the one of the biggest websites for vehicle resells in Bulgaria. The statistical processing of the data lets to the calculation of the share of heavy and light trucks imported related to the number of those, equipped with refrigeration system. This share after related to the number of the vehicles imported in the country based on data from NSI, gives us the number of vehicles with refrigeration equipment, divided by categories.
A default EF of 20% (average for Europe) for operation emissions is used, which falls within the boundaries set by the Guidelines (IPCC, 2006). There is no production of mobile refrigeration equipment in the country. It is assumed that 5% in 1995 of the refrigerated trucks used HFCs, reaching 75% in 2010 (IPCC, Working group III). Here, as well as in other categories because of lack of enough stable data for the country, the data concerning the average quantity and type of agent

within the different categories of equipment is taken from different European studies (F-gases Germany, 2005). The emissions from disposal are calculated based on lifetime of 9 years.

4.7.1.2.4 Mobile air conditioning (2.F.1.e)

The Guidelines does not take into account the quantities of refrigerant under 1.5 kg and therefore offers no default emission factors for such systems. Only quantities over 1.5 kg for bus air-conditioners are used for the calculations.
Due to the specifics of the Bulgarian car market, a detailed model for the emissions calculation from Car AC subsector had to be created. Regarding the fact that in Bulgaria there is no production of trucks or buses, data about import from NSI was used (data from the Association of Automobile manufacturers and their authorized representatives in Bulgaria, which have data from 1991 up to nowadays is used for verification). For the proper assessment of the Bulgarian fleet, a detailed statistics of the Road Control Department and the largest website in the country for trade of new and used cars, including the year of manufacture of the vehicle, the presence of air-conditioning system and the year of import in Bulgaria was obtained. From 2011 to 2014, there is production of cars in Bulgaria and data for F-gases (HFC-134A) has been provided by the producer. The results obtained are based on Tier 2a method.
For the selection of appropriate EF, a number of foreign researches have been reviewed. The most detailed information was found in a British study (AEAT, 2003), in which values are set for an average amount of agent 1,2 kg in 1993, declining to 0,8 kg in 2000. Expectations of this study is the amount to decrease up to 0,6 kg in 2010 on the annual level of losses (which include losses from normal use and losses in accidents), the data show that losses in 1995 is amounted to 15%, reducing to 10% in 2000 and projections are for about 6% in 2010. Disposal emissions are not calculated as average lifetime for the country is very high (over 20 years). Overall emissions are overestimated due to the fact that it is assumed that after the refrigerant has been leaked, it has been recharged in 100% of the cases.
According to various international studies (F-gases Germany, 2005; AEAT, 2003), the average quantity of refrigerant in air conditioning systems in the cabins of trucks varies around 1,00-1,20 kg. Similar studies are an appropriate source of information for this report, since Bulgaria does not produce trucks, as well as studies in this field.
According to the classification of NSI (NSI, 2011) whose data were used, mainly trucks are divided by weight - less than 5 t, 5-20 t and over 20 t. In the lowest grade trend over the years is the amount of refrigerant to decrease from 1 to 0,85 kg, while in the other two classes, it remains constant - 1,20 kg. However, for the purposes of this project, a constant quantity of 1 kg for the lower class was chosen, because of the lack of accurate data on truck fleet in Bulgaria and the assumption that the car park is older than the average age for Western Europe. The amount of coolant in the three classes vary in small range, since it considers that the magnitude of the cabin and the corresponding volume to be cooled remain almost identical regardless of the increasing weight of the vehicle.
The refrigerant used is mainly HFC-134a. It enters mass market after 1993-1995, as a substitute of CFC-12. At the end of 1993 in Germany, half of all new trucks used cooling agent based on HFCs. Admittedly, in Bulgaria this share was lower. Studies show that from 1994 to 2002, the percentage of trucks with air conditioners has increased from 5 to 32% and this share continues to grow today, especially for heavy trucks (Schwarz, 2007a).
Operating losses of coolant here are much higher than in ordinary vehicle AC for number of reasons such as long time driving, larger loads, the greater length of piping and more. No evidence of studies on the loss of agent in trucks over 1,5 t was observed. Additional 5% to 10% emissions during operation are considered acceptable because of the possibility of higher losses in trucks compared to cars and light trucks. The results obtained are based on Tier 2a.
It is assumed that all coaches manufactured after 1999 are equipped with air-conditioning system, and since 1995 their percentage is growing slowly from 20% (AEAT, 2003). As with other mobile air conditioning systems, here the most used cooling agent is HFC-134a. Its average quantity contained in one air conditioner is assumed to be 12 kg. The length of piping may exceed 30 m in order to reach the cooled air to all passengers. Due to this great length, emissions from leakage are increased. Emissions of refrigerant in use are accepted as 15% annually. Here, as in trucks, to 10% emission factor adopted for passenger cars a further 5% were added due to longer pipelines and more frequent bus exploitation. Equipment lifetime is assumed to be 15 years. Emissions from disposal are also included. Calculations were conducted according to Tier 2a methodology.

Since this year the data from the railways is divided to refirgaration and air conditioning(before that all were reported as refrigeration). The quantities of imported carriages for passenger transport are included in this category. To calculate the emissions from this sub-category an EF of 15% is used. Production of air conditioners for railway carriages started in 2011 and all of it is exported. The data is acquired from the manufacturer's report, where it is said that the used cooling agents are HFC-134a and R-407C. An EF of 0.35% is used for emission estimation.

4.7.1.2.5 Stationary air conditioning (2.F.1.f)

Data about domestic AC was received from NSI. The most commonly used refrigerants are R-407C and R-410A (in ratio of approximately 2:3). The calculation of emissions from domestic systems was made after the following assumptions: EF of 5 % (Preparatory study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases, Germany, 2011) was used and the average quantity of agent is 1,5 kg per unit equipment. The equipment lifetime is set to 15 years(as average value) after the emission inventory rewiew in 2020. The results are calculated based on Tier 2a.
Data on F-gas quantities used in the commercial air conditioning equipment were obtained from RIEW reports that importers, operators and service companies are required to report each year. Emission factor of 1.0% was used for the first year and 10% emission factor for emissions from operation (IPCC, 2006). Emissions from disposal of equipment are accounted only if this is explicitly written in the reports of any of the 16 RIEWs, from which the data is taken. The results are based on Tier 2a.

4.7.1.3 Uncertainties and time-series consistency

4.7.1.3.1 Commercial and industrial refrigeration (2.F.1.a and 2.F.1.c)

Since the beginning of 2009 in Bulgaria a new legal instrument (Ordinance establishing measures for the implementation of Regulation (EC) № 842/2006 on certain fluorinated greenhouse gases, called The Ordinance for short) is in effect, that fulfils the Regulation (EC) № 842/2006 requirements. According to the Ordinance, operators of equipment containing more than 3 kg refrigerant must report annually their relevant quantities to RIEWs, which then send a summary report of all reported to MOEW. Prior to 2008, the reports have been prepared under the legislation for the control and management of ODS. In order to assess emissions from this sector, reports from all 16 RIEW in Bulgaria for the period 1996-2012 were analysed. After summarizing the information it was concluded that in the years before 2009 a significant number of companies were not aware of the new reporting obligations. Therefore, to make an accurate assessment of this sector data from 2010 was used and then linearly extrapolated back in time

4.7.1.3.2 Domestic refrigeration (2.F.1.b)

The share of domestic refrigeration equipment using HFCs in Bulgaria has been allocated approximately from 0% in 1990 to a maximum of 90% in 1998. A drop follows to 40% in 2002 and 5% in 2005. These numbers show the change of Bulgarian producers and importers to use a hydrocarbon refrigerant, replacing HFCs. It is believed that the level of equipment containing HFCs after 2005 remains within 5%. According to a relevant British study (AEAT, 2003) the only agent to be used in this sector is HFC-134a, which has GWP of 1300. Data about the calculation of emission was extracted from the import of refrigeration and air conditioning of the NSI from 2000 to 2010. Data for the years 1988-1999 was extrapolated as a function of data about the total amount of imports of goods and services in Bulgaria (NSI, 2011). An uncertainty in the rage of 20-100% is applied.
Uncertainty is assumed to be around 50%.

4.7.1.3.3 Transport refrigeration (2.F.1.d)

It is a high uncertainty (80%) that emissions from this subsector are calculated based on many assumptions extracted from foreign studies and do not reflect in the best way the Bulgarian case.

4.7.1.3.4 Mobile air conditioning (2.F.1.e)

Data for passenger cars are provided by Ministry of Interior - General Directorate National Police for the period 2005-. The data for the years between 1990 and 2004 were extrapolated from the data as a function of the total imports of new and second hand cars in Bulgaria.
NSI data for imports of trucks provides information only on the years 2000- and therefore it was necessary here on the basis of imports of goods and services (World Bank, 2011) to extrapolate the input data back to 1988.
Data on the number of buses imported into the country were taken from NSI, but only for the years 2000 to . For the years before 2000, data were based on extrapolation of the imports of goods and services for the period 1988-1999 (World Bank, 2011).The subsector is assumed to have approximately 80% of uncertainty.

4.7.1.3.5 Stationary air conditioning (2.F.1.f)

Data for actual numbers of AC units is available for the period 2000-2005. For the period after 2006 the NSI provides data only for the total money spent on AC equipment. To estimate the number of units after 2006, first the average price of an AC unit calculated for 2005 and the the total numbers for the next period were divided into in. The average price for 2005 was taken insted of average price for 2000-2005 because throught the period the price of a single AC unit drops with a stready trend. Admission was made that before 1999 the majority of equipment was using CFCs and therefore, the calculations do not include the years before 2000. After 2007, legislative modifications have forced the import of equipment with HFCs. Despite that 35% of the refrigerant used in this sector is assumed still to be a CFC (AEAT, 2003).
It is believed that the data concerning commercial AC and reported for the years before 2009 from RIEW reports are not reliable enough. Therefore, to calculate the emissions, data for were used by 1% emission factor for the first year and 10% in operating emission factor (IPCC, 2006) and then linearly extrapolated back to 1999. Uncertainty is assumed to be around 15%.

4.7.1.4 Source-Specific QA/QA and Verification

In general, the whole Refrigeration and air conditioning subsector (CRF 2.F.1) is verified by an external expert from the MOEW. The expert was introduced with all activity data collection and assumptions, methodological issues and calculation approaches. After a discussion, some measures and improvements, concerning assumptions of the overall subsector were implemented.

4.7.1.5 Source-Specific recalculations

For the subcategory Stationary air conditioning (2.F.1.f) a recalculation was made after the emission inventory review in 2020. The equipment lifetime factor was changed to 15 years.

4.7.1.5.1 Commercial and industrial refrigeration (2.F.1.a and 2.F.1.c)

There are no source specific recalculations for this category.

4.7.1.5.2 Domestic refrigeration (2.F.1.b)

There is recalculation due to recalculation of the data submitted for 2017 from the NSI of Bulgaria.

4.7.1.5.3 Transport refrigeration (2.F.1.d)

There is recalculation due to technical mistake for this category (the emissins from decommissioning were not included in 2017).

4.7.1.5.4 Mobile air conditioning (2.F.1.e)

There is recalculation due to (1)recalculation in Cars sector, concerning the new cars and the use of a new cooling agent since 2014, and (2)a technical mistake in the cars air conditioning (initial emmissions).

4.7.1.5.5 Stationary air conditioning (2.F.1.f)

There are no source specific recalculations for this category, except recalculation for 2017 due to tehinical mistake.

4.7.1.6 Source-specific planned improvements

If new information is available for changes and trends in the category, improvements will be made in the relevant field including AD, EF etc.

4.7.2 FOAM BLOWING(CRF 2.F.2)

4.7.2.1 Source category description

Only two types of HFCs are used in the manufacture of extruded polystyrene insulation foams (XPS), solid polyurethane foams and one component foams (OCF). In Bulgaria, there are several larger companies in the production of foams. The largest of them, using as a blowing agent HFCs, imports raw materials from abroad. Others are using CO_2 and/or water as a substitute for HCFCs.
A large manufacturers of XPS, using HFCs is on the Bulgarian market since 2005. Quantity of imported and used HFCs is reported annually. These quantities (reported to RIEW/MoEW) are used to calculate emissions in this category, by assuming the entire quantity of produced foams stays in the country (although more than 50% is exported). There is no data available for the quantities of foams containing HFCs that were imported in the country.
There issignificant change in the foam blowing – HFC – 152a amount for due to technological change in one operator`s manufacturing in the country.
The following two tables represent the activity date for the subsector:

Table 142 Activity data for Foam blowing – HFC-134a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
2008	C	C	NO	60.18	NO	NO
2009	C	C	NO	4.55	1.35	NO
2010	NO	C	NO	NO	1.45	NO
2011	NO	C	NO	NO	1.44	NO
2012	NO	C	NO	NO	1.42	NO
2013	NO	C	NO	NO	1.41	NO
2014	NO	C	NO	NO	1.40	NO
2015	NO	C	NO	NO	1.39	NO
2016	NO	C	NO	NO	1.38	NO
2017	NO	C	NO	NO	1.37	NO
2018	NO	C	NO	NO	1.36	NO
2019	NO	C	NO	NO	1.35	NO

Table 143 Activity data for Foam blowing – HFC-152a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
2005	C	C	NO	77.01	NO	NO
2006	C	C	NO	205.28	19.25	NO
2010	C	C	NO	107.20	153.65	NO
2015	C	C	NO	86.52	80.84	NO
2016	C	C	NO	80.75	82.26	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2017	C	C	NO	89.49	81.88	NO
2018	C	C	NO	8.76	83.78	NO
2019	C	C	NO	0	65.03	NO

4.7.2.2 Methodological issues

The data about quantities of HFCs were obtained from questionnaires and annual reports of RIEWs. Market research in Bulgaria showed that only HFC-134a and HFC-152a are used, where foam blowing is carried out with HFCs. For the purposes of the calculations, default emission factors were used as follows - for HFC-134a 25% loss in the first year and 0.75% annual loss, for HFC-152a - 50% EF for the first year and 25% per annum thereafter (IPCC, 2006). Global warming potential of the two gases are respectively 1430 and 38 for HFC-134a and HFC-152a.

Activity data for Foam blowing – HFC-152a, HFC-134a could not be reported, because there is only one producer and data is confidential.

4.7.2.3 Uncertainties and time-series consistency

It is assumed that the import and the export balance each other, but could also be 40/60 or 60/40 (20% uncertainty).

4.7.2.4 Source-Specific QA/QA and Verification

No source-specific QA/QC and verification is obtained.

4.7.2.5 Source-Specific recalculations

There are no source specific recalculations for this category.

4.7.2.6 Source-Specific planned improvements

There are no planned improvements in this category.

4.7.3 FIRE PROTECTION (CRF 2.F.3)

4.7.3.1 Source category description

According to experts from the industry, who have been asked, fire protections activities with the use of HFC in Bulgaria are implemented in very rare cases - mainly in fire protection systems installed in the server and computer rooms. At the same time in Bulgaria filling of fire fighting equipment is not practiced. It is all imported, as there are no Bulgarian manufacturers of fire protection equipment, using HFC.
The following two tables represent the activity date for the subsector:

Table 144 Activity data for Fire Protection – HFC-125 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	0.148	0.148	NO	NO	0.007	NO
2005	0.071	0.359	NO	NO	0.018	NO
2010	0.000	3.407	NO	NO	0.170	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2015	4.345	11.506	NO	NO	0.575	NO
2016	1.406	12.911	NO	NO	0.646	NO
2017	2.224	15.135	NO	NO	0.757	NO
2018	1.789	16.924	NO	NO	0.846	NO
2019	3.302	20.226	NO	NO	1.011	NO

Table 145 Activity data for Fire Protection – HFC-227a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	3.065	3.065	NO	NO	0.153	NO
2005	1.466	7.406	NO	NO	0.370	NO
2010	0.000	17.514	NO	NO	0.876	NO
2015	0.000	27.206	NO	NO	1.360	NO
2016	0.872	28.078	NO	NO	1.404	NO
2017	0.206	28.284	NO	NO	1.414	NO
2018	1.989	30.273	NO	NO	1.514	NO
2019	0.775	31.047	NO	NO	1.552	NO

4.7.3.2 Methodological Issues

Data about banked HFC quantities in firefighting equipment were used (mainly FM-200 and NAFS-125 type), according to which the mainly used HFC is HFC-227ea (80%) and to a lesser extent - HFC-125. This data is provided by "National Fire Safety and Protection of Population Service" in Ministry of Interior. Using default EF of 5% of the IPCC Guidelines, 1996.

4.7.3.3 Uncertainties and time-series consistency

Analysis of data obtained by the questionnaires from operators and importers determined that there is no use of F-gases in fire protection equipment before 2005, while reports of RIEW have reported small amounts of HFC-227ea imports since 2001. Therefore, it is assumed that the starting year of HFC usage in fire protection equipment is 2001. To calculate emissions for the years before 2008, an assumption for linear growth of about 25% in fire fighting equipment was made. Uncertainty is considered to be in range of 60-100% of the original value.

4.7.3.4 Source-Specific QA/QA and Verification

No source-specific QA/QC and verification is obtained.

4.7.3.5 Source-Specific recalculations

There are no source specific recalculations for this category.

4.7.3.6 Source-Specific planned improvements

No source-specific planned improvements are to be performed.

4.7.4 AEROSOLS (CRF 2.F.4)

4.7.4.1 Source category description

The used HFCs as propellants currently are HFC-134a, HFC-227ea and HFC-152a. Data on their use as medical and technical aerosols were obtained directly from industry by telephone calls and questionnaires. After direct contact with experts from the industry, the researched showed that in Bulgaria there is only one producer, which uses HFC-134a in the production of aerosols. There are several companies working in this field, but they do not use any F-gases.
Concerning the import and usage of meter dose inhalers (MDIs) in the medicine, according to an official letter of the Executive Drug Agency in Bulgaria HFC-134a is the only F-gas used in MDIs. The Agency provided a full list of operators and importers of MDIs, containing HFC-134a. A profound research on those companies and contacting them helped in collecting data for the use of such equipment since 2005. Therefore, the results are based on real numbers, reported by the companies.
The following table represents the activity date for the subsector:

Table 146 Activity data for Aerosols/Meter dose inhalers – HFC-134a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1998	1.559	NO	NO	0.779	NO	NO
2000	0.134	0.462	NO	0.067	0.462	NO
2005	1.990	0.820	NO	0.995	0.820	NO
2010	7.194	4.017	NO	3.597	4.017	NO
2015	10.567	2.623	NO	5.283	2.623	NO
2016	9.915	5.283	NO	4.957	5.283	NO
2017	8.628	4.957	NO	4.314	4.957	NO
2018	10.193	4.314	NO	5.097	4.314	NO
2019	9.356	5.097	NO	4.678	5.097	NO

4.7.4.2 Methodological Issues

According to the 2006 IPCC Guidelines, aerosol emissions are considered to be immediate, occurring during the first year of production. Using data on quantities of HFC-134a consumed by the company for the period 1988-2019, the default EF of 50% for the first year and 100% for the next year (IPCC, 2006). The EFs selected are default because of the absence of specific empirical data on the territory of Bulgaria. Results are obtained according to Tier 2a method.

4.7.4.3 Uncertainties and time-series consistency

Uncertainty is assumed to be around 30% for the whole subsector.

4.7.4.4 Source-Specific QA/QA and Verification

Data is verified by MOEW expert.

4.7.4.5 Source-Specific recalculations

There are no source specific recalculations for this category.

4.7.4.6 Source-Specific planned improvements

No source-specific planned improvements are to be performed.

4.7.5 SOLVENTS (2.F.5)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

4.7.6 OTHER APPLICATION USING ODS SUBSTITUTES (2.F.6 CRF SOURCE CATEGORY NUMBER)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

4.7.7 SEMICONDUCTOR MANUFACTURING (CRF SOURCE CATEGORY NUMBER)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

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4.8 OTHER PRODUCT MANUFACTURE AND USE (CRF 2.G)

4.8.1 ELECTRICAL EQUIPMENT (CRF 2.G.1)

4.8.1.1 Source category description

In electrical engineering, sulfur hexafluoride is used as a gaseous dielectric for high voltage (usually from 52 kV to 800 kV) equipment - circuit breakers, disconnectors, bushing systems and whole substations and increasingly in medium voltage (6 - 52 kV) networks. It is not flammable. It serves as an arc-extinguishing and insulation medium (in the latter function, in place of air). It has 3 times better electrical insulation properties than air, which allows a substantial reduction in the size of the equipment. To improve the electrical insulation properties, these devices maintain an increased pressure (from 5 to 10 bar due to its wide application in high voltage electrical equipment is often referred to as electric (electric) gas).
It breaks into an electric arc but quickly recovers its insulating properties as the products of the disintegration re-form SF6.
In 2009, the ExEA has conducted a study concerning the determination of banked quantities of SF_6 in the country. The survey on the banked quantities of SF6 is performed on an annual basis - detailed questionnaires to 30 companies were sent, including importers and operators of equipment. The purpose of the survey was to gather additional historical data, with the desire to apply a higher tier to calculate the emissions and in view of the fact that reported data for imports of SF_6 and equipment containing SF_6 is incomplete.
Under Bulgarian law, companies using SF6-containing equipment are required to report annually data on their available equipment. Additionally, companies are sent reminders to provide information about used equipment containing SF6.
In Bulgaria there is no production of SF6 and switchgear containing SF6, it is only imported . The main share (85-90%) of the use of SF6 in switching equipment belongs to a state-owned company for electricity generation and transmission (Bulgarian Energy Holding with four subsidiaries), three electricity distribution companies and the National Company "National Railway Infrastructure Company", the rest SF6 equipment is serviced by thermal power plants and companies with their own substations.

The following table represents the activity date for the subsector:

Table 147 Activity data for Eclectrical Equipment – SF6 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	0.47	5.96	NO	0.033	0.112	NO
1990	0.53	6.67	NO	0.037	0.125	NO
1995	0.70	8.84	NO	0.049	0.166	NO
2000	0.93	11.72	NO	0.064	0.220	NO
2005	0.93	15.26	NO	0.066	0.292	NO
2010	8.06	25.02	NO	0.469	0.354	NO
2015	2.00	34.14	NO	0.132	0.660	NO
2016	2.09	35.41	NO	0.141	0.681	NO
2017	0.77	35.41	NO	0.064	0.704	NO
2018	1.02	35.64	NO	0.085	0.704	NO
2019	1.08	35.92	NO	0.091	0.710	NO

4.8.1.2 Methodological Issues

Emission data is based on annual reports from companies on available equipment in the relevant year.
The data obtained were used to assess emission using Tier 2a and default EF, according to the IPCC Guidelines, 2006.
Due to the long life of the equipment and the lack of sufficient research data, it is not possible to calculate country-specific EF.Default EF given by the IPCC Guidelines for the equipment containing SF_6, are 0.002 (0.2%) (for Sealed-for-life Equipment) and 0.026 (2.6%) (for Closed Pressure Systems) (IPCC, 2006).
Extremely small amounts were reported as installation emissions. No amounts of SF_6 were reported as used in servicing of equipment or quantities contained in retiring equipment.
According to the IPCC Guidelines 2006, equipment is divided into two main types - with and without the possibility of topping up. Systems without the possibility of additional charging (Sealed-for-life Equipment) usually have a capacity of less than 5 kg per functional unit and they are used at a voltage below 52 kV. They do not require any maintenance during the period of operation; their respective emission factor is much lower. Systems capable of charge (Closed Pressure Systems) are used in more than 52 kV voltage and may contain amounts of 5 to several hundred kg.
Since it is not possible to do a detailed disaggregation between the equipment with or without possibility of charge, it was assumed that the equipment of the high-voltage grid owned by "Electricity System Operator" PLC is close-pressured (about 97% of equipment is with a capacity of over 5 kg and is part of 110, 220 or 400 kV grid). It was assumed that 25% of the quantities of equipment could be initially charged, according to data from the annual reports about the newly installed equipment. and the quantities used for initial charging.

4.8.1.3 Uncertainties and time-series consistency

Although the study was designed to cover the years from 1988 to 2015, almost no company that can report on data from the years before 2003, but most of them reported only data from the last 2-3 years. Therefore, the calculations for previous years were made by extrapolation of the reported amounts for 2009 under the assumption for annual growth rate of newly installed equipment by 5.8% for the period 1995-2003 and 3.9% for the period 2004-2015 (Ecofys, 2005).
Activity data in last years is assumed to be uncertain by +/-10%, in 1988 much less information is available (+/-50%). Furthermore, based on the default EF used, also default uncertainty of the EF (+/-30%) is applied.

4.8.1.4 Source-Specific QA/QA and Verification

No source-specific QA/QC and verification is performed.

4.8.1.5 Source-Specific recalculations

There are no source specific recalculations for this category.

4.8.1.6 Source-Specific planned improvements

No source-specific planned improvements are to be performed.

4.8.2 SF_6 AND PFCS FROM OTHER PRODUCT USE (CRF 2.G.2)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

4.8.3 N_2O FROM PRODUCT USES - MEDICAL APPLICATION (CRF 2.G.3A)

4.8.3.1 Source category description

N_2O emissions are caused by medical uses of N_2O (for anaesthesia).
Calculation of N_2O emission from subcategory *2G3a Other product manufacture and use, medical application* are based on emission factor in accordance with the 2006 IPCC Guidelines.

4.8.3.2 Trend description

Trend for N_2O emissions from subcategory 2G3 N_2O from product use (2G3a - Medical application). The N_2O emissions from 2G3a - Medical application are calculated for the entire time series 1988 – . The trend of N_2O emissions is presented in the following figure.

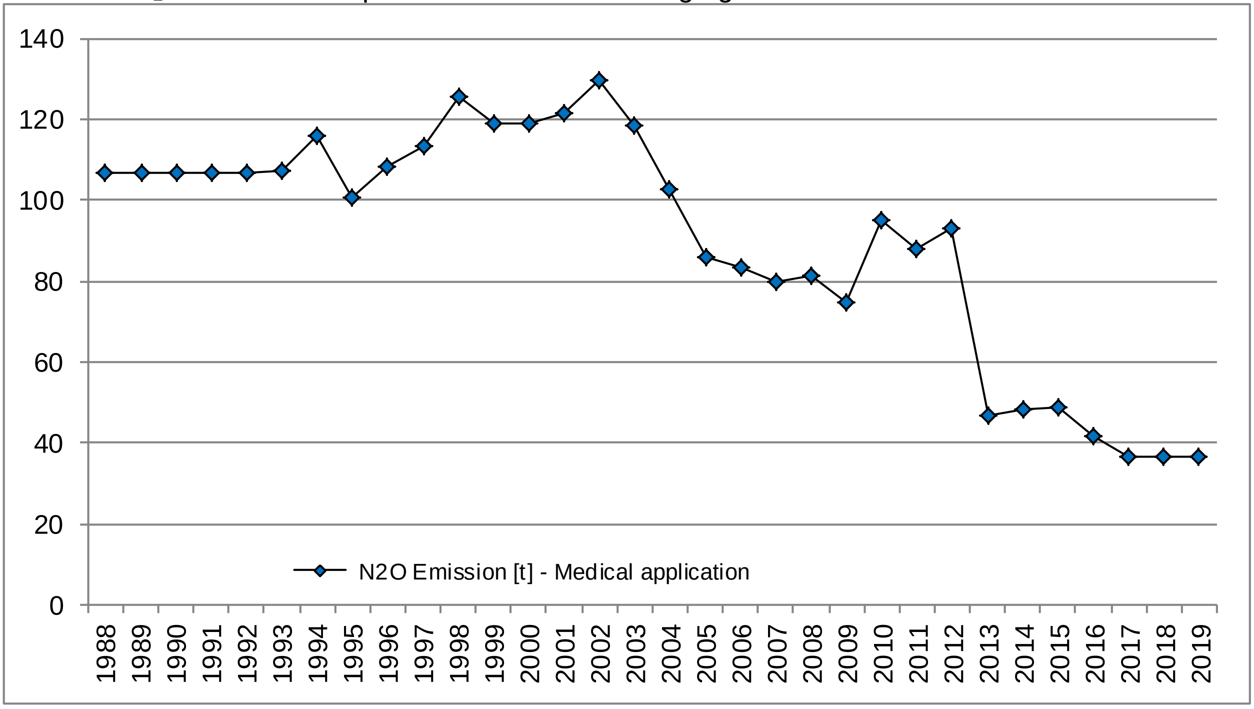


Figure 85 Medical application (Anaesthesia) – N2O emissions.

4.8.3.3 Methodological issues.

4.8.3.3.1 Method

The N_2O emissions from 2G3a Medical application are estimated based on methodological issues set in the 2006 IPCC Guideline (Volume 3: Industrial Processes and Product Use, Chapter 8). Equation 8.24 for estimation of N_2O emissions from other product use is implemented. It is assumed that none of the administered N_2O is chemically changed by the body, and all is returned to the atmosphere. It is reasonable to assume an emission factor of 1.0.

4.8.3.3.2 Emission Factor

The default emission factors used for assessment of emissions of N_2O from 2G3a Medical application are presented inTable 148.

Table 148 Emission factor N2O for 2G3a is 1.0.

2G3 N_2O from product uses (Medical application)				
SNAP activity	Name of activity	Emission factor	Unit	Reference
2G3a	Medical application	1.0	Mg/Mg	CORINAIR

4.8.3.3.3 Activity Data

For the period 1988 – 2012 data are obtained by the single manufacturer of N2O in the country. Since 2012 the company has not possessed a license for this activity and stops to work as it is not able to meet the additional requirements to the quality of the production, which are related to unreasonably high capital costs for restructuring of the installation.
A letter to the Drug Agency has been sent in order to obtain the list of the companies which are licensed to import and trade with this product. Letters are sent to those companies which have submitted data for the imported quantities of N_2O in the country.

Due to lack of data, the activity data for the period 1988 – 1991 are taken the same as first available year.

Table 149 AD for N2O emissions from 2G3 N2O from product use (2G3a - Medical application), Mg

2G3a - N_2O from product uses (Medical application)	
Year	**N2O Emissions [t N2O]**
1988	106.95
1990	106.95
1995	100.95
2000	119.30
2005	86.17
2010	95.36
2015	48.56
2016	41.83
2017	36.77
2018	36.74
2019	36.74

4.8.3.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 150 .

Table 150 Uncertainty of subcategory 2G3 N2O emissions from product uses (2G3a Medical application), %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	N_2O	10	1	10,05

4.8.3.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.8.3.6 Source specific recalculation

There are no source specific recalculations for this category.

4.8.3.7 Source specific planned improvements

No source specific improvements are planned.

4.8.4 N_2O FROM PRODUCT USES - PROPELLANT FOR PRESSURE AND AEROSOL PRODUCT (CRF 2.G.3.B)

4.8.4.1 Source category description

N_2O emissions are caused by uses of Propellant for pressure and aerosol product (aerosol cans). Calculation of N_2O emission from subcategory *2G3b* N_2O from product uses (2G3b - Propellant for pressure and aerosol product), are based on emission factor in accordance with the 2006 IPCC Guidelines.

4.8.4.2 Trend description

Trend for N_2O emissions from subcategory 2G3b N_2O from product use (2G3b Propellant for pressure and aerosol product).The N_2O emissions from 2G3b - Propellant for pressure and aerosol product are calculated for the entire time series 1988 – 2019.

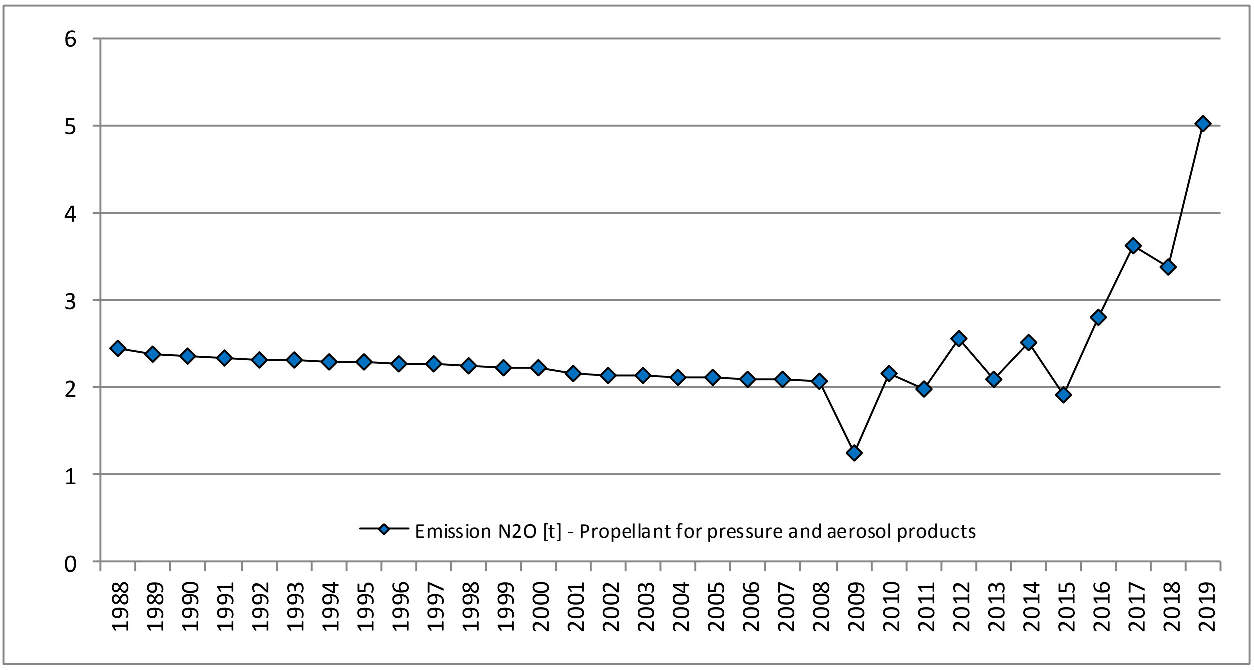


Figure 86 Propellants for pressure and aerosol product - N2O emissions.

4.8.4.3 Methodological issues.

4.8.4.3.1 Method

The data are provided from the importing companies in the cream spray. Available data on the amount of cream sprayed are for the period 2009-2019 and the nitric oxide content in cans. On the basis of the data on the population of the country (provided by the NSI), an average emission factor was calculated which was applied for the period 1988-2008.

4.8.4.3.2 Emission Factor

The default emission factors used for assessment of emissions of N_2O from 2G3b – 100% of the quantity of N_2O contained in the cans of cream spray imported to the country.

4.8.4.3.3 Activity Data

Data on the amount of N_2O imported in the country was obtained by sending letters to the importing companies to which these imports were authorized by the Bulgarian Food Safety Agency.

Table 151 AD for N2O emissions from 2G3 N2O from product use (2G3b - Propellant for pressure and aerosol product), Mg

2G3b - N_2O from product uses (Propellant for pressure and aerosol product)		
Year	N_2O Emissions [t N_2O]	Population [1000 number]
1988	2.4528	8986.636
1990	2.3662	8669.269
1995	2.2886	8384.715
2000	2.2244	8149.468
2005	2.1068	7718.750
2010	2.1678	7504.868
2015	1.9123	7153.784

2G3b - N_2O from product uses (Propellant for pressure and aerosol product)		
Year	**N_2O Emissions [t N_2O]**	**Population [1000 number]**
2016	2.8088	7101.859
2017	3.6236	7050.034
2018	3.3906	7000.039
2019	5.0270	6951.482

4.8.4.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 152

Table 152 Uncertainty of subcategory 2G3 N_2O emissions from product uses (2G3b Propellant for pressure and aerosol products), %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2G3b	No	N_2O	10	1	10,05

4.8.4.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.8.4.6 Source specific recalculation

There are no source specific recalculations for this category.

4.8.4.7 Source specific planned improvements

No source specific improvements are planned.

4.8.5 DOMESTIC SOLVENT USE (CRF 2G4I)

4.8.5.1 Source category description

This category deals with the following activities:

- Domestic solvent use (other than paint application) (SNAP activity 060408)
- Domestic use of pharmaceutical products (SNAP activity 060411)

It comprises mainly the application of cleaning agents and solvents in private households for building and furniture cleaning and personal hygiene. The cleaning agents contain solvents which evaporate during use or after the application.

4.8.5.2 Trend description

The trend of emissions for sector 2.G.4.i Domestic solvent use is presented in the following chart.

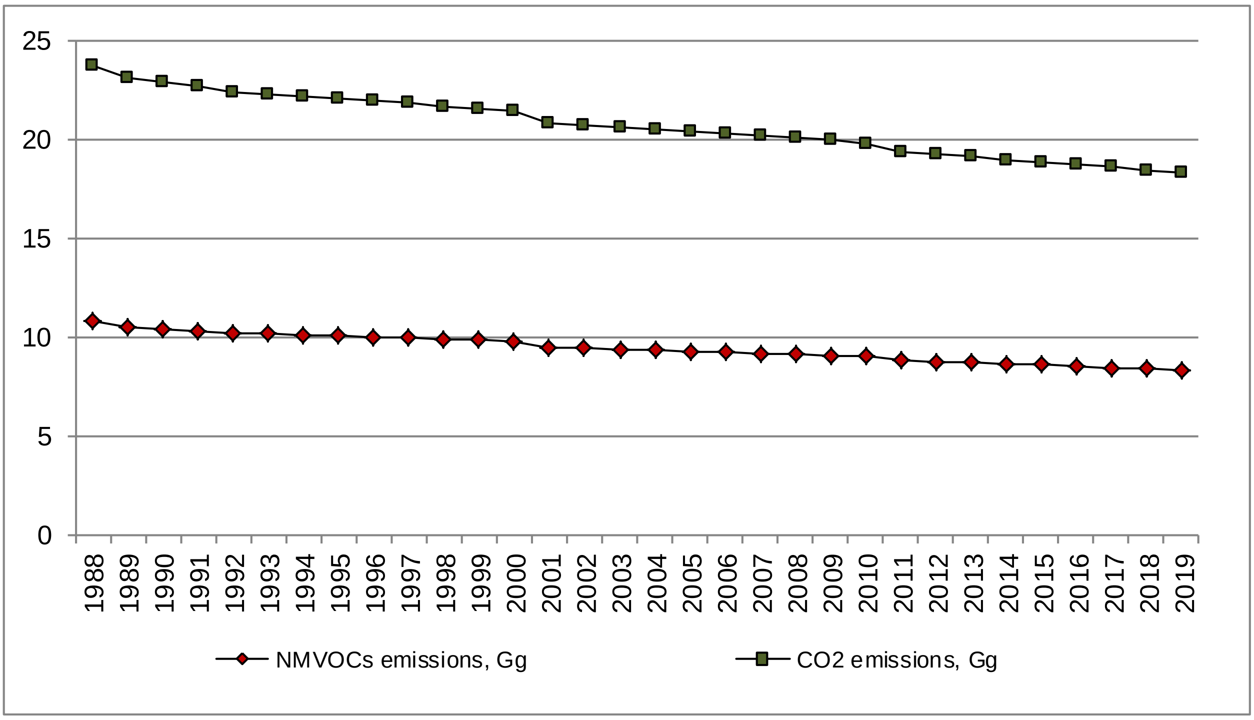


Figure 87 Trend of CO2 and NMVOC emissions in sector 2.G.4.i Domestic solvent.

4.8.5.3 Methodological issues.

4.8.5.3.1 Emission Factor

The emission factor has been derived from an assessment of the emission factors presented in GAINS model developed by IIASA. So, for Bulgaria we assume to use the EF of 1.2 kt/M people.
Converting of NMVOC into CO_2 with conversion factor is provided in the 2006 IPCC Guidelines, Volume 1, Chapter 7.2.1.5 Carbon Emitted in Gases Other than CO_2.
From NMVOC:

$$\boldsymbol{Inputs_{CO_2} = Emissions_{NMVOC} \times C \times \frac{44}{12}}$$

Where C is the fraction carbon in NMVOC by mass (default = 0.6)
Reference for default: conversion- factor NMVOC – CO_2, the 2006 IPCC Guidelines , Volume 3, Chapter 5: Industrial Processes and Product Use, page 5.17, 2006 IPCC Guidelines s, Volume 1, Chapter 7: Precursors and Indirect Emissions, page 7.6
Time-series have been created due to application of EMEP/EEA Guidebook 2013.

4.8.5.3.2 Activity Data

All emissions related to domestic use of solvents and pharmaceuticals are calculated proportional to the Bulgarian population.

Table 153 Activity data of 2G4i Domestic solvent use in 1990-2019

Years	Inhabitants, 1000 person	NMVOCs emissions, Gg	CO_2 emissions, Gg
1988	8986.6	10.78	23.72
1990	8669.3	10.40	22.89
1995	8384.7	10.06	22.14
2000	8149.5	9.78	21.51
2005	7718.8	9.26	20.38
2010	7504.9	9.01	19.81
2015	7153.8	8.58	18.89
2016	7101.9	8.52	18.75
2017	7050.0	8.46	18.61

2018	7000.0	8.40	18.48
2019	6951.5	8.34	18.35

4.8.5.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 152

Table 154 Uncertainty of subcategory 2G4i Domestic solvent use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2G4i	No	CO_2	10	30	31.62

4.8.5.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.
The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.8.5.6 Source specific recalculation

There are no source specific recalculations for this category.

4.8.5.7 Source specific planned improvements

No source specific improvements are planned.

4.8.6 OTHER PRODUCT USE (CRF 2G4I)

4.8.6.1 Source category description

This category deals with the following activities:

- Fat, edible and non-edible oil extraction (SNAP activity 060404)
- Application of glues and adhesives (SNAP activity 060405)
- Preservation of wood (SNAP activity 060406)
- Printing (SNAP activity 060403)

4.8.6.2 Trend description

The trend of emissions for sector 2.G.4.I Other product use is visualized in the following chart.

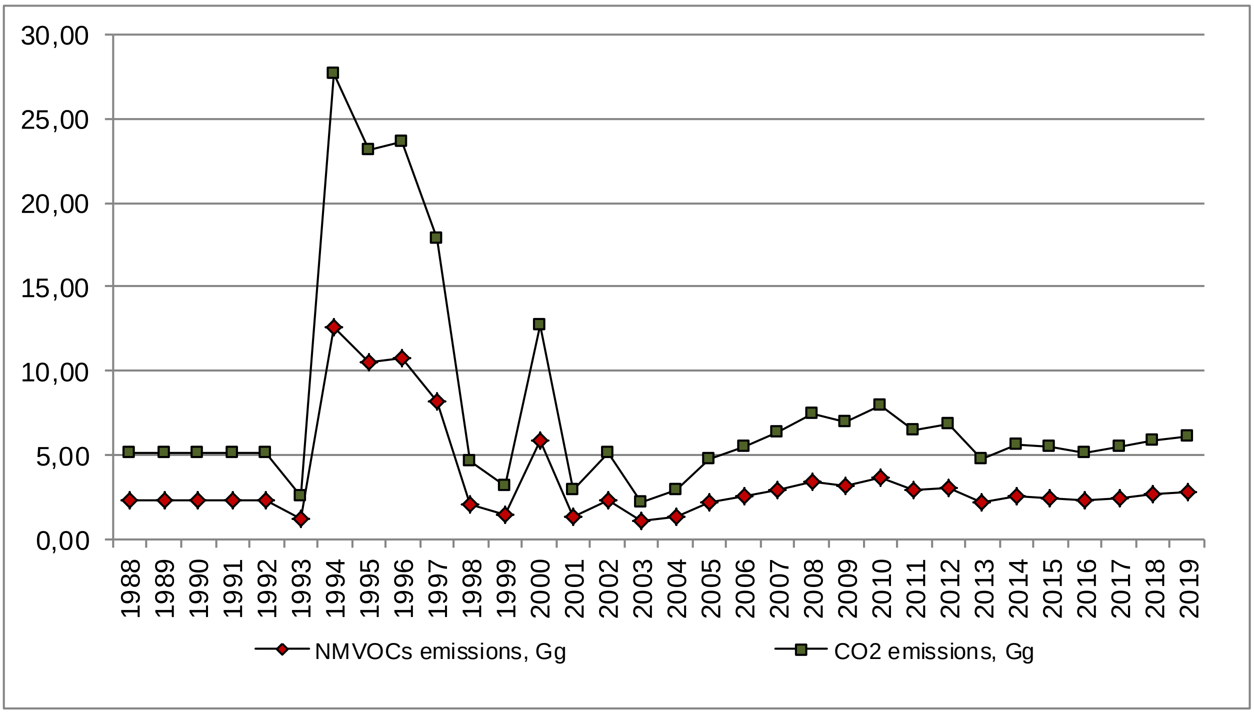


Figure 88 Trend of NMVOC and CO2 emissions in sector 2.G.4.I Other product use.

4.8.6.3 Methodological issues.

4.8.6.3.1 Emission Factor

The Tier 1 default approach has been implemented. The general equation is:

E pollutant = AR production × EF pollutant

where:
E pollutant = the emission of the specified pollutant,
AR production = the activity rate (consumption of paint, chemical production data, solvent consumption)
EF pollutant = the emission factor for this pollutant.

This equation is applied at the national level, using annual national total figures for the activity data. TIER1 EFs provided in the EMEP/EEA 2013 Guidebook are used for NMVOC.

Table 155 Emission factors used for Other product use (CRF 2G4I)

SNAP activity	Name of activity	Emission factor	Unit	Reference
Other product use*				
060404	Fat, edible and non-edible oil extraction	1.57	g/kg seed	EMEP/EEA guidebook 2016
060405	Application of glues and adhesives	522	g/kg adhesives	EMEP/EEA guidebook 2016
060406	Preservation of wood: Creosote preservative type Waterborne preservative	 945 105 0,5	g/kg preservative	EMEP/EEA guidebook 2016
060403	Printing	730	g/kg ink	EMEP/EEA guidebook 2016

** The other SNAP activities under CRF 2G4I Other product use are not estimated due to lack of activity data.*

Converting of NMVOC into CO_2 with conversion factor is provided in the 2006 IPCC Guidelines, Volume 1, Chapter 7.2.1.5 Carbon Emitted in Gases Other than CO_2.
From NMVOC:

$$\boldsymbol{Inputs_{CO_2} = Emissions_{NMVOC} \times C \times \frac{44}{12}}$$

Where C is the fraction carbon in NMVOC by mass (default = 0.6)
Reference for default: conversion- factor NMVOC – CO_2, the2006 IPCC Guidelines , Volume 3, Chapter 5: Industrial Processes and Product Use, page 5.17, 2006 IPCC Guidelines s, Volume 1, Chapter 7: Precursors and Indirect Emissions, page 7.6

4.8.6.3.2 Activity Data

Activity data for sector 2.G.4.I Other product use are provided by PROTPROM for the activity "Fat, edible and non-edible oil extraction" and by NSI for the following activities: "Application of glues and adhesives" (SNAP activity 060405), "Preservation of wood" (SNAP activity 060406) and "Printing" (SNAP activity 060403).
Data on used quantities of substances used to protect wood in the manufacture of railway sleepers was obtained from the only one factory in the country. Information on the amount of creosote used in the production for the period 2005- was provided, and in 2009 the company started to buy creosote with less solvent. The company also provides data on the water-soluble wood preservative used. For the period before 2005 an extrapolation of the data used by the NSI was made. In Bulgaria there are other smaller woodworking companies for the purpose of preservation, which only use a water solution preparations based on metal salts.
The activity data for sector 2.G.4.I Other product use are presented in the following table.

Table 156 Activity data for sector 2.G.4.i – Other product use

2.G.4.i – Other product use			
Year	Other product use [kt]	NMVOC Emissions [kt NMVOC] [kt]	CO2 Emissions [kt CO2] [kt]
1988	11.14	2.30	5.07
1990	11.14	2.30	5.07
1995	20.91	10.51	23.12
2000	121.36	5.79	12.74
2005	53.95	2.13	4.69
2010	355.48	3.61	7.94
2015	767.48	2.47	5.44
2016	740.71	2.34	5.16
2017	813.57	2.47	5.43
2018	890.00	2.63	5.79
2019	984.92	2.77	6.09

4.8.6.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 152

Table 157 Uncertainty of subcategory 2G4i Other product use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2G4i	No	CO_2	10	30	31.62

4.8.6.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken in CRF sector Other product use.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors (time series)
- Time series consistency
- Plausibility checks of dips and jumps
- Documentation and archiving of all information required in NIR,
- Background documentation and archive.

4.8.6.6 Source specific recalculation

There are no source specific recalculations for this category.

4.8.6.7 Source specific planned improvements

No source specific improvements are planned.

5 AGRICULTURE (CRF SECTOR 3)

5.1 OVERVIEW OF SECTOR

This chapter gives information about the estimation of greenhouse gas emissions from Sector Agriculture in correspondence to the data reported under the Sector 3 in the Common Reporting Format. The following sources exist in Bulgaria:

- domestic livestock activities with enteric fermentation and manure management,
- rice cultivation,
- agricultural soils,
- agricultural residue burning, and
- urea fertilisation.

5.2 EMISSION TRENDS

In the year 2019 the sector agriculture contributed 11,17% to the total of Bulgaria's greenhouse gas emissions (without LULUCF). The trend of GHG emissions from 1988 to 2019 shows a decrease of 54.10 % for this sector due to decrease in activity data. (Figure 89)

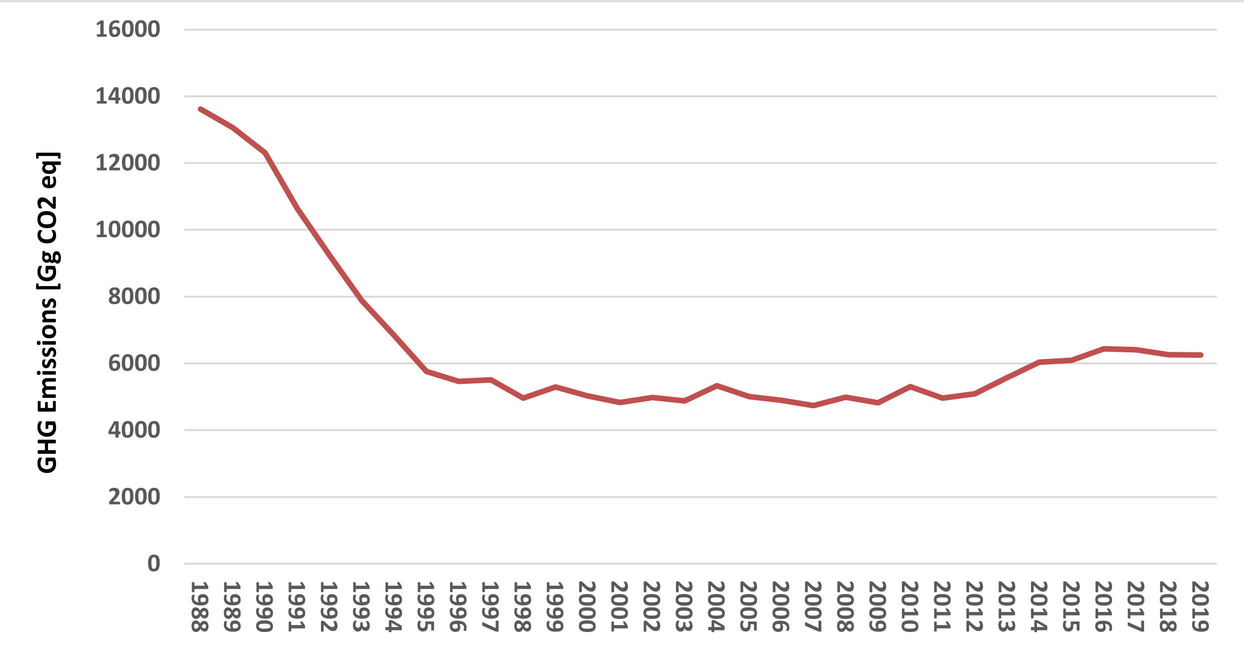


Figure 89 Trend of GHG Emissions from agriculture

5.3 EMISSION TRENDS PER GAS

CH_4 emissions are 30% from of the total emissions in the sector in CO_2-eq in 2019. A steady trend of emissions decrease is observed after 2004 due to reduction in animal numbers.

N_2O emissions from the sector are also significant. The share of N_2O emissions is 69% for the year 2019. The biggest share in these emissions has the Agricultural soils category with 93.05%. N_2O emissions from manure management and field burning of agricultural residues are of an order of magnitude smaller.

Since 1988 the CH_4 emissions from agriculture decreased by 70% and N_2O emissions by 40%. The trend is presented in Table 158.

CH_4 emissions were 74,96 Gg in the year 2019. The decrease for the year 2019 is 0,29% compared to 2018. N_2O emissions increase from 14,44 Gg in 2018 to 14,57 Gg in 2019 year.

Table 158 Emissions of greenhouse gases from agriculture 1988 – 2019.

Year	GHG emissions [Gg]		
	CH_4	N_2O	CO_2
1988	252.45	24.30	62.17
1990	240.51	20.97	45.49
1995	111.97	9.88	14.88
2000	96.43	8.72	16.65
2005	89.31	9.26	18.32
2010	80.18	11.01	18.05
2015	79.87	13.63	31.27
2016	79.26	14.83	35.93
2017	78.31	14.82	33.42
2018	76.91	14.44	33.74
2019	74.96	14.57	33.04

5.3.1 EMISSION TRENDS PER SUB CATEGORY

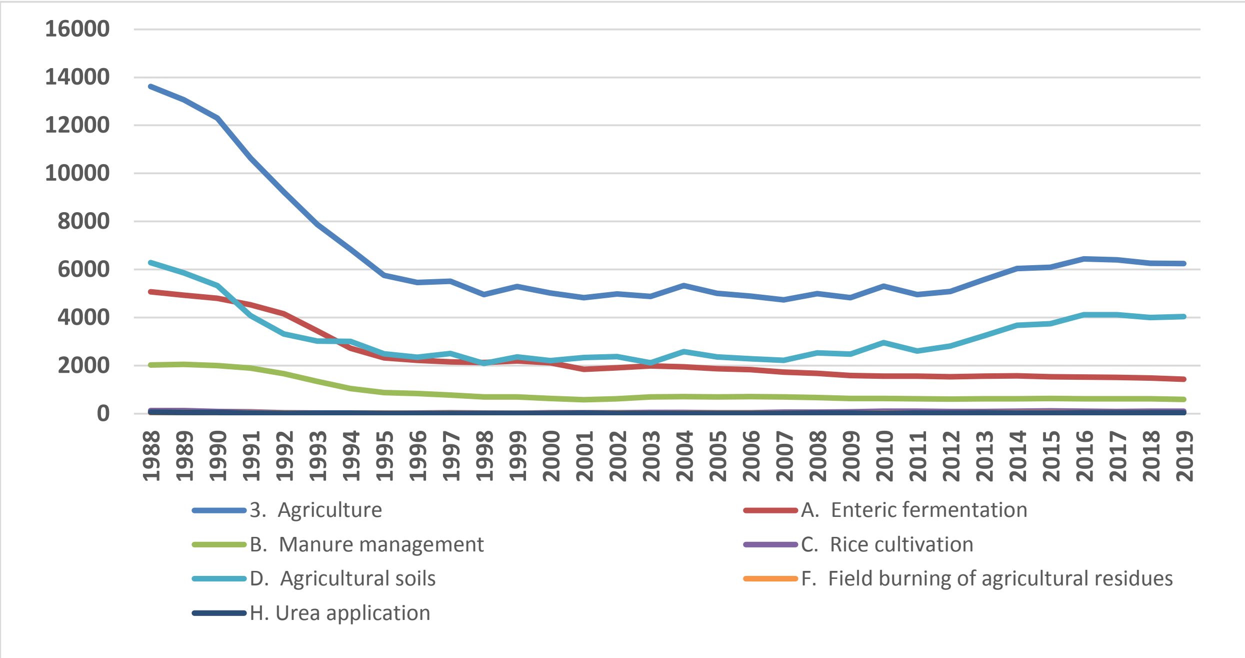


Figure 90 GHG emission trends 1988–2019 of agriculture by categories (Gg CO2-eq)

Table 159 and Figure 90 present total GHG emissions and trend 1988–2019 from agriculture by sub-categories as well as the contribution to the overall inventory emissions. Important categories are 3.D Agricultural soils (65%) and 3.A Enteric Fermentation (23%) followed by 3.B Manure management (9.6%).

Table 159 GHG emissions 1988–2019 of agriculture by categories.

Year	GHG emissions [Gg CO_2 equivalent] by categories						
	3	3.A	3.B	3.C	3.D	3.F	3.H
1988	13615.02	5071.20	2024.82	126.99	6292.44	37.40	62.17
1990	12307.65	4804.54	1997.43	95.37	5327.24	37.57	45.49
1995	5759.75	2329.68	883.88	12.43	2495.27	23.62	14.88
2000	5026.36	2113.83	638.19	32.16	2210.18	15.34	16.65
2005	5010.47	1869.65	696.85	40.53	2364.78	20.33	18.32
2010	5303.80	1566.57	628.34	107.87	2956.80	26.17	18.05
2015	6089.34	1535.49	629.52	111.77	3749.27	32.02	31.27
2016	6438.02	1521.87	625.65	107.97	4113.69	32.91	35.93

Year	GHG emissions [Gg CO_2 equivalent] by categories						
	3	3.A	3.B	3.C	3.D	3.F	3.H
2017	6408.97	1512.39	617.58	93.97	4116.77	34.82	33.42
2018	6259.97	1478.56	614.60	99.10	3998.37	35.59	33.74
2019	6249.25	1434.83	596.89	106.47	4040.47	37.55	33.04
Share in Total 2019	-	22.96%	9.55%	1.70%	64.66%	0.60%	0.53%

As can be seen in Table 159 and Figure 90, the overall trend for emissions in the most categories is decreasing. The reasons for the decrease are structural changes in agricultural holdings which lead to reduction in farm animal populations and decrease in arable land area.

5.3.2 KEY CATEGORIES

Table 160 Key sources of agriculture.

IPCC Category	Source Categories	Key Sources	
		GHG	KS-Assessment*
3.D.1	Direct N_2O emissions from Agricultural soils	N_2O	Yes
3.A.1	Enteric Fermentation - cattle	CH_4	Yes
3.B2	Manure Management	N_2O	Yes
3.D.2	Indirect N_2O from Nitrogen used in Agriculture	N_2O	Yes

5.3.3 COMPLETENESS

Table 161 gives an overview of the IPCC categories included in this chapter and provides information on the status of emission estimates of all subcategories. A "✓" indicates that emissions from this sub-category have been estimated.

Table 161 Overview of sub-categories of agriculture.

IPCC Category		CH_4		N_2O	CO_2
3.A	**ENTERIC FERMENTATION**	**ENTERIC FERMENTATION**	✓	**NA**	**NO**
3.A.1	Cattle	–	✓	NA	**NO**
3.A.1.	Dairy Cattle	Dairy cows	✓	NA	**NO**
3.A.1.	Non-Dairy Cattle	Other cattle	✓	NA	**NO**
3.A.1.	Young cattle	Calves and heifers	✓	NA	**NO**
3.A.2	Sheep	Sheep	✓	NA	**NO**
3.A.3	Swine	Swine	✓	NA	**NO**
3.A.4	Other livestock				**NO**
3.A.4	Buffalo	Buffalos	✓	NO	**NO**
3.A.4	Goats	Goats	✓	NA	**NO**
3.A.4	Camels and Lamas	Camels	NO	NO	**NO**
3.A.4	Horses	Horses	✓	NA	**NO**
3.A.4	Mules and Asses	Mules and asses	✓	NA	**NO**
3.A.4	Poultry	Laying hens, broilers, other poultry	NA	NA	**NO**
3.B.	**MANURE MANAGEMENT**	**MANURE MANAGEMENT REGARDING ORGANIC COMPOUNDS** **MANURE MANAGEMENT REGARDING NITROGEN COMPOUNDS**	✓ **NO**	**NO** ✓	**NO**
3.B.1.1 + 3.B.2.1	Cattle	–	✓	✓	**NO**
3.B.1.1 + 3.B.2.1	Dairy Cattle	Dairy cows	✓	✓	**NO**
3.B.1.1 + 3.B.2.1	Non-Dairy Cattle	Other cattle	✓	✓	**NO**
3.B.1.1 +	Young cattle	Calves and heifers	✓	✓	**NO**

IPCC Category		CH_4		N_2O	CO_2
3.B.2.1					
3.B.1.4 + 3.B.2.4	Buffalo	Buffalos	✓	✓	**NO**
3.B.1.2 + 3.B.2.2	Sheep	Sheep	✓	✓	**NO**
3.B.1.4 + 3.B.2.4	Goats	Goats	✓	✓	**NO**
3.B.1.4 + 3.B.2.4	Horses	Horses	✓	✓	**NO**
3.B.1.4 + 3.B.2.4	Mules and Asses	Mules and asses	✓	✓	**NO**
3.B.1.3 + 3.B.2.3	Swine	Swine	✓	✓	**NO**
3.B.1.4 + 3.B.2.4	Poultry	Laying hens, broilers, Other poultry (ducks, gooses,…)	✓	✓	**NO**
3.B.2.5	Emissions per MMS	Emissions per MMS		✓	**NO**
3.C	**RICE CULTIVATION**	**Rice Field (with fertilizers)** **Rice Field (without fertilizers)**	✓	**NO**	**NO**
3.D	**AGRICULTURAL SOILS**	**CULTURES WITH FERTILIZERS** **CULTURES WITHOUT FERTILIZERS**	**NO**	✓	**NO**
3.D.1	Direct Soil Emissions	Cultures with and without fertilizers	NO	✓	**NO**
3.D.1.3	Pasture, Range and Paddock Manure	Cultures without fertilizers	NO	✓	**NO**
3.D.3	Indirect Emissions	Cultures with and without fertilizers	NO	✓	**NO**
3.E	**PRESCRIBED BURNING OF SAVANNAS**	**–**	**NO**	**NO**	**NO**
3.F	**FIELD BURNING OF AGRICULTURAL RESIDUES**	**ON-FIELD BURNING OF STUBBLE, STRAW, …**	✓	✓	**NO**
3.F.1	Cereals	Cereals	✓	✓	**NO**
3.F.2	Pulses	Pulse	✓	✓	**NO**
3.F.3	Tubers and Roots	Tuber and Root	✓	✓	**NO**
3.F.4	Sugar Cane	Sugar Cane	✓	✓	**NO**
3.G	**LIMING**	**NO**	**NO**	**NO**	**NO**
3.H	**UREA FERTILIZATION**	**NO**	**NO**	**NO**	✓

5.3.4 QA/QC ACTIVITIES

- Sector specific QA/QC procedures are to be intensified;
- Comparison of emissions using alternative approaches;
- Food and Agriculture Organization of the United Nations (FAO);
- Documentation and archiving of all information required in NIR, background documentation and archive.

5.3.5 RECALCULATIONS AND TIME-SERIES CONSISTENCY

In submission 2021, emissions from the Agriculture sector have been recalculated for the whole time series. The revised estimate are for 3B Manure management, CH_4 and N_2O, and also affects category 3D. The recalculations were made due to a potencial technical correction by TERT during 2020 Review. TERT identified a potential underestimate in CH4 emissions and an overestimate in N2O emissions. This potential underestimate of CH4 emissions and overestimate of N2O emissions arises as a result of the use of the animal waste management system "dry lot" in the estimation of emissions from the animal categories cattle, sheep, swine, poultry and other in this category. The revised estimate was made for cattle and swine. The TERT agreed with the revised estimate provided by Bulgaria.

5.4 ENTERIC FERMENTATION (CRF SECTOR 3A)

Emissions from this key source are result from fermentation in ruminant animals' digestive system (e.g., cattle, sheep, goats). Non – ruminant livestock (horses, mules and asses) and monogastric livestock (swine) produce lower methane emissions. The amount of methane that is released depends on age, weight of the animal, and the quality and quantity of the feed consumed. All domestic animals indicated in 2006 IPCC GL except for llamas and camels are bred in Bulgaria.
In 2019, this source category was responsible for 23% of the total GHG emissions from the agriculture sector.

5.4.1 SOURCE CATEGORY DESCRIPTION

CH4 emissions in CO2-eq. were 1434.83 Gg in the year 2019. Compared to base year a decrease of 72% is observed.
CH_4 emissions from the enteric fermentation of domestic livestock are given in Table 162**.**

Table 162 Greenhouse gas emissions from enteric fermentation 1988–2019.

Year	CH_4 emissions [Gg] per Livestock Category								
	3.A	3.A.1	3.A.1	3.A.1	3.A.4	3.A.2	3.A.4	3.A.4	3.A.3
	Total	Mature Dairy	Mature Non-Dairy	Young	Buffalo	Sheep	Goats	Horses, Mules & asses	Swine
1988	202.85	66.18	12.11	44.71	1.66	64.13	2.17	5.82	6.06
1990	192.18	64.80	11.40	42.10	1.53	58.16	2.17	5.68	6.34
1995	93.19	38.69	3.63	13.39	1.02	24.46	3.68	5.27	3.04
2000	84.55	42.36	2.86	11.85	0.64	15.69	4.47	4.77	1.91
2005	74.79	38.27	3.24	12.99	0.53	11.59	3.32	3.45	1.41
2010	62.66	32.74	3.51	10.13	0.58	9.89	1.79	2.98	1.05
2015	61.42	30.50	6.86	9.71	0.67	9.82	1.42	1.57	0.86
2016	60.87	29.56	8.15	8.88	0.76	9.92	1.29	1.31	0.91
2017	60.50	28.29	8.94	9.20	0.82	9.86	1.24	1.23	0.91
2018	59.14	26.24	9.79	8.73	0.93	9.87	1.32	1.31	0.94
2019	57.39	24.20	10.39	8.47	1.06	9.79	1.25	1.37	0.86
Share 2019	-	42%	18%	15%	2%	17%	2%	2%	2%
Trend 1988–2019	-72%	-63%	-14%	-81%	-36%	-85%	-42%	-76%	-87%

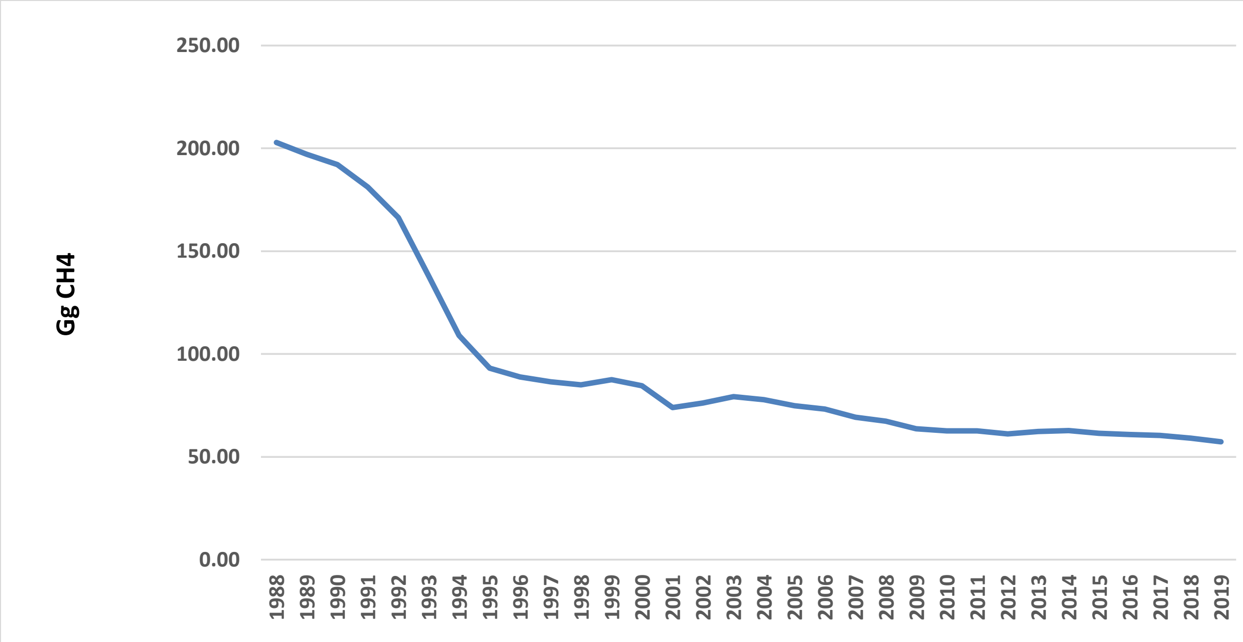


Figure 91 CH_4 emissions from enteric fermentation

Figure 91 shows steady decrease in CH_4 emissions after 2002. The rapid decrease in the period 1991-1995 is consequence of a reform in agricultural holdings during this period. The overall reduction is caused by a decrease in total numbers of animals.

5.4.2 METHODOLOGICAL ISSUES

5.4.2.1 Methods

The IPCC Tier 1 method has been used to estimate the emissions from all farm animal categories with the exception of cattle (IPCC Sub-category 3A1) and sheep (IPCC Sub-category 3A2) for which Tier 2 method is used and option B for cattle.

5.4.2.2 Emission factors

Country specific emission factors are used for cattle and sheep. They are calculated from the specific gross energy intake and the methane conversion rate.

$$\mathbf{EF_i = [GE_i \bullet Ym_i \bullet 365] / 55.65}$$

With *i = each livestock category*
EF_i expressed in kg CH_4/head/year
Y_m Methane conversion rate
Ge =Gross energy intake
The factor 55.65 expressed in MJ/kg of CH_4

➔ See equation 10.21 in the 2006 IPCC GL.
For the Tier 1 method, default GE is usually provided in the 2006 IPCC GL. For the Tier 2 method, GE is the combination of various feed intake – or net energy – estimates relating to maintenance, activity, growth, etc. of the animals.
The methane conversion rate (Y_m) is taken from the 2006 IPCC GL.

Tier 2 method – cattle and sheep

The IEF for cattle and sheep are representing in Table 163.
For **dairy cattle**, the EF has been calculated by combining activity data, coefficients and parameters shown in Table 164. Bulgarian specific values for dairy cows were derived from feed intake data and energy content of food in dependency of annual milk yields.
DE% has been update in submission 2017 with value equal to 71%.

Information have been based on the article "Effect of sunflower expeller supplementation on intake and digestibility of pasture grass with low protein content"[26] published in *Bulgarian Journal of Agricultural Science, 15 (No 2) 2009, 168-176, Agricultural Academy.*

Table 164 Activity data and parameters used for IPCC Sub-category 3A1 – Cattle – Mature Dairy Cattle

Parameter	Unit	Source
Livestock (# of animals)	#	Ministry of Agriculture, Food and Forestry
Live Weight	Kg	Executive Agency for Selection and Reproduction in Animal Breeding (see Table 173)
Calf Birth weight	Kg	Ministry of Agriculture, Food and Forestry
Daily Weight Gain	kg/day	NA
Annual Milk Yield	kg/cow/year	Ministry of Agriculture, Food and Forestry (see . Table 171)
Daily Milk Yield	kg/cow/day	Calculated using division by 365 days/yr
Fat Content of Milk	%	Ministry of Agriculture, Food and Forestry(see . Table 171)
Digestible Energy	%	Country-specific value equal to 71 %;
Net Energy for Maintenance	MJ/day	Eq. 10.3 & Table 10.4 - 2006 IPCC GL
Net Energy for Activity	MJ/day	Eq. 10.5 & Table 10.5 - 2006 IPCC GL
Net Energy for Growth	MJ/day	Eq. 10.6 - 2006 IPCC GL
Net Energy for Lactation	MJ/day	Eq. 10.8 - 2006 IPCC GL
Net Energy for Work	MJ/day	Eq. 10.11 - 2006 IPCC GL
Net Energy for Pregnancy	MJ/day	Eq. 10.13 & Table 10.7 - 2006 IPCC GL
Ratio of Net Energy in a Diet for Maintenance to Digestible Energy Consumed		Eq. 10.14 - 2006 IPCC GL
Ratio of Net Energy Available for Growth in a Diet to Digestible Energy Consumed		Eq. 10.15 - 2006 IPCC GL
Gross Energy Intake (average)	MJ/day	Eq. 10.16 - 2006 IPCC GL
CH4 conversion rate (average)	%	Table 10.12 - 2006 IPCC GL
Implied Emission Factor - CH4	kg CH_4/head/ year	Eq. 10.21 - 2006 IPCC GL

For the **other cattle** categories, IEF's are obtained by combining slightly different parameters which are listed in Table 165.

Table 165 Activity data and parameters used for IPCC Sub-category 3A1 – Cattle – Non-Dairy Cattle

Parameter	Unit	Source
Livestock	#	Ministry of Agriculture,Food and Forestry
Live weight	kg	Executive Agency for Selection and Reproduction in Animal Breeding (see Table 173)
Live body weight	kg	Agrostatistics bulletins
Daily weight gain	kg/day	- mature non-dairy cattle: NA - young cattle: Default
Digestible energy	%	- 60%, Table 10.2 IPCC 2006
Net energy for maintenance	MJ/day	equation 10.3 & table 10.4 – 2006 IPCC GL
Net energy for activity	MJ/day	equation 10.5 & table 10.5 – 2006 IPCC GL
Net energy for growth	MJ/day	equation 10.6 – 2006 IPCC GL
Net energy for lactation	MJ/day	Equation 10.8 – 2006 IPCC GL
Net energy for work	MJ/day	equation 10.11 – 2006 IPCC GL
Net energy for pregnancy	MJ/day	Equation 10.13& table 10.7 – 2006 IPCC GL
Ratio of Net Energy in a Diet for Maintenance to Digestible Energy Consumed	#	equation 10.14 – 2006 IPCC GL

[26] N. A. TODOROV (Thracian University, Faculty of Agriculture, BG-6000 Stara Zagora, Bulgaria) and H. S. ALI (Research Institute of Mountain Stockbreeding and Agriculture, BG-5600 Troyan, Bulgaria)

Parameter	Unit	Source
Ratio of Net Energy Available for Growth in a Diet to Digestible Energy Consumed	#	equation 10.15 – 2006 IPCC GL
Gross Energy Intake (average)	MJ/day	equation 10.16 – 2006 IPCC GL
CH4 Conversion Rate (average)	%	table 10.12 – 2006 IPCC GL

For the **Sheep,** EF has been calculated by combining activity data, coefficients and parameters shown in table below.

For more accurate estimations, sheep have been divided into follow sub-categories:

- Mature sheep for meat or wool production or both;
- Mature sheep for commercial milk production;
- Other (males);
- Young sheep – intact males, castrates & females;

All estimations are based on the equations listed in IPCC 2006 and activity data provided from Ministry of Agriculture, Food and Forestry (please see table below).

Table 166 Activity data and parameters used for IPCC Sub-category 3A2 – Sheep:

Parameter	Unit	Source
Livestock (# of animals)	#	Ministry of Agriculture, Food and Forestry
Live Weight	kg	Ministry of Agriculture, Food and Forestry (see Table 173)
Weight at weaning	kg	Ministry of Agriculture, Food and Forestry
Daily Weight Gain	kg/day	NA
Annual Milk Yield	kg/sheep/year	Ministry of Agriculture, Food and Forestry
Daily Milk Yield	kg/sheep/day	Calculated using division by 365 days/yr
Fat Content of Milk	%	Ministry of Agriculture, Food and Forestry– 6.5 % for the whole time series
Digestible Energy	%	Table 10.2 - 2006 IPCC GL
Net Energy for Maintenance	MJ/day	Eq. 10.3 & Table 10.4 - 2006 IPCC GL
Net Energy for Activity	MJ/day	Eq. 10.5 & Table 10.5 - 2006 IPCC GL
Net Energy for Growth	MJ/day	Eq. 10.7 - 2006 IPCC GL
Net Energy for Lactation	MJ/day	Eq. 10.9 - 2006 IPCC GL
Net Energy for Pregnancy	MJ/day	Eq. 10.13 & Table 10.7 - 2006 IPCC GL
Ratio of Net Energy in a Diet for Maintenance to Digestible Energy Consumed		Eq. 10.14 - 2006 IPCC GL
Ratio of Net Energy Available for Growth in a Diet to Digestible Energy Consumed		Eq. 10.15 - 2006 IPCC GL
Gross Energy Intake (average)	MJ/day	Eq. 10.16 - 2006 IPCC GL
CH4 conversion rate (average)	%	Table 10.13 - 2006 IPCC GL
Implied Emission Factor - CH4	kg CH_4/head/year	Eq. 10.21 - 2006 IPCC GL

Table 167 Enteric fermentation emission factors for cattle and sheep:

	Emission Factor [kg CH_4/head*yr]			
Year	Mature Diary Cattle	Mature Non-Diary Cattle	Young Cattle	Sheep
1988	105.28	78.94	50.72	6.95
1989	104.70	78.94	50.69	6.93
1990	104.67	78.94	50.69	6.95
1991	99.61	78.94	50.69	6.88
1992	97.30	78.94	50.69	6.87
1993	95.26	78.94	50.69	6.88
1994	96.53	78.94	50.69	6.90
1995	100.73	78.94	50.69	6.83
1996	102.92	78.94	50.69	6.85
1997	103.56	78.94	50.69	6.81
1998	106.54	78.94	50.69	6.86
1999	105.10	78.94	50.66	6.86
2000	108.07	78.55	51.77	7.04
2001	104.68	78.25	49.01	7.10
2002	107.38	78.77	49.62	7.04
2003	107.29	78.98	51.04	7.01
2004	107.79	79.14	48.76	6.98
2005	106.83	79.35	52.44	7.03
2006	107.96	79.17	53.21	7.03
2007	104.03	78.69	47.63	7.05
2008	105.73	78.75	51.02	7.14
2009	105.69	79.28	49.85	7.17
2010	108.25	78.64	52.06	7.14
2011	107.64	78.08	52.72	7.09
2012	107.84	78.01	51.72	7.12
2013	109.86	78.04	53.49	7.26
2014	108.06	77.74	52.83	7.36
2015	106.73	77.27	54.85	7.37
2016	108.34	76.95	50.93	7.37
2017	108.11	76.90	53.79	7.37
2018	107.98	76.85	53.62	7.40
2019	107.74	76.73	53.49	7.44

For mature dairy cattle, over the period 1988-2019, the milk yield has increased by 6% (see Table 171). At the same time the dairy cattle population decline. As these two parameters are the main drivers for the calculation of the EF under the Tier 2 method, it is the reason to have slight fluctuations in the EF expressed in CH_4/head/year for mature dairy cattle.
The slight fluctuations in EFs for mature non-dairy cattle are because those are weight average EF between several categories (mature males and females).
The main driver for the calculation of the EF for young cattle is the live-weight, and for them this weight is not constant (see Table 174), so this is the reason for the differences in EF.
The slight fluctuations in EFs for sheep are because those are weight average EF between several categories.

Tier 1 method – all farm animal categories except cattle and sheep

For farm animals, other than cattle and sheep, the IEFs are the default enteric fermentation EFs for developed countries represent in following tables.

Table 168 Activity data, coefficients and parameters used for goats, horses, mules and asses, swine:

Parameter name	Unit	Parameter source
Livestock	#	-Ministry of Agriculture, Food and Forestry–Agrostatistics department -Bulgarian Foodsafety Agency, Animal Health and Welfare Directorate

Live Weight	kg	- Ministry of Agriculture, Food and Forestry–Agrostatistics department (see Table 173) - Executive Agency for Selection and Reproduction in Animal Breeding

Table 169 Enteric fermentation emission factors for farm animals, other than cattle and sheep (buffalo, goats, horses, mules and asses, swine):

Livestock category	Emission factor [kg CH_4 $HEAD^{-1}$ YR^{-1}]	Reference
Buffalo	66*	Table 10.10 - 2006 IPCC GL
Goats	5	Table 10.10 - 2006 IPCC GL
Horses	18	Table 10.10 - 2006 IPCC GL
Mules and Asses	10	Table 10.10 -2006 IPCC GL
Swine	1.5	Table 10.10 - 2006 IPCC GL

*Emission factor for buffalo have been recalculated, according TERT recommendation (BG NIR 2017) - The ERT recommended Bulgaria scale the EF used for estimating CH4 emissions from Enteric fermentation for buffalo following the recommendations in the 2006 IPCC guidelines by multiplying the default EF factor of reference by $(380/300)^{0.75}$ in accordance with table 10.10 of the 2006 IPCC Guidelines (Volume 4, Chapter 10.3.2 (p.10.28)

5.4.2.3 Activity data

5.4.2.3.1 Livestock populations

Table 170 Domestic livestock populations 1988–2019(1000 number) (I).

	Dairy cattle	Non-dairy cattle-females	Non-dairy cattle - bulls	Young cattle - <1yr	Young cattle 1-2yrs	Goats	Buffalo
1988	628.64	134.37	18.97	688.06	193.45	434.78	25.31
1989	628.78	130.11	18.37	666.28	187.32	431.98	23.89
1990	619.14	126.59	17.87	648.25	182.25	434.28	23.27
1991	601.25	118.77	16.77	608.21	171.00	465.51	24.28
1992	585.30	103.66	14.64	530.84	149.24	525.41	25.34
1993	530.33	79.43	11.21	406.75	114.36	581.98	23.64
1994	452.79	53.14	7.50	272.12	76.51	643.83	19.68
1995	384.11	40.28	5.69	206.25	57.99	735.93	15.46
1996	359.52	35.77	5.05	183.15	51.49	814.38	13.69
1997	363.21	31.64	4.47	162.03	45.55	841.03	12.57
1998	371.85	29.22	4.13	149.63	42.07	907.43	11.00
1999	404.24	30.81	4.35	157.78	44.36	1006.86	10.46
2000	392.02	32.40	3.97	183.50	45.42	893.82	9.67
2001	360.63	30.01	3.27	206.41	38.52	707.66	7.76
2002	358.41	35.22	4.68	219.26	45.26	714.88	7.01
2003	360.01	42.72	6.11	237.08	63.86	739.89	7.68
2004	365.28	38.76	5.83	224.58	65.50	721.71	7.92
2005	358.24	35.15	5.66	190.67	56.97	663.27	8.09
2006	348.95	35.81	5.44	180.61	54.23	578.75	8.22
2007	343.02	38.12	4.91	174.20	54.91	522.28	8.61
2008	325.28	39.32	5.18	160.90	52.80	462.66	9.10
2009	305.71	38.56	6.07	148.90	52.99	395.33	8.77
2010	302.46	39.58	5.02	141.36	53.22	358.58	8.78
2011	307.50	44.42	4.49	139.75	54.88	348.85	9.56
2012	297.80	48.96	4.82	129.78	60.52	317.50	9.55
2013	297.92	51.59	5.13	133.91	62.29	291.47	9.59
2014	301.24	60.68	5.24	133.53	63.51	290.98	9.76
2015	285.77	83.21	5.51	113.18	63.83	284.78	10.20
2016	273.74	100.54	5.36	112.42	61.97	257.23	11.56
2017	261.69	110.59	5.66	112.55	58.56	247.26	12.54

	Dairy cattle	Non-dairy cattle-females	Non-dairy cattle - bulls	Young cattle - <1yr	Young cattle 1-2yrs	Goats	Buffalo
2018	243.06	121.47	5.97	106.51	56.30	264.35	14.22
2019	224.64	129.67	5.78	101.24	57.15	250.11	16.18

Domestic livestock populations 1988–2019 (1000 number) (II).

	Mature sheep			Young sheep	Horses	Swine	Mules & Asses	Poultry	
	For meat or wool production or both	commercial milk production	Other (males)	Intact males, castrates & Females				Chicken (1)	ducks, geese, etc.(2)
1988	590.22	6 838.09	217.21	1 579.05	122.13	4 042.18	362.20	35 856.16	4 723.47
1989	559.69	6 484.38	205.97	1 497.37	122.41	4 076.47	355.27	36 770.38	4 843.90
1990	535.52	6 204.34	197.08	1 432.71	120.45	4 225.23	351.51	34 523.50	4 547.91
1991	514.06	5 955.66	189.18	1 375.28	117.16	4 259.10	349.19	28 423.85	3 744.38
1992	468.41	5 426.78	172.38	1 253.15	114.85	3 663.99	347.42	21 959.95	2 892.87
1993	368.47	4 268.97	135.60	985.79	113.99	2 910.56	335.32	18 369.90	2 419.94
1994	274.41	3 179.21	100.99	734.14	113.44	2 375.53	322.03	16 825.50	2 216.49
1995	229.09	2 654.12	84.31	612.89	123.11	2 028.76	305.86	16 495.86	2 173.06
1996	216.93	2 513.21	79.83	580.35	141.78	2 063.10	294.69	16 671.62	2 196.22
1997	204.83	2 373.11	75.38	548.00	160.50	1 820.23	301.10	15 390.86	2 027.50
1998	187.70	2 174.62	69.08	502.16	148.34	1 490.09	273.06	13 692.69	1 803.79
1999	179.04	2 074.24	65.89	478.98	129.79	1 600.62	239.41	13 453.35	1 772.26
2000	142.63	1 652.50	52.49	381.60	137.20	1 276.43	230.12	13 540.63	1 783.76
2001	106.45	1 233.33	36.37	264.40	140.67	809.90	216.38	13 233.72	1 743.33
2002	106.54	1 234.38	37.36	271.60	145.50	892.46	185.77	14 636.46	1 928.12
2003	105.59	1 223.32	42.21	292.34	142.85	1 014.39	151.50	17 673.16	1 849.54
2004	104.48	1 210.50	39.47	291.08	130.66	981.85	130.75	18 239.40	1 970.25
2005	99.63	1 233.17	36.14	278.44	130.66	937.20	110.00	17 182.20	2 331.35
2006	97.55	1 207.74	36.87	276.68	141.50	977.82	94.00	17 582.00	2 254.00
2007	106.91	1 157.90	36.48	279.61	151.50	950.63	83.00	17 192.50	2 235.00
2008	102.40	1 113.38	35.54	249.31	161.64	836.13	71.90	16 095.50	2 028.00
2009	79.07	1 087.72	33.64	237.11	171.68	756.72	60.90	15 883.50	1 591.50
2010	72.49	1 041.76	27.20	242.67	134.39	696.90	56.52	15 032.50	1 635.00
2011	78.62	1 054.48	27.19	251.01	87.17	636.13	54.19	13 606.00	1 688.50
2012	80.94	1 048.25	30.61	248.28	79.94	569.61	50.51	13 493.00	1 464.50
2013	87.48	1 031.56	30.59	215.93	77.52	558.68	48.44	12 751.50	1 485.50
2014	84.63	1 046.34	31.76	189.69	75.74	569.77	45.05	12 318.00	1 593.50
2015	86.21	1 026.82	32.39	188.18	67.78	576.59	35.33	13 614.00	1 490.50
2016	97.55	1 025.39	31.79	191.26	58.62	608.25	25.53	13 353.00	1 297.00
2017	103.49	1 009.15	32.29	193.51	60.70	604.79	13.89	12 656.00	1 572.00
2018	117.91	990.23	33.92	191.35	62.52	623.85	18.89	13 368.00	1 770.00
2019	128.06	969.20	32.62	185.63	61.55	573.18	25.82	13 807.00	1 735.00

Data is collected from the Agricultural Statistics Department of the Ministry of Agriculture, Food and Forestry, Bulgarian Food Safety Agency, FAO Database and National Statistics Institutes' yearbooks 1990-2000.
The FAO agricultural data base (FAOSTAT) provides worldwide harmonized data. In the case of Bulgaria, this data comes from the national statistical system. FAOSTAT data are seemingly based on the official data but there is an annual attribution error (according FAO's requirements numbers of animal should be presented from 1 October to 30 September. In Bulgaria agriculture statistics is collected by 1 November, so the official data from the year before are the data for the present year in FAO).
For the period 1988-2000 the main data source is National statistics Institute's yearbooks.

For the period 2000-present there is agreement with the Agrostatistics Department at the Ministry of Agriculture, Food and Forestry (MAFF), to provide activity data for the preparation of the NGHGI, and this is the official source of agricultural statistics.
MAFF collect agricultural statistics in Bulgaria with surveys. There are large legal basis with Regulations and Ordinances which determinate the methods and conduct of statistical surveys.
The livestock statistics is based on Regulation (EC) No 1165/2008 of the European Parliament and of the Council concerning livestock and meat statistics and repealing Council Directives 93/23/EEC, 93/24/EEC and 93/25/EEC.
According to the Statistical National program, the results of the statistical surveys, carried out by the Agrostatistics Department, are published on the website of the MAFF.
Every year there are agrostatistics bulletins with information on livestock (number of agricultural animals, milk production, meat production, live weight) and crops productions.
(see http://www.mzh.government.bg/MZH/bg/ShortLinks/SelskaPolitika/Agrostatistics.aspx).
According Ordinance on the terms and procedure for organizing the national inventories of emissions of harmful substances and greenhouse gases into the ambient air, there is an agreement with the Bulgarian Food Safety Agency, which presented information on numbers of horses, mules and asses after 2010 year to present. Before 2010, activity data are provided as follow – 1988 - 2001: National statistics Institute's yearbooks; 2002 - 2009: FAO data base.

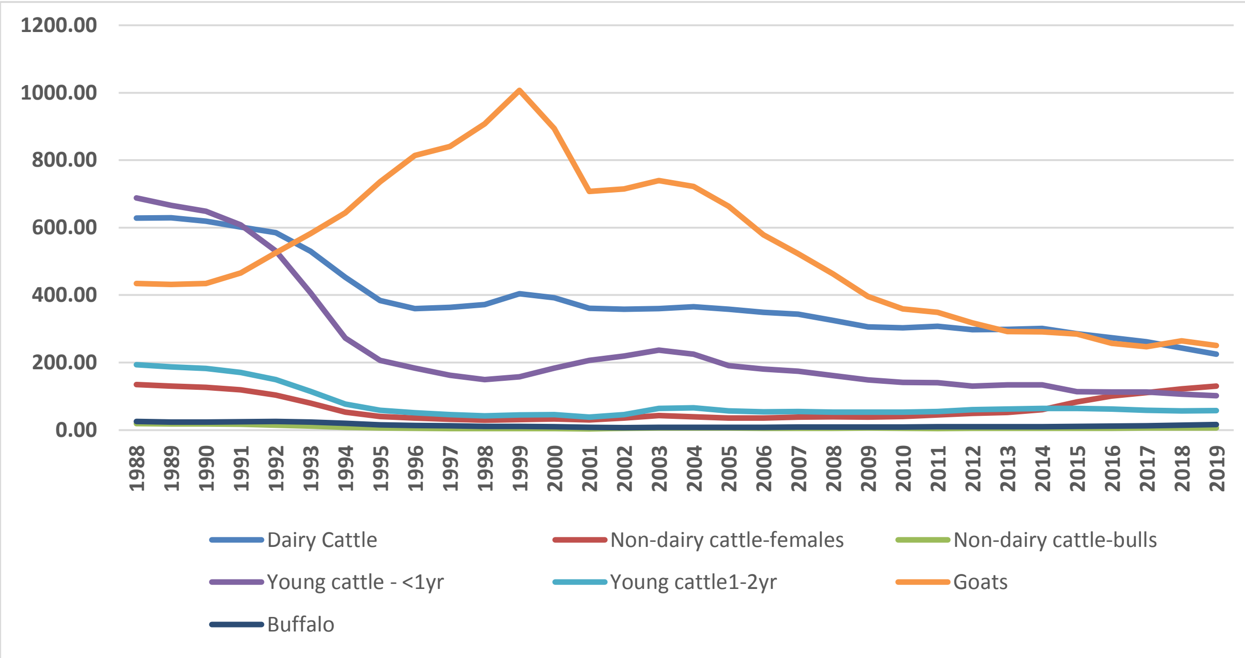


Figure 92 Domestic livestock populations (I)

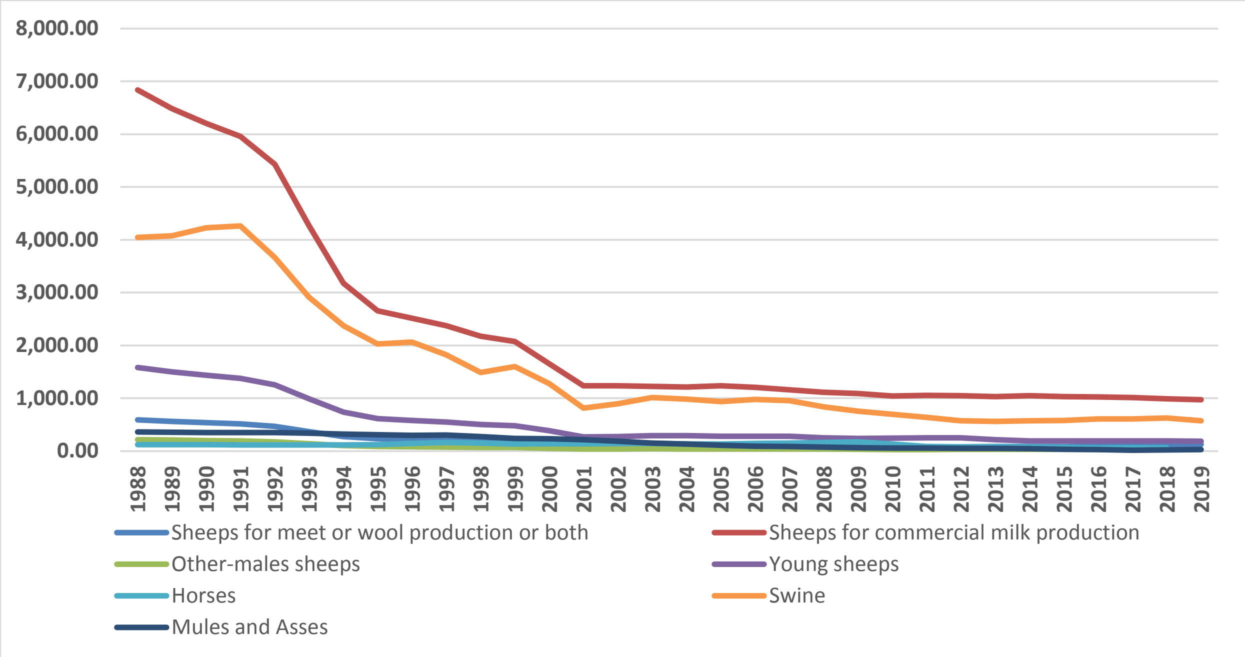


Figure 93 Domestic livestock populations (II)

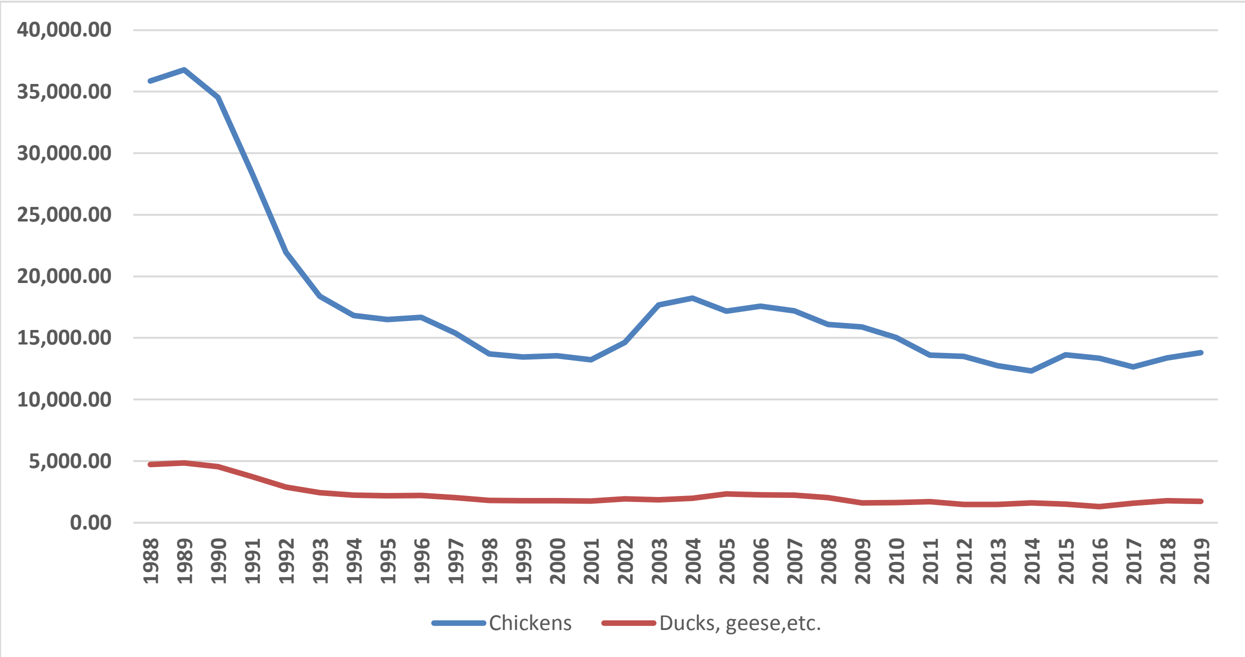


Figure 94 Domestic livestock populations (III)

(1) broiler and layer chickens, roosters, chicks
(2) ducks, geese, turkeys, guinea-fowls, wild poultry

The rapid decline in cattle, swine and sheep numbers in the period 1992-1994 is due to reforms in agricultural holdings.The main reasons for the declining GHG emission trend in Bulgaria are the structural economic changes due to the radical transition process from a centrally-planned economy to a market-based economy.

5.4.2.3.2 Milk yield and fat content

The milk yield is obtained by dividing the milk production by the number of dairy cows. It is measured in kg per head. The Agrostatistics department at the Ministry of Agriculture, Food and Forestry calculates the milk production by adding up the amount of milk collected by the dairy industry directly from the farmers. All milk production is considered.
Over the period 2000-2015, the milk yield has decreased by 3 %. This is the reason for the slight fluctuations in Gross energy intake expressed in MJ/head/day.

The fat content of milk for 2019 is 3,68 %. Data on the fat content of milk is available in EUROSTAT.

Table 171 Milk yield, gross energy intake for dairy cattle: 1988 – 2019:

Year	Milk Yield	Gross Energy Intake
	[kg/cow*yr]	[MJ/head*day]
1988	4127.43	246.94
1990	4060.55	245.51
1995	3626.27	236.27
2000	4435.56	253.48
2005	4299.03	250.58
2010	4448.66	253.90
2015	4305.16	250.35
2016	4452.84	254.12
2017	4427.48	253.58
2018	4425.25	253.28
2019	4380.69	252.71

Source: Ministry of Agriculture and Food, Agrostatistics Department

For the sheep, milk yield is obtained by dividing the milk production by the number of mature sheep. It is measured in kg per head. Data is provided by the Agrostatistics department at the Ministry of Agriculture, Food and Forestry. MAFF provided the data on the fat content. It's constant over the time – 6,5 %.

Table 172 Milk yield, gross energy intake for sheep: 1988 – 2019

Year	Milk Yield	Gross Energy Intake
	[kg/sheep*yr]	[MJ/head*day]
1988	80.82	16.64
1990	80.82	16.63
1995	80.82	16.36
2000	80.82	16.84
2005	85.19	16.82
2010	81.59	17.09
2015	72.38	17.55
2016	77.71	17.56
2017	68.75	17.56
2018	72.24	17.64
2019	69.10	17.72

5.4.2.3.3 Live weight

Live-weight for most animal categories has been provided by the Agrostatistics department of Ministry of Agriculture, Food and Forestry. These data are not published as such and, therefore, might be considered as expert judgments. However, they rely on measurements and are not purely speculative. These weights are constant over time and are provided in Table 173. For buffalo, goats, horses and mules and asses the live-weight is default from Table 10A-6 and Table 10A-9 - 2006 IPCC GL.

Table 173 Live-weight for farm animals reported in the inventory

Livestock category	Live-weight in kg used for estimating enteric fermentation emissions
Cattle – Mature Dairy Cattle	588
Cattle – Mature Non-Dairy Cattle – Females	613
Cattle – Mature Non-Dairy Cattle – Males	880
Cattle – Young Cattle – Calves	199
Cattle – Young Cattle – Growing Heifers	390
Sheep-Mature ewes where either meat or wool production or both is the primary	61.00

Livestock category	Live-weight in kg used for estimating enteric fermentation emissions	
purpose		
Sheep-Mature ewes where commercial milk production is the primary purpose	45.20	
Mature Sheep-Other(males)	65.00	
Young sheep - Intact males, castrates & Females	Slaughter body weight	16,00
	Weight at weaning	12.90
Swine	104.00	
Poultry – Chickens	2.10	
Other – Other Poultry	4.48	
Buffalo	380.00	
Goats	38.50	
Horses	377.00	
Mules and asses	130.00	

Source: Ministry of agriculture and Food, Agrostatistics department

Live-weight for young cattle is not constant over the time. The live-weight for calves and growing heifers has been provided by the Agrostatistics department of Ministry of Agriculture, Food and Forestry(see Table 174). Due to lack of data, for the period 1988 – 1999 average value have been used.

Table 174 Live-weight for young cattle 1988 – 2019:

Year	Live-weight Cattle – Young Cattle – Calves	Live-weight Cattle – Young Cattle – Growing Heifers
1988	200.38	369.06
1990	200.38	368.07
1995	200.38	368.07
2000	211.30	361.05
2005	209.75	379.45
2010	200.60	385.15
2015	211.00	389.55
2016	187.68	363.43
2017	207.15	381.55
2018	204.20	384.35
2019	206.55	370.40

5.4.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty from methane emissions from this source is 50%.

Table 175 Uncertainty of sub-sector Enteric Fermentation for 2019, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
3.A.1	Cattle	CH_4	0.64	20	20
3.A.4	Buffalo	CH_4	0.64	50	50
3.A.2	Sheep	CH_4	1.63	20	20
3.A.4	Goats	CH_4	1.65	50	50
3.A.4	Horses	CH_4	2	50	50
3.A.4	Mules and Asses	CH_4	2	50	50
3.A.3	Swine	CH_4	0.51	50	50
3.A.4	Poultry	CH_4	2	50	50

Emission factor's uncertainty is default ones from 2006 IPCC GL.

AD uncertainties have been provided by MAFF.
AD uncertainty is based on the official statistical data in the country. It's country specific and it's based on the Regulation (EC) No 1165/2008 of the European Parliament and of the Council concerning livestock and meat statistics and repealing Council Directives 93/23/EEC, 93/24/EEC and 93/25/EEC. Statistical samples are representative of level 6 statistical areas (NUTS2).

5.4.4 SOURCE-SPECIFIC QA/QC AND VERIFICATION

All activities regarding QC as described in QA/QC System have been undertaken.
Data were checked for transcription errors between input data and calculation sheets. Calculations were examined focusing on units/scale and formulas.

Activity data check

The inventory compiler reviews livestock data collection methods, in particular checking that livestock subspecies data were collected and aggregated correctly. The data is cross-checked with previous years to ensure the data are reasonable and consistent with the expected trend. Inventory compilers documents data collection methods, identifies potential areas of bias, and evaluate the representativeness of the data.

Review of emission factors

- Cross-check country-specific factors against the IPCC defaults;
- Sector specific QA/QC procedures are intensified according to QMS;
- Comparison of emissions using alternative approaches (Tier 1 method);
- Compared national statistics activity data with data from Food and Agriculture Organization of the United Nations (FAO);
- Documentation and archiving of all information required in NIR, national statistic of agriculture and food provided by MAFF, background documentation and archive.

5.4.5 SOURCE-SPECIFIC RECALCULATIONS

The recalculation have been made for 2018 due to technical mistake in activity data for live-weight for young cattle.

5.4.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements for this category.

5.5 MANURE MANAGEMENT (CRF sector 3B)

The section describes the estimation of methane and nitrous oxide emissions produced during the storage and treatment of manure, and from manure deposited on pasture (CH_4), and treatment of manure before it is applied to land (N_2O). In accordance with the IPCC guidelines, the term "manure" is used here collectively to include both dung and urine produced by livestock.
In 2019, this source category was responsible for 10% of the total GHG emissions from the agriculture sector.

5.5.1 SOURCE CATEGORY DESCRIPTION

CH_4 and N_2O emissions from manure management are given in Table 176 and Table 177

Table 176 CH4 emissions from Manure management 1988 –2019, Gg

CH_4 emissions from manure management [Gg]										
Livestock categories										
Year	3.B.1* Total	3.B.1.1 Dairy	3.B.1.1 Non Dairy	3.B.1.1 Young	3.B.1.4 Buffalo	3.B.1.2 Sheep	3.B.1.4 Goats	3.B.1.4 Horses, Mules and asses	3.B.1.3 Swine	3.B.1.4 Poultry
1988	43.36	10.45	1.81	6.67	0.13	1.87	0.06	0.47	20.80	1.11
1990	43.32	10.23	1.70	6.28	0.12	1.70	0.06	0.46	21.74	1.04
1995	17.54	5.42	0.48	1.77	0.08	0.71	0.10	0.42	7.93	0.57
2000	10.10	4.68	0.30	1.24	0.05	0.46	0.12	0.39	2.35	0.43
2005	12.26	5.74	0.46	1.84	0.04	0.34	0.09	0.29	2.92	0.50
2010	12.39	5.93	0.60	1.73	0.04	0.29	0.05	0.25	3.08	0.40
2015	12.99	6.34	1.35	1.91	0.05	0.29	0.04	0.13	2.54	0.34
2016	13.04	6.15	1.60	1.74	0.06	0.29	0.03	0.11	2.72	0.33
2017	12.96	5.88	1.76	1.81	0.06	0.29	0.03	0.11	2.69	0.33
2018	12.69	5.46	1.92	1.71	0.07	0.29	0.03	0.11	2.74	0.35
2019	12.14	5.03	2.04	1.66	0.08	0.28	0.03	0.12	2.53	0.35
Share 2019		**41.47%**	**16.82%**	**13.71%**	**0.67%**	**2.34%**	**0.27%**	**0.95%**	**20.85%**	**2.92%**
Trend 1988–2019	**-72.01%**	**-51.84 %-**	**13.08%**	**-75.06%**	**-36.09 %**	**-84.81%**	**-42.47%**	**-75.17%**	**-87.83%**	**-68.10%**

Code 3.B.1 indicates **CH_4 from Manure management*

Table 177 N_2O emissions from Manure management 1988 –2019, Gg

Year	N_2O emissions from manure management (without indirect emissions) [Gg]									
	Livestock categories									
	3.B.2* Total	3.B.2.1 Dairy	3.B.2.1 Non Dairy	3.B.2.1 Young	3.B.2.4 Buffalo	3.B.2.2 Sheep	3.B.2.4 Goats	3.B.2.4 Horses, Mules & Asses	3.B.2.3 Swine	3.B.2.4 Poultry
1988	1.82	0.39	0.06	0.29	0.00	0.36	0.02	0.03	0.03	0.63
1990	1.75	0.38	0.06	0.27	0.00	0.32	0.02	0.03	0.03	0.62
1995	0.88	0.23	0.02	0.08	0.00	0.14	0.04	0.03	0.06	0.27
2000	0.80	0.22	0.01	0.07	0.00	0.09	0.05	0.03	0.09	0.23
2005	0.80	0.23	0.02	0.08	0.00	0.06	0.04	0.02	0.04	0.31
2010	0.65	0.19	0.02	0.07	0.00	0.05	0.02	0.02	0.01	0.26
2015	0.62	0.19	0.04	0.06	0.00	0.05	0.02	0.01	0.00	0.24
2016	0.61	0.18	0.05	0.06	0.00	0.05	0.01	0.01	0.00	0.23
2017	0.59	0.17	0.05	0.06	0.00	0.05	0.01	0.01	0.00	0.22
2018	0.60	0.16	0.06	0.06	0.00	0.05	0.01	0.01	0.00	0.24
2019	0.60	0.15	0.06	0.06	0.00	0.05	0.01	0.01	0.00	0.25
Share 2019		**24.95%**	**10.05%**	**9.64%**	**0.32%**	**8.66%**	**2.37%**	**1.53%**	**0.73%**	**41.75%**

Year	N_2O emissions from manure management (without indirect emissions) [Gg]									
	Livestock categories									
	3.B.2* Total	3.B.2.1 Dairy	3.B.2.1 Non Dairy	3.B.2.1 Young	3.B.2.4 Buffalo	3.B.2.2 Sheep	3.B.2.4 Goats	3.B.2.4 Horses, Mules & Asses	3.B.2.3 Swine	3.B.2.4 Poultry
Trend 1988–2019	-67.19%	-61.60%	-5.08%	-80.10%	-36.09%	-85.46%	-42.47%	-71.48%	-86.28%	-60.57%

Code 3.B.2 indicates **N_2O from Manure management*

5.5.2 METHODOLOGICAL ISSUES

5.5.2.1 CH_4 emissions from manure management

Animal numbers are the same as the ones used for calculating emissions from enteric fermentation. Pigs are divided into sub-categories in order to estimate more accurately the nitrogen excretion. Division of pigs is presented in Table 184.
Buffalos, goats, horses, mules, asses are of minor importance in Bulgaria, therefore the CH_4 emissions of these livestock categories are estimated with the Tier 1 approach with default EFs from the 2006 IPCC GL.
The 2006 IPCC GL Tier 2 methodology has been applied to estimate CH_4 emissions from manure management of cattle and swine as these are key sources. This method requires detailed information on animal characteristics and the manner in which manure is managed.
Emissions from sheep and poultry also have been calculated with Tier 2 method.
The following formula has been used (2006 IPCC GL, Equation 10.23):

$$EF_i = VS_i * 365\ [days\ yr^{-1}] * B_{0i} * 0.67\ [kg\ m^{-3}] * \Sigma_{jK}\ MCF_{jK} * MS\%_{ijK}$$

EF_i = annual emission factor (kg) for animal type i (e.g. dairy cows)
VS_i = Average daily volatile solids excreted (kg) for animal type i
B_{0i} = maximum methane producing capacity (m³ per kg of VS) for manure produced by animal type I
MCF_{jK} = methane conversion factors for each manure management system j by climate region K
$MS\%_{ijK}$ = fraction of animal type i`s manure handled using manure systems j in climate region K

Average daily volatile solids excreted **(VS)** is estimate by using equation 10.24 in 2006 IPCC GL. The estimations are based on digestibility of the feed, gross energy intake and the ash content of manure.

$$\boldsymbol{VS} = [\boldsymbol{GE} * (\mathbf{1} - \frac{\boldsymbol{DE}\%}{\mathbf{100}}) + (\boldsymbol{UE} * \boldsymbol{GE})] * [(\frac{\mathbf{1} - \boldsymbol{ASH}}{\mathbf{18.45}})]$$

VS = volatile solid excretion per day on a dry-organic matter basis, kg VS day-1
GE = gross energy intake, MJ day-1(see Table 14)
DE% = digestibility of the feed in present (based on Guidelines IPCC 2006)
(UE•GE) = urinary energy expressed as fraction of GE (0.04GE for ruminants and 0.02GE for swine).
ASH = the ash content of manure calculated as a fraction of the dry matter feed intake
18.45 = conversion factor for dietary GE per kg of dry matter (MJ kg-1)

The values of VS for **cattle** have been determinate from country-specific gross energy intake. Values for DE% and GE are the same as used in Enteric fermentation. Values for UE (0,04) and ASH (8%) are according 2006 IPCC GL.

2006 IPCC GL presented default values for VS for breeding and market **swine** (normally 90% of the pig population is market swine and 10% - breeding). An average default value is 0,32 kg VS kg dry matter/head/day. Bulgaria used country-specific value of 0,23 kg dry matter/head/day. In order to estimate more accurately VS, swine were divided into sub-categories (seeTable 184), not only on breeding and market pigs. For each sub-category were determined different country-specific values for the DE% and GE. Data were provided from scientific studies published in Global Journal of Science Frontier Research (volume 14, issue 5).

The ASH contain (ASH = 12,21%) is provided from the same scientific studies. Data about pig excrements, are based on own studies and represent the average values of 6 samples of different origin – pig-fattening farms. Pig dung (without urine) – taken by Ampulla recti for pigs – 110 kg from slaughter-houses – pure (without being in contact with the floor).

Value for UE (0.02) is default from 2006 IPCC GL.

The values of VS (0,35 kg-dm/head/day compared with the default 0,40 kg-dm/head/day in 2006 IPCC GL) for **sheep** have been determinate from country-specific gross energy intake. Values for DE% and GE are the same as used in Enteric fermentation. Values for UE (0,04) and ASH (8%) are according 2006 IPCC GL. Sheep have been divided into sub-categories listed above (chapter Enteric fermentation).

Implied emission factor for **poultry** is weighted average between several categories – layers, broilers, turkeys, and ducks. Values of B_o and VS have been taken from Table 10A-9. AWMS distribution have been calculated as 50% dry lot and 50% solid storage.

Maximum methane producing capacity (**B_0**) values are from 2006 IPCC GL for all farm animals (Table 10A-4 to Table 10A-9).

Methane conversation factors (**MCF**) are default 2006 IPCC GL presented in Table 178, and are based on cool allocation by climate.

Table 178 Methane conversion factors

AWMS	Allocation by climate	MCF
Liquid system	Cool	20%
Solid storage	Cool	2%
Dry lot	Cool	1%
Other	Cool	1%

A survey conducted with the Agricultural University of Plovdiv, provided data about the **distribution of AWMS** for cattle, swine and sheep.

The survey provided data for 5 pillar years – 1995, 2000, 2005, 2010 and 2015. Bulgaria have been recalculated the data between the period 2010 – 2015 year due to new data from the agriculture statistics for year 2015. This data as well as interpolated data is provided in Table 179.

A survey was based on following components:

- Identification of the number of animals per species and categories;
- Determining the quantity fresh manure and nitrogen in animal categories;
- Determining the nitrogen emitted into different parts of the ecosystem.

The data collection methodology is based on the methodologies used by EUROSTAT since the raw data is collected by the Agrostatistics department at the Ministry of Agriculture, Food and Forestry (MAFF). On every 5 years there is a complete survey on all farms.

Finally all of these determinations were used to calculate the animal waste management systems distribution data.

In Bulgaria all farms with more than 50 sows, store the manure in liquid systems, all farms with 10-50 sows store the manure in dry lot and for all farms with up to 10 sows (small private farms) is accepted (conditionally) that manure is collect in solid storage.

The AWMS variation in the period 1988 – 2019 provided in Table 179 shows that 90% of manure is tread in liquid systems for swine, decreasing to 27% in 2000 and increasing back to 83% in 2011.

Reasons for these variations are reforms in agricultural holdings. In the period 1993 – 2000 the agriculture sector is in a crisis. Most of the farms are small and this is the reason for higher per cent for solid storage and dry lot management system in this years.

After 2005 there is stabilization in the sector and the farms with more than 50 sows increase.

Table 179 AWMS distribution for cattle, swine, and sheep:

	Cattle	Swine	Sheep

	Solid storage	Liquid systems	Pasture range paddock	Liquid systems	Solid storage	Dry lot	Solid storage	Pasture range paddock
1988	33.54%	46.96%	19.50%	92.00%	8.00%	0.00%	35%	65%
1989	33.54%	46.96%	19.50%	92.00%	8.00%	0.00%	35%	65%
1990	33.54%	46.96%	19.50%	92.00%	8.00%	0.00%	35%	65%
1991	33.54%	46.96%	19.50%	92.00%	8.00%	0.00%	35%	65%
1992	33.54%	46.96%	19.50%	92.00%	8.00%	0.00%	35%	65%
1993	35.20%	44.60%	20.20%	84.00%	16.00%	0.00%	35%	65%
1994	36.70%	42.30%	21.00%	75.70%	24.30%	0.00%	35%	65%
1995	38.40%	40.00%	21.60%	67.80%	32.20%	0.00%	35%	65%
1996	40.00%	37.70%	22.30%	59.70%	40.30%	0.00%	35%	65%
1997	41.60%	35.40%	23.00%	51.60%	48.40%	0.00%	35%	65%
1998	43.20%	33.10%	23.70%	43.50%	56.50%	0.00%	35%	65%
1999	44.80%	30.70%	24.50%	35.40%	64.60%	0.00%	35%	65%
2000	46.40%	28.40%	25.20%	27.35%	72.65%	0.00%	35%	65%
2001	45.00%	31.50%	23.50%	32.60%	67.40%	0.00%	35%	65%
2002	43.60%	34.30%	22.10%	37.90%	62.10%	0.00%	35%	65%
2003	42.20%	37.50%	20.30%	43.20%	56.80%	0.00%	35%	65%
2004	40.70%	40.60%	18.70%	48.40%	51.60%	0.00%	35%	65%
2005	39.30%	43.60%	17.10%	53.60%	46.40%	0.00%	35%	65%
2006	36.80%	46.10%	17.10%	58.70%	41.30%	0.00%	35%	65%
2007	34.30%	48.70%	17.00%	63.60%	36.40%	0.00%	35%	65%
2008	32.80%	51.10%	16.10%	68.60%	31.40%	0.00%	35%	65%
2009	29.20%	53.70%	17.10%	73.50%	26.50%	0.00%	35%	65%
2010	26.70%	56.10%	17.20%	78.60%	21.40%	0.00%	35%	65%
2011	25.40%	58.10%	16.50%	81.23%	18.77%	0.00%	35%	65%
2012	24.00%	60.30%	15.70%	83.86%	16.14%	0.00%	35%	65%
2013	22.70%	62.30%	15.00%	86.48%	13.52%	0.00%	35%	65%
2014	21.30%	64.40%	14.30%	89.11%	10.89%	0.00%	35%	65%
2015	20.00%	66.50%	13.50%	91.74%	8.26%	0.00%	35%	65%
2016	20.00%	66.50%	13.50%	91.74%	8.26%	0.00%	35%	65%
2017	20.00%	66.50%	13.50%	91.74%	8.26%	0.00%	35%	65%
2018	20.00%	66.50%	13.50%	91.74%	8.26%	0.00%	35%	65%
2019	20.00%	66.50%	13.50%	91.74%	8.26%	0.00%	35%	65%

5.5.2.2 Direct N_2O emissions from manure management

Following the guidelines, all emissions of N_2O taking place before the manure is applied to soils are reported under manure management.

For the estimation of N_2O emissions from manure management systems a Tier 1 approach have been used for farm animal other than cattle, swine and poultry.

The 2006 IPCC GL method for estimating N_2O emissions from manure management entails multiplying the total amount of N excretion (from all animal species/categories) in each type of manure management system by an emission factor for that type of manure management system. Emissions are then summed over all manure management systems (see formulas below).

<u>N excretion per animal waste management system:</u>

$$\mathbf{Nex_{(AWMS)} = \sum_{(T)}[N_{(T)} \times Nex_{(T)} \times AWMS_{(T)}]}$$

$Nex_{(AWMS)}$ = *N excretion per animal waste management system [kg yr^{-1}]*
$N_{(T)}$ = *number of animals of type T in the country*
$Nex_{(T)}$ = *N excretion of animals of type T in the country [kg N $animal^{-1}$ yr^{-1}]*

$AWMS_{(T)}$ = fraction of $Nex_{(T)}$ that is managed in one of the different distinguished animal waste management systems for animals of type T in the country
T = type of animal category

N$_2$O emission per animal waste management system:

$$N_2O_{(AWMS)} = \sum[Nex_{(AWMS)} \times EF_{3(AWMS)}]$$

$N_2O_{(AWMS)}$ = N_2O emissions from all animal waste management systems in the country [kg N yr^{-1}]
$Nex_{(AWMS)}$ = N excretion per animal waste management system [kg yr^{-1}]
$EF_{3(AWMS)}$ = N_2O emissions factor for an AWMS [kg N_2O-N per kg of Nex in AWMS

AWMS

The animal waste management systems distribution data applied to estimate N_2O emissions from Manure Management is the same as used for the estimation of CH_4 emissions from Manure Management (see Table 179).

5.5.2.2.1 Nitrogen excretion

Bulgaria used country-specific data for nitrogen excretion from cattle, swine and poultry. Calculations have been made by combining activity data for the feeding situation of these farm animals. The main drivers for the estimations are the daily protein intake by cattle and average protein content in swine feed, amount of nitrogen in protein content, undigested N provided by the experts from the Agricultural University of Plovdiv and Trakia University of Stara Zagora.

- **Cattle:**

In submission 2019 the Nex values for cattle have been recalculated due to implementation of new activity data on the feeding characteristics of cattle. New data have been provided by project prepared by prof. Lazar Kozelov from Institute of animal science (http://www.ias.bg/english/index_en.html). The values are calculated based on the animal's food intake.
The equation used is:

Daily N intake x amount of non-digested N(%) x 365 = Annual Nex

The daily N intake for the different cattle categories is as follows:

Table 180 Amount of nitrogen per day in cattle food

Animal type	Amount of N per day(g)
Mature dairy cattle	334
Mature non-dairy cattle	192
Fattening claves under 1 year	146
Other calves under 1 year	146
Bovine 1-2 years	164
Heifers	183

The value for the fraction of N which is retained by the animals is taken from table 10.20 from the 2006 IPCC GL and is assumed the rest is excreted.

Table 181 Activity data for estimating nitrogen excretion from cattle

	Mature dairy cattle		Mature non-dairy cattle		Young cattle under 1 year		Bovine and heifers 1-2years	
	Population size	Daily N excretion (g)	Population size	Daily N excretion (g)	Population size	Daily N excretion (g)	Population size	Daily N excretion (g)
1988	628640		153338		688059		193448	165,46
1990	619145		144465		648247		182255	165,46
1995	384111	267,2	45965	178,6	206253	135,5	57988	165,46
2000	392017		36362		183503		45418	165,21
2005	358237		40811		190675		56967	166,03

	Mature dairy cattle		Mature non-dairy cattle		Young cattle under 1 year		Bovine and heifers 1-2years	
	Population size	Daily N excretion (g)	Population size	Daily N excretion (g)	Population size	Daily N excretion (g)	Population size	Daily N excretion (g)
2010	302461		44607		141362		53215	165,45
2015	285767		88724		113181		63833	165,91
2016	273745		105902		112417		61970	166,12
2017	261693		1162525		112551		58563	166,21
2018	243056		1227440		106505		56303	166,14
2019	224637		135451		101241		57147	165.84

- **Swine:**

Data have been provided by the experts from the Agricultural University of Plovdiv and Trakia University of Stara Zagora.
The values are calculated based on the animal's food intake.
The equation used is:

Daily N intake x Amount of non-digested N(%) x 365 = Annual Nex

This general equation is used for each swine categories and is slightly modified to meet the features of smallest piglet with body weight below 20 kg and also the features of pregnant and lactating sows.
The adjustment for piglets below 20 kg is that 8 grams of N are added to the daily N taken with the fodder. These 8 grams are from the mother's milk.
The adjustment for pregnant and lactating sows is to reflect the fact that each sow goes through pregnancy and the lactates. During these two periods the amount of feed given to the animal is adjusted according to the national swine growing standards.
The equation for piglets below 20 kg is:

(Daily N intake + 8) x Amount of non-digested N(%) x 365 = Annual Nex

The equation for sows is:

Daily N intake (in pregnancy) x Amount of non-digested N (%) x 302 + Daily N intake (when lactating) x Amount of non-digested N (%) x 63 = Annual Nex.

The ratios of undigested N are as follows:

Table 182 Undigested N (swine)

Animal weight/condition	Undigested N(%)
<20 kg	50%
20-50 kg	60%
50-80 kg	60%
80-110 kg	60%
>110 kg and boars	60%
Pregnant	70%
lactating	65%

The amount of N the animals receive with the food is as follows:

Table 183 Amount of nitrogen per day in swine food

Animal weight/condition	Amount of N per day(g)

Animal weight/condition	Amount of N per day(g)
<20 kg	40.00
20-50 kg	47.60
50-80 kg	54.91
80-110 kg	59.39
>110 kg and boars	73.92
Pregnant	58.24
lactating	184.80

Table 184 Activity data for estimating nitrogen excretion from swine

	Population size					
	Pigs < 20 kg	Pigs 20-50 kg	Pigs 50 -80 kg	Pigs 80 -110 kg	Pigs > 110 kg, and boars	Breeding pigs
1988	760204	740890	663715	848329	612470	416569
1990	794631	774442	693772	886746	640206	435434
1995	381545	371851	333117	425774	307397	209075
2000	240056	233957	209586	267883	193404	131543
2005	176598	175458	177554	190536	121197	95856
2010	127246	141764	107584	142807	108823	68677
2015	135448	145674	100071	111940	26801	56658
2016	125289	153310	122390	119584	25347	61329
2017	133,951	149,962	114500	128,271	19369	58,283
2018	142848	147677	128041	129768	9450	66072
2019	122162	143945	114578	126024	6051	60422
Daily N excretion (g)	***20***	***28,56***	***32,95***	***35,64***	***44,35***	***Pregnant- 40,77 Lactating- 120,12***

- **Poultry:**

Poultry calculations are based on the quantities of poultry manure per day and content of nitrogen in the poultry manure (see Table 185). Data have been provided by Agriculture university of Plovdiv.[27]

Table 185 Activity data for estimating nitrogen excretion from poultry

Layer hen		Broilers		Other Poultry	
Kg Manure/day	Kg N in 1000 Kg manure	Kg Manure/day	Kg N in 1000 Kg manure	Kg Manure/day	Kg N in 1000 Kg manure
0.13	14.2	0.15	18.30	0.23	22.30

- **Other farm animals:**

For estimation of nitrogen excretion from buffalo, sheep, goats, horses and mules and asses default values for nitrogen excretion rate were used represented in Table 10.19 in the 2006 IPCC GL. Estimations for these farm animals are based to eq. 10.30 (2006 IPCC GL):

$$Nex_{(T)} = Nrate_{(T)} \times TAM/1000 \times 365$$

$Nex_{(T)}$ = *N excretion of animals of type T in the country [kg N animal-1 yr-1]*
$N_{rate(T)}$ = *default N excretion rate, kg N (1000 kg animal mass)* $^{-1}$*day*$^{-1}$ *(table 10.19, IPCC 2006)*
TAM = *typical animal mass, kg animal -1 (see Table 173, chapter Enteric fermentation)*

Values of nitrogen excretion of animal of type are present in

Table 186.

[27] D. PENKOV, V. GERZILOV et all, 2012 Data on the chemical content and management of waste from industrial poultry breeding

Table 186 Nitrogen excretion of the livestock category.

Livestock category	Nitrogen excretion [kg/animal*yr.]
Mature Dairy Cattle	97.53
Mature Non Dairy Cattle	65.17
Young Cattle – Calves under 1 year	49.45
Young Cattle - Growing Heifers 1 – 2 years	60.64
Buffalo	44.38
Sheep	14.02
Goats	17.99
Horses	41.28
Mules & Asses	14.24
Swine(weight average) - Pigs <20 kg - Pigs20-50 kg - Pigs 50-80 kg - Pigs 80-110 kg - Pigs >110 kg and boars - Breeding pigs	11.66 7.30 10.42 12.03 13.01 16.19 19.88
Poultry average Poultry Chickens Other Poultry	0.93 0.81 1.87

5.5.2.2.2 Emission factors

N_2O emission factors of the 2006 IPCC GL have been used for all AWMS.
Emission factors applied in the Bulgarian inventory are listed in the following table:

Table 187 Emission factors for N_2O from manure management

Animal Waste Management System	Emission factor [kg N_2O-N per kg N excreted]	Reference
Liquid system	0.00	Table 10.21 - 2006 IPCC GL
Solid storage	0.005	Table 10.21 - 2006 IPCC GL
Dry lot	0.02	Table 10.21 - 2006 IPCC GL
Other	0.001	Table 10.21 - 2006 IPCC GL

5.5.2.3 Indirect N_2O emissions from manure management

Table 188 Indirect N2O emissions from Manure Management

Year	Total N volatilised as NH_3 and NOx (kg N/year)	N_2O emissions (Gg)
1988	85191964	1.34
1990	84083284	1.32
1995	39308618	0.62
2000	31436568	0.49
2005	32371984	0.51
2010	26753856	0.42
2015	25705614	0.40
2016	25431339	0.40
2017	25033141	0.40
2018	25273795	0.40
2019	24696874.	0.39

Indirect N_2O emissions from manure management are result from diffusion into the surrounding air (volatilisation) and from leaching and runoff. All indirect N_2O emissions from the pasture range and paddock manure management systems are reported under the Agricultural soils category.
The 2006 IPCC GL Tier 1 methodology is used for calculating N_2O emissions resulting from volatilisation:

$$N_2O_{G(mm)} = (N_{volatilization\text{-}MMS} \times EF_4) \times \frac{44}{28}$$

$N_2O_{G(mm)}$ – indirect N_2O emissions due to volatilization of N from Manure Management, kg N2O/year
EF_4 – emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N2O-N/kg NH3-N + NOx-N volatilised – default value is 0,01 kg N_2O-N/kg NH_3-N + NOx-N volatilised (table 11.3, 2006 IPCC GL);

$$N_{volatilization\text{-}MMS} = \sum_S [\sum_T [(N \times Nex \times MS) \times (\frac{FracGasMS}{100})]]$$

$N_{volatilization\text{-}MMS}$ - amount of manure nitrogen that is lost due to volatilization of NH3 and NOx, kg N/year;
N – number of head of livestock species
Nex – annual average N excretion per head of species, kg N/animal/year (see

Table 186*);*
MS – fraction of total annual nitrogen excretion for each livestock that is managed in manure management system;
$Frac_{GasMS}$ – present of managed manure nitrogen for livestock category that volatilises as NH3 and NOx in the manure management system, % (see below).

Table 189 2006 IPCC GL values for nitrogen loss due to volatilisation of NH3 and NOx from Manure management (source: Table 10.22, 2006 IPCC GL):

Animal type	Manure Management system	$Frac_{GasMS}$
Swine	Liquid system	48 %
	Solid storage	45 %
Dairy Cow	Solid storage	30 %
	Liquid system	40 %
Poultry	Poultry without litter	55 %
Other cattle	Liquid system	40 %
	Solid storage	45 %
Other	Solid storage	12 %

The 2006 IPCC GL Tier 1 methodology for determining indirect N_2O emissions does not provide values for nitrogen loss due to leaching and run-off. There has been no country-specific emission factors derived for leaching and runoff from manure management systems in Bulgaria. Anyway, the loss fractions in Table 10.23 include also losses of N which are not included in the indirect emissions from volatilizations.

5.5.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Uncertainties have been revised due to ERT recommendations.

Table 190 Uncertainty of sub-sector Manure Management for 2019, %

CRF categories	Key Category	GHG	Activity data uncertainty, %	Emission factor uncertainty, %	Combined uncertainty, %
3.B.2.1	Cattle	N_2O	0.64	50	50
3.B.2.4	Buffalo	N_2O	0.64	100	100
3.B.2.2	Sheep	N_2O	1.63	50	50
3.B.2.4	Goats	N_2O	1.65	100	100
3.B.2.4	Horses	N_2O	2	100	100
3.B.2.4	Mules and Asses	N_2O	2	100	100
3.B.2.3	Swine	N_2O	0.51	50	50
3.B.2.4	Poultry	N_2O	2	100	100
3.B.1.1	Cattle	CH_4	0.64	20	20
3.B.1.4	Buffalo	CH_4	0.64	30	30
3.B.1.2	Sheep	CH_4	1.63	20	20

CRF categories	Key Category	GHG	Activity data uncertainty, %	Emission factor uncertainty, %	Combined uncertainty, %
3.B.1.4	Goats	CH_4	1.65	30	30
3.B.1.4	Horses	CH_4	2	30	30
3.B.1.4	Mules and Asses	CH_4	2	30	30
3.B.1.3	Swine	CH_4	0.51	20	20
3.B.1.4	Poultry	CH_4	2	30	30

Default values from the IPCC guidelines for the EF; Ministry of Agriculture, Food and Forestry for the AD

5.5.4 SOURCE-SPECIFIC QA/QC AND VERIFICATION

All activities regarding QC as described in QA/QC System have been undertaken.

Activity data check

The inventory compiler reviews livestock data collection methods, in particular checking that livestock subspecies data were collected and aggregated correctly. The data is cross-checked with previous years to ensure it is reasonable and consistent with the expected trend. Inventory compilers document data collection methods, identify potential areas of bias, and evaluate the representativeness of the data. Population modelling can be used to support this approach.

Review of emission factors

If cross-check country-specific factors against the IPCC defaults finds significant differences between country-specific factors and default factors are explained and documented.

5.5.5 SOURCE-SPECIFIC RECALCULATIONS

In submission 2021, emissoions from 3B Manure management subsector have been recalculated for the whole time series. The revised estimate are for direct CH_4 and N_2O emissions and indirect emissions of N_2O in this subsector. The recalculations were made due to a potencial technical correction by TERT during 2020 Review. TERT identified a potential underestimate in CH4 emissions and an overestimate in N2O emissions. This potential underestimate of CH4 emissions and overestimate of N2O emissions arises as a result of the use of the animal waste management system "dry lot", which is actualy AWMS "liquid system". The revised estimate was made for cattle and swine. The TERT agreed with the revised estimate provided by Bulgaria.

5.5.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements for this category.

5.6 RICE CULTIVATION (CRF SECTOR 3.C)

5.6.1 SOURCE CATEGORY DESCRIPTION

Rice cultivation is a traditional Bulgarian agricultural activity. During the structural reforms, rice crop areas decreased from 14 100 ha in 1988 to 1417 ha in 1999. There has been a restoration of rice crop areas after 1999, reaching 11 822 ha in 2019.
106.47 Gg CH_4 CO_2-eq. has been emitted in 2019. Emission increase by 7.4% compared to the year 2018 (99.10 Gg CH_4 CO_2-eq) which is due to the increase of the areas with rice crops.
In Bulgaria rice is produced under the continuously flooded water regime with season length of 125 days and one harvest per year.

5.6.2 METHODOLOGICAL ISSUES

5.6.2.1 Methods

CH_4 emission calculation is carried out according to the default method from the 2006 IPCC GL for continuously flooded water regime.

$$CH_{4\ Rice} = EF \times t \times A \times 10^{-6}$$

EF – daily emission factor, kg CH4/ha/day (see 5.6.2.2);
t – cultivation period of rice = 125 days[28];
A – annual harvested area of rice, ha/day;

5.6.2.2 Emission factors

Daily emission factor are estimated according equation 5.2 from the 2006 IPCC GL:

$$EF = EF_c \times SF_w \times SF_p \times SF_o$$

Table 191 Emissions factors for Rice calculations

Baseline Emission Factor (EF_c)	1.30	Table 5.11 2006 IPCC GL
Scaling factor to account for the difference in water regime during the cultivation period (SF_w)	0.78	Table 5.12 2006 IPCC GL
Scaling factor to account for the difference in water regime before the cultivation period (SF_p)	1.22	Table 5.13 2006 IPCC GL
Scaling factor organic amendments (SF_o)	2.33	Eq. 5.3; Table 5.14 2006 IPCC GL

SFo have been calculated with equation 5.3 from the 2006 IPCC GL.
All parameters except Application rate of organic amendment (ROA) are from IPCC 2006.
ROA have been estimated based on the Good Agricultural practices – "Program of measures to reduce and prevent nitrate pollution from agricultural sources", approved by order of the Ministry of Environment and Water (MoEW). In the program there is a methodology which is used to calculate the application rate of organic amendment (in fresh weight).

5.6.2.3 Activity data

Data comes from the Agricultural Statistics Department of the Ministry of Agriculture, Food and Forestry based on surveys on yields of main crops, and for the years before National Statistics Institutes'' yearbooks and FAO's database.

5.6.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty of emission factor is 60 % (2006 IPCC GL). Activity data uncertainty is 20 %.

5.6.4 SOURCE-SPECIFIC QA/QC AND VERIFICATION

All activities regarding QC as described in QA/QC System have been undertaken.

5.6.5 SOURCE-SPECIFIC RECALCULATIONS

There are no recalculations for this category.

5.6.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements for this category.

[28] According NAAS (National Agricultural Advisory Service)

5.7 AGRICULTURAL SOILS (CRF SECTOR 3D)

Microbial processes of nitrification and denitrification in agricultural soils produce nitrous oxide emissions. In 2019 this category generates 93,05% of N_2O emissions from Agricultural sector.
There is a decrease of 35,79 % for this category from 1988 to 2019 (Figure 95). The reasons are structural changes in agricultural holdings and decrease in arable land area.

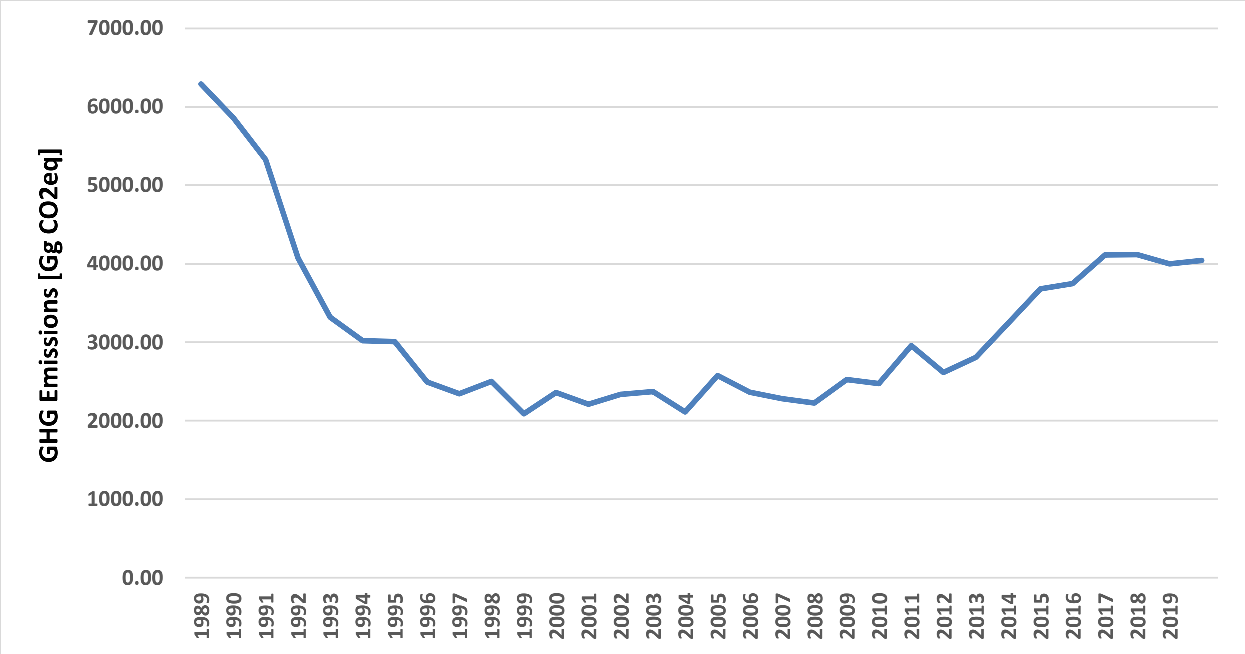


Figure 95 Trend of GHG Emissions from agricultural soils

5.7.1 SOURCE CATEGORY DESCRIPTION

The emissions from this subsector include the two main categories N_2O emissions:

- Direct emissions;
- Indirect emissions.

These two categories above are key sources in the year 2019.
Direct emissions in Bulgaria are results from:

- Soil fertilization with synthetic nitrogenous fertilizers;
- Nitrogen input from manure applied to soils (excluding manure from pasture animals);
- Sewage sludge spreading on agricultural soils;
- Decomposition of vegetable waste from different crops;
- Animal excretion on pasture range and paddock;
- N mineralisation associated with loss of soil organic matter resulting from change of land use;
- Cultivation of organic soils (i.e. Histosols).

Indirect emissions include:

- ammonia and nitrous oxides release in the ambient air after nitrogen fertilization;
- emissions from drawing of water.

Activities described above are differentiated according to the IPCC classification. One has to take into consideration that the existing emissions of methane from soil are considered natural (non-anthropogenic) and is not subject of the inventory.
Direct N_2O emissions are 3172.95 Gg CO_2-eq. in 2019.
Indirect N_2O emissions are 867.52 Gg CO_2-eq. in 2019.

5.7.2 METHODOLOGICAL ISSUES

5.7.2.1 Methods

The IPCC Tier 1 method was applied and IPCC default emission factors were used.
The following formula has been used to estimate Direct emissions (2006 IPCC GL, eq. 11.1).

$$N_2O_{Direct} - N = [(F_{SN} + F_{ON} + F_{CR} + F_{SOM}) \times EF_1] + (F_{OS,CG,Temp} \times EF_{2CG,Temp}) + (F_{PRP,CPP} \times EF_{3PRP,CPP}) + (F_{PRP,SO} \times EF_{3PRP,SO})$$

F_{SN} – annual amount of synthetic fertiliser N applied to soil (kg N/yr)
F_{ON} – annual amount of animal manure and sewage sludge applied to soil (kg N/yr)
F_{CR} – annual amount of N in crop residues, returned to soils (kg N/yr)
F_{SOM} – annual amount of N in mineral soils that is mineralised, in association with loss of soil C from soil organic matter as a result of changes to land use, kg N/yrF_{PRP}
F_{Os} – annual area of managed organic soils, ha
F_{PRP} – annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, (kg N/yr); The subscripts CPP and SO refer to Cattle, Poultry and Pigs, and Sheep and Other animals
EF_1, $EF_{2CG,Temp}$, $EF_{3PRP,CPP}$, $EF_{3PRP,SO}$ – default emission factors (kg N_2O-N/kg N), see Table 193

- F_{SN} has been estimated from the total amount of synthetic fertiliser consumed annually (according to 2006 IPCC GL);
- F_{ON} included annual amount of animal manure and sewage sludge applied to soil (equation 11.3 from the 2006 IPCC GL).
  - Annual manure applied to soils has been calculated with equation 10.34 and default values for nitrogen loss from manure management (Frac $_{LossMS}$) given in table 10.23 from the 2006 IPCC GL. In the estimations the amount of nitrogen from bedding is not included due to that information is not available in Bulgaria.
  - Anual amount of sewage sludge applied to soil in Bulgaria have been calculated since 2007 year. Bulgaria became a member of the EU in 2007 and due to the current national legalisation no activity did occur before 2007. The main legal framework for the use of sewage sludge in the Member States is ensured by Directive called the Sewage Sludge Directive (86/278 / EEC), which deals entirely with the use of sludge in agriculture
  - The 2006 IPCC GL included in F_{ON} annual amount of total compost N applied to soils. Composting in Bulgaria is preaty new technology (there are three composting instalation working from 2011 year). The compost is not with high quality and it used mainly for recultivation. There is no data in the country for composting in Agriculture.
- F_{CR} has been calculated with eq. 11.7 A from the 2006 IPCC GL. Default values for all parameters given in 2006 IPCC GL Table 11.2 are used except from dry matter values which are based on national values. Annual harvested area of crops and harvested yield for crops are provided by Ministry of Agriculture and Food; dry matter fractions of crops are provided by University of Agriculture of Plovdiv.
- F_{SOM} has been calculated with eq. 11.8 from the 2006 IPCC GL. Land use type is Annual Cropland converted to Perennial Cropland. Area and net carbon stock change in soils are listed in LULUCF chapter (CRF table 4B). C:N ratio is default from the 2006 IPCC GL.
- F_{OS} – According to the ERT and TERT reccomendations, the area of cultivated organic soils has been included in the current submission. The area have been provided by FAO database.
- F_{PRP} has been calculated with eq. 11.5 from the 2006 IPCC GL.

Conversion of N_2O – N emission to N_2O emission for reporting purposes is performed by using the following equation:

$$N_2O = N_2O - N \times 44/28$$

Indirect emissions including emissions from atmospheric deposition of N volatilised from managed soils and nitrogen leaching (and run-off). Emissions were estimate by using equation 11.9 and 11.10 according the 2006 IPCC GL and default fractions ($Frac_{LEACH-(H)}$) shown in Table 11.3 in the 2006 IPCC GL.
Bulgaria have been used country - specific parameter for $Frac_{GASF}$ to estimate N_2O emissions from ammonia volatilization.
The synthetic fertilizers quantities are provided by the National Service for Plant Protection at the Ministry of Agriculture Food and forestry. According to the EMEP/EEA Guidebook 2016, the NH_3 emission depends on fertiliser type. There is no such information for the consumption of each fertiliser type in the county, so for the estimation of NH3 - N emissions ($Frac_{GASF}$) the sales data from IFA for 2010 were used (Table A1-2, Chapter 3.D, EMEP 2016). Furthermore, the NH_3 emission factor for each fertiliser is given, based on the values from the EMEP/EEA Guidebook 2016. The major part of

the Bulgarian emission is related to the use of ammonium nitrate. The Bulgarian $Frac_{GASF}$ is low compared to the IPCC default value. This is due to the small consumption of urea, which has a high emission factor compared to the other fertilisers.
In the 2018 submission, $Frac_{GASF}$ have been recalculated, according new data in the EMEP/EEA Guidebook 2016.

Table 192 Activity data for the estimations of $Frac_{GASF}$.

Fertiliser type	NH_3 Emission factor, kg NH_3-N per kg N	Percent	Consumption, t N	Average NH_3-N emission ($Frac_{GASF}$)
Urea	0.155	31%	105898.5	0.064
Ammonium nitrate (AN)	0.015	55%	187884.4	
CAN	0.008	1%	3416.08	
Ammonium sulphate (AS)	0.09	4%	13664.32	

5.7.2.2 Emission factors

Emission factors are the default ones from the 2006 IPCC GL. So far, there are no assessments of these emission factors, which result from measurements in the country. The factors are represented in Table 193.

Table 193 N_2O emissions factors for agricultural soils.

Category	Emission Factor [kg N_2O-N/kg N]	Source
3.D.1 Direct Soil Emissions		
3.D.1.1 - Synthetic fertilizers (mineral fert.)	0.01	Table 11.1 - 2006 IPCC GL
3.D.1.2.a - Animal waste applied to soils		
3.D.1.2.b - Sewage sludge spreading		
3.D.1.4 - Crop residue return to soil		
3.D.1.3 Pasture, range and paddock manure – weighted average between several animals categories		
- Cattle, poultry and pigs - Sheep and "other animal"	0.02 0.01	Table 11.1 - 2006 IPCC GL
3.D.1.6. Cultivation of organic soils	8 kg N_2O–N ha^{-1}	Table 11.1 - 2006 IPCC GL
3.D.2 Indirect soil emissions		
3.D.2.1 - Atmospheric deposition	0.01/ kg of volatized nitrogen	Table 11.3 -2006 IPCC GL
3.D.2.2 - Nitrogen leaching (and run-off)	0.0075/ kg N-loss by leaching	Table 11.3 - 2006 IPCC GL

5.7.2.3 Activity data

- **The synthetic fertilizers quantities:**

It's provided with official letters by Bulgarian Food Safety agency/ National Service for Plant Protection (see Table 195) (1988-2016). Since 2017 the data is provided with official letter by Ministry of Agriculture, Food and Forestry. Also it is crossed-check with report of The National state of the environment. The report is published every year on the website of the Executive Agency of environment. Every year data have been provided to EUROSTAT (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=aei_fm_usefert&lang=en).

Bulgaria has been cross-checked the data with the informations presented by FAO. There are differences due to activity data presented by FAO is not official but the data obtained as a balance.

The main reasons for the declining in the fertiliser's quantity are the structural economic changes due to the radical transition process from a centrally-planned economy to a market-based economy.

- **Manure quantity:**

Its calculated using the prototype parameters for different types of animals in the Eastern Europe region, given in the 2006 IPCC GL and using the data provided by the Agricultural University of Plovdiv.

- **Sewage sludge:**

At the national level the data on the sludge are collecting according several regulations and orders.
Each year waste wastewater treatment plants have provided in the Executive Environment Agency (ExEA) annual reports for the previous year. Also ExEA receive data from Basin Directorates for the new wastewater treatment plants and information about the technology that they use for wastewater treatment.
ExEA summarizing the information and every year published official report on the use of sewage sludge in agriculture - https://eea.government.bg/bg/nsmos/waste/dokladi (available only on Bulgarian).

- **Annual crop production:**

Data have been provided by the Agrostatistics department at the Ministry of Agriculture, Food and Forestry and is cross-checked with the FAO database. For the period 1988-2000 the main data source is National statistics Institute's yearbooks.
MAFF collect agricultural statistics in Bulgaria with surveys. There are large legal basis with Regulations and Ordinances which determinate the methods and conduct of statistical surveys.
The crop statistics is based on Regulation (EC) No 543/2009 of the European Parliament and of the Council concerning crop statistics.
According to the Statistical National program, the results of the statistical surveys are presented to Eurostat and NSI.
Every year MAFF published the information on their website.

- **Area of organic soils**

Data is provided by Institute of Soil, Agrotechnology and Plant Protection "Nikola Pushkarov"

Table 194 Activity data for Agricultural soils

Category	Data Sources
3.D.1 Direct soil emissions	
Synthetic fertilizers (mineral fert.)	Ministry of agriculture food and forestry
Animal waste applied to soils	Calculations within source category 3.B and eq. 10.34 and default data in table 10.23 from the 2006 IPCC GL.
Crop residue	Harvested amount of agricultural crops - MAFF
Sewage sludge spreading	Data from wastewater treatment plants
Area of organic soils	Institute of Soil, Agrotechnology and Plant Protection " Nikola Pushkarov "
3.D.1.3 Pasture, range and paddock manure	
Grazing Animals	Calculations within source category 3.B
3.D.2 Indirect soil emissions	
Atmospheric deposition	The amount of manure left for spreading was calculated within source category 3.B. Mineral fertiliser data
Nitrogen leaching (and Run-off)	see above (synthetic fertilizers, animal waste, sewage sludge)

Table 195 Area of crop land (ha)

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Wheat	1162775	1181115	978575	1101807	1131565	1105916	1192589	1144519	1212012	1198682
Barley	359950	369211	251962	264519	245328	175957	159830	128365	103570	112029
Maize	424428	475256	466475	298713	327525	498644	406942	398152	444623	560911
Oats	35225	35715	40600	30571	24353	11076	15323	13266	11339	12153
Rye	24499	14183	21200	8782	10795	6304	7468	8237	8316	6097
Rice	10590	1380	3571	4501	11977	12410	11988	10434	11004	11822
Maize for silage	424317	64081	57758	32211	20314	26555	31102	29930	27242	27500

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Bean	39381	42747	30762	8552	1410	3314	2410	2749	1809	1396
Peas	38138	6723	5500	1402	1981	8758	18286	766	479	919
Soya	16816	15113	3000	272	725	34468	14162	11530	2315	3862
Chick peas	4600	3794	2500	593	911	2466	4722	22564	59841	11373
Lentils	7720	2301	3500	2064	2879	1449	3853	4471	3179	1273
Potatoes	41000	56000	53000	23999	13805	11017	8376	12806	14096	9291
Sugar beet	36479	9378	2210	1294	0	0	0	0	0	0
Cotton	8995	11482	9260	1119	558	2171	4490	4805	3157	3461
Feet beet	310000	286000	341000	87302	337313	117853	140679	172723	183218	165052
Peanuts	11738	12167	600	1094,3	519	222	222	443	605	471
Sunflower	280203	586009	511015	635003	729889	810841	817511	898844	788656	815561
Tobacco	52897	14254	28523	40869	24518	13360	9963	7721	5812	3536
Alfalfa	399576	172818	150741	64851	74832	64802	84685	88182	91592	69361

Table 196 Total emissions from N_2O [Gg] in Crop Residues returned to Soils 1990-2019

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	
Total emissions from N_2O in Crop Residues Returned to Soils [Gg]	**3.18**	**2.18**	**1.52**	**2.07**	**3.37**	**3.30**	**3.92**	**4.19**	**4.05**	**3.98**	

Table 196 Consumption of synthetic fertilizers for the period 1988 – 2019:

	1988	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Amount of synthetic fertilizers (kt N/year)	**541**	**396**	**130**	**145**	**160**	**199**	**342**	**366**	**351**	**339**	**352**

Table 197 Sewage sludge spreading, 2008 – 2019:

	2008	2009	2010	2011	2012	2013
Sewage sludge spreading (t/dm)	**52 117**	**16644**	**13644**	**17561**	**21241**	**16680**
	2014	**2015**	**2016**	**2017**	**2018**	**2019**
	16363	**30444**	**26229**	**22251**	**29797**	**26385**

During the revision in October 2018 the AD for Inorganic fertilizers (2016) have been revised due to technical mistake. The data is available in EUROSTAT: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=aei_fm_usefert&lang=en.

5.7.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty from the direct N_2O emissions from this source is 200% and from the indirect emissions - 500%.

Table 198 Uncertainty of sub-sector Agricultural soils for 2019, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
3D1	Direct soil emissions	N_2O	3	200	200
3D2	Indirect Emissions	N_2O	3	500	500

Default values

5.7.4 SOURCE-SPECIFIC QA/QC

All activities regarding QC as described in QA/QC System have been undertaken.

5.7.5 SOURCE-SPECIFIC RECALCULATIONS

In submission 2021, the emissoions from 3D Agricultural soils subsector have been recalculated for the whole time series due to the recalculation in Manure management sector (please see above).

• According to TERT and ERT recommendations from the ESD review 2020, emissions from cultivation of organic soils have been recalculated due to new activity data for the area of cultivated organic soils (Histosols), provided by Institute of Soil, Agrotechnology and Plant Protection ″Nikola Pushkarov" and included in the submission 2021;

• In Submission 2020 has been made a recalculataion in sector LULUCF, which is not reflected in subsector 3.D.1.5 (Mineralization associated with loss/gain of soil organic matter). The value of carbon stocks in the soils after 20 years of transition is equal to 67.74 t C/ha(89.92 t C/ha- old value) and the value of carbon stock in the soils before the conversion is equal to 67.49 t C/ha(76.52 t C/ha-old value) for the whole time series. This recalculation affected all land use categories and it is applied for the whole time series. The average SOC stock per land use category is estimated for the soil depth of 0-30 cm instead of 0-40 as it is in the previous submissions. The average SOC stock of GL subcategories – Pastures and meadows and Shrubs and grasslands has been estimated. The recalculation is included in submission 2021.

• A recalculation have been made for 2018 due to technical mistake in activity data for chick peas.

5.7.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements for this category.

5.8 FIELD BURNING OF AGRICULTURAL RESIDUES (CRF SECTOR 3F)

5.8.1 SOURCE CATEGORY DESCRIPTION

This sector covers the emissions of non-CO_2 greenhouse gases from the burning (in the field) of crop residue and other agricultural waste on site.
Despite field burning is prohibited by the Bulgarian law, this "tradition" continues and is emission source not only of main GHGs but also of GHGs-precursors.
37.55 Gg CO_2-eq. aggregated GHGs were emitted in 2019 (0,60 % of Agriculture emission). The estimations are based on the expert judgement that 3% of the vegetal residues, left on the fields after yielding the crops, are burned.

5.8.2 METHODOLOGICAL ISSUES

According to the provisions in the IPCC GPG 2000, the calculation methodology took into account the 1996 IPCC GL default emissions ratios (Table 4-16 of Reference Manual). Emission ratios are presented in Table 199.

The rationale for using the 1996 IPCC GL approach, and not the 2006 IPCC GL approach, is as follows:

(1) the 2006 IPCC GL equation was developed to be broadly applicable to all types of biomass burning, and, thus, is not specific to agricultural residues;

and (2) the 2006 IPCC GL default factors are provided only for four crops (corn, rice, sugarcane, and wheat), while this Inventory analyzes emissions from much more crops.

Table 199 Default emission factors for burning of agricultural residues

Gas	Default IPCC 1996 emission ratios
Methane	0.005
Carbon monoxide	0.06
Nitrous oxide	0.007
Nitrous oxides	0.121

Activity data for harvested production by crops is provided by the Statistical Department of the MAFF. Specific parameters used for calculations of the emissions are provided from the Agricultural University of Plovdiv (see Table 200).

Table 200 Specific parameters used for calculation of Total carbon released

GREENHOUSE GAS SOURCE AND SINK CATEGORIES						
	Residue / Crop ratio	Dry matter fraction of residue	Fraction burned in fields	Fraction oxidized	C fraction of residue	N - C radio in biomass residues
1.Cereals						
Wheat	1.3	0.84	0.03	0.9	0.4853	0.006
Barley	1.2	0.85	0.03	0.9	0.4567	0.009
Maize	1	0.78	0.03	0.9	0.4709	0.02
Oats	1.3	0.92	0.03	0.9	0.4466	0.016
Rye	1.6	0.9	0.03	0.9	0.4238	0.01
Rice	1.4	0.85	0.03	0.9	0.4144	0.016
Maize for silage	1	0.78	0.03	0.9	0.4709	0.017
2.Pulses						
Dry beans	2.1	0.85	0.03	0.9	0.4812	0.03
Peas	1.5	0.87	0.03	0.9	0.4466	0.031
Soybeans	2.1	0.86	0.03	0.9	0.4129	0.056
Lentils	**0.3**	**0.18**	**0.03**	**0.9**	**0.4642**	**0.036**
Chick peas	0.3	0.18	0.03	0.9	0.4642	0.036
3.Tubers and Roots						
Potatoes	0.4	0.25	0.03	0.9	0.42	0.026
Sugar beet	2.2	0.72	0.03	0.9	0.53	0.014
4.Other						
Cotton	1.3	0.84	0.03	0.9	0.49	0.03
Sunflower	1.3	0.84	0.03	0.9	0.49	0.03
Peanuts	1	0.86	0.03	0.9	0.46	0.023
Tobacco	1.3	0.84	0.03	0.9	0.49	0.03
Feetbeet	0.3	0.86	0.03	0.9	0.41	0.06
Alfalfa	0.3	0.90	0.03	0.9	0.41	0.06

5.8.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Uncertainty for the CH_4 emission factor is 50%, and for the N_2O – 20 % (default values based on the IPCC 1996).
For the AD uncertainty is 3 % (crop uncertainty base on the official statistics in the country).

5.8.4 *SOURCE-SPECIFIC QA/QC*

All activities regarding QC as described in QA/QC System have been undertaken.
Activity data has been cross-checked with FAO's statistical database.

5.8.5 SOURCE-SPECIFIC RECALCULATIONS

There are no source-specific recalculations.

5.8.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements for this category.

5.9 CO_2 EMISSIONS FROM LIMING (CRF sector 3G)

There is no liming in Bulgaria after 1987.
During the UNFCCC review in October 2018, the ERT raised a question about Liming in Bulgaria. Bulgaria asked the INSTITUTE OF SOIL SCIENCE, AGROTECHNOLOGY AND PLANT PROTECTION "NIKOLA POUSHKAROV" in order to clarify if liming is a current practice in Bulgaria. The ERT confirmed that the liming is not a practice since 1988- after political reforms in the country. After the closure of the so-called 'Labor cooperative farm' the liming practice is unprofitable and does not apply in the country.

5.10 CO_2 EMISSIONS FROM UREA FERTILIZATION (CRF sector 3H)

5.10.1 SOURCE CATEGORY DESCRIPTION

Adding urea ($CO(NH_2)_2$) to soils during fertilization leads to a loss of CO_2 .
Emission of CO_2 from use of urea contributes with less than 1% of the CO_2 emission from the agricultural sector.

5.10.2 METHODOLOGICAL ISSUES

A Tier 1 method as given in the 2006 IPCC GL is used.

5.10.2.1 Activity data

The amount of urea used on agricultural soils is provided by National service for Plant Protection (see below).
According to the ERT recommendation, for the period 1988 – 2005, activity data have been interpolated base on the total consumption of N fertilizers, due to for this period of time there are no data on the urea consumption in agriculture sector.

Table 201 Consumption of urea fertilizers (t/year) for the period 2006 – 2019

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Urea (t/year)	23348	21481	27686	33891	24619	35840	42712	50739	42082	42639	49000	45577	46007	45061

Data were provided by National service for Plant Protection

5.10.2.2 Emission factors

The default emission factor of 0.20 given in the 2006 IPCC GL is used.

5.10.2.3 Methods

CO_2 emissions from urea fertilization were estimated with Equation 11.13 from the 2006 IPCC GL:

$$\mathbf{CO_2 - C\ Emission = M \times EF}$$

M – annual amount of urea fertilization, tones urea/year (see above);
EF – emission factor, tone of C/ tone of urea = 0,20 (2006 IPCC GL).

To convert CO_2 – C emissions in CO_2, emissions were multiply by 44/12.

Table 202 CO_2 emissions from urea fertilisation

	2006	2007	2008	2009	2010	2011	2012
CO_2 emissions (Gg)	17,12	15,75	20,30	24,85	18,05	26,28	31,32
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
	37,21	30,86	31,27	35,93	33,42	33,74	33,04

5.10.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty of emissions from this source is 50%.

5.10.4 SOURCE-SPECIFIC QA/QC

All activities regarding QC as described in QA/QC System have been undertaken.

5.10.5 SOURCE-SPECIFIC RECALCULATIONS

There are no recalculations for this category.

5.10.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements in this category.

6 LAND-USE, LAND-USE CHANGES AND FORESTRY (CRF SECTOR 4)

6.1 OVERVIEW OF SECTOR LULUCF

Land Use, Land-Use Change and Forestry (LULUCF) sector includes emissions and greenhouse gas removals from different land-use types, changes in the land-use and forestry. The greenhouse gas inventory of LULUCF sector comprises emissions and removals of CO_2 due to overall carbon gains or losses in the relevant carbon pools of the predefined six land-use categories. These pools are above-ground biomass, below-ground biomass, dead organic matter (litter and dead wood) and soils. Sources of the non-CO_2 emissions in the LULUCF sector are the biomass burning, lime and urea application, as well as fertilisation.

Since reporting year 2015 the methodology used to calculate emissions and removals in LULUCF follows that of the 2006 IPCC Guidelines. The predefined land-use categories are Forest land (FL), Cropland (CL), Grassland (GL), Wetland (WL), Settlements (S), Other land (OL). In accordance with the 2006 IPCC Guidelines emissions and removals should be reported into two sub-categories – land remaining in the same category and land converted to another land-use category. All the land-use changes were traced down and reported for a transition period of 20 years (as require in IPCC 2006) after which they are reported in the respective categories.

6.1.1 SECTOR COVERAGE

In the 2021 Inventory submission Bulgaria reports carbon stock changes, as well as greenhouse gas emissions and removals from Forest Land (CRF 4.A), Cropland (CRF 4.B) and Grassland (CRF 4.C), Wetlands (CRF 4.D), Settlements (CRF 4.E) and Other land (CRF 4.F) and harvested wood products (HWP). The quantity of CH_4 and N_2O emissions are estimated for these sub-categories, where they occur. The completeness of the estimated emissions from sources and removals by sinks is shown in the table below.

Table 203 Overview of subcategories of CRF Sector 4 – LULUCF: status of emission estimates for CO_2, CH_4 and N_2O

Land-Use Categories	Net CO_2 emissions/removal	CH_4	N_2O
A. Forest Land	**X**	**x**	**x**
1. Forest Land remaining Forest Land	X	x	x
2. Land converted to Forest Land	X	x	x
B. Cropland	**X**	**NO**	**x**
1. Cropland remaining Cropland	X	NO	NO
2. Land converted to Cropland	X	NO	x
C. Grassland	**X**	**NO**	**x**
1. Grassland remaining Grassland	X	NO	x
2. Land converted to Grassland	X	NO	NO
D. Wetlands	**X**	**NO**	**x**
1. Wetlands remaining Wetlands	NO, NE	NO	NO
2. Land converted to Wetlands	X	NO	x
E. Settlements	**X**	**NO**	**x**
1. Settlements remaining Settlements	NO, NE	NO	NO
2. Land converted to Settlements	X	NO	x
F. Other Land	**NO**	**NO**	**NO**
1. Other Land remaining Other Land	NO	NO	NO
2. Land converted to Other Land	NO	NO	NO

Land-Use Categories	Net CO_2 emissions/removal	CH_4	N_2O
G Harvested Wood Products (HWP)	X		
1. HWP Produced and Consumed domestically	X		
2.HWP Produced and Exported	X		

6.1.2 KEY CATEGORIES

The key source categories within this sector are presented in the table below.

Table 204 Key sources of LULUCF sector

Land-Use Categories	Gas	Level assessment	Trend assessment
4.A.1 Forest Land Remaining Forest Land	CO2	x	x
4.A.2 Land Converted to Forest Land	CO2	x	x
4.B.1 Cropland Remaining Cropland	CO2	x	x
4.B.2 Land Converted to Cropland	CO2	x	x
4.C.2 Land Converted to Grassland	CO2	x	x
4.E.2 Land Converted to Settlements	CO2	x	x
4.G Harvested Wood Products	CO2	x	x
4.D.2 Land Converted to Wetlands	CO2		x
4(III) Direct N2O emissions from N mineralization/immobilization	N2O	x	x

6.1.3 EMISSION TRENDS

The emissions and removals in the different categories are presented in Table 205

Table 205 Net emissions and removals of greenhouse gases from land use, land use changes and forestry by categories in CO_2 eq.

Year	Total CO_2 removals	4 A Total Forestland	4 B Total Cropland	4 C Total Grassland	4 D Total Wetlands	4 E Total Settlements	4 F Total Other land	4 G HWP
1988	-18977.68	-17217.19	-822.39	-993.07	119.89	484.27	NO	-583.27
1990	-19128.42	-17272.94	-823.56	-1064.80	107.27	475.66	NO	-583.27
1995	-18656.30	-17254.16	-660.00	-1664.18	91.08	455.59	NO	344.00
2000	-17807.51	-16375.32	-576.17	-1275.81	141.99	511.63	NO	-268.48
2005	-16320.26	-12210.40	-772.95	-3141.86	194.47	534.99	NO	-961.02
2010	-12668.74	-11074.22	38.49	-1772.76	266.48	780.28	NO	-957.18
2015	-9323.77	-8178.97	465.80	-1273.38	289.65	826.99	NO	-1530.65
2016	-9228.30	-8202.35	210.66	-1230.58	285.16	768.55	NO	-1136.75
2017	-9304.49	-8238.28	249.12	-1070.74	272.26	762.40	NO	-1356.29
2018	-9583.31	-8297.39	201.29	-1134.46	259.29	649.79	NO	-1338.61
2019	-9562.01	-8298.00	182.01	-1226.22	246.34	798.16	NO	-1338.61

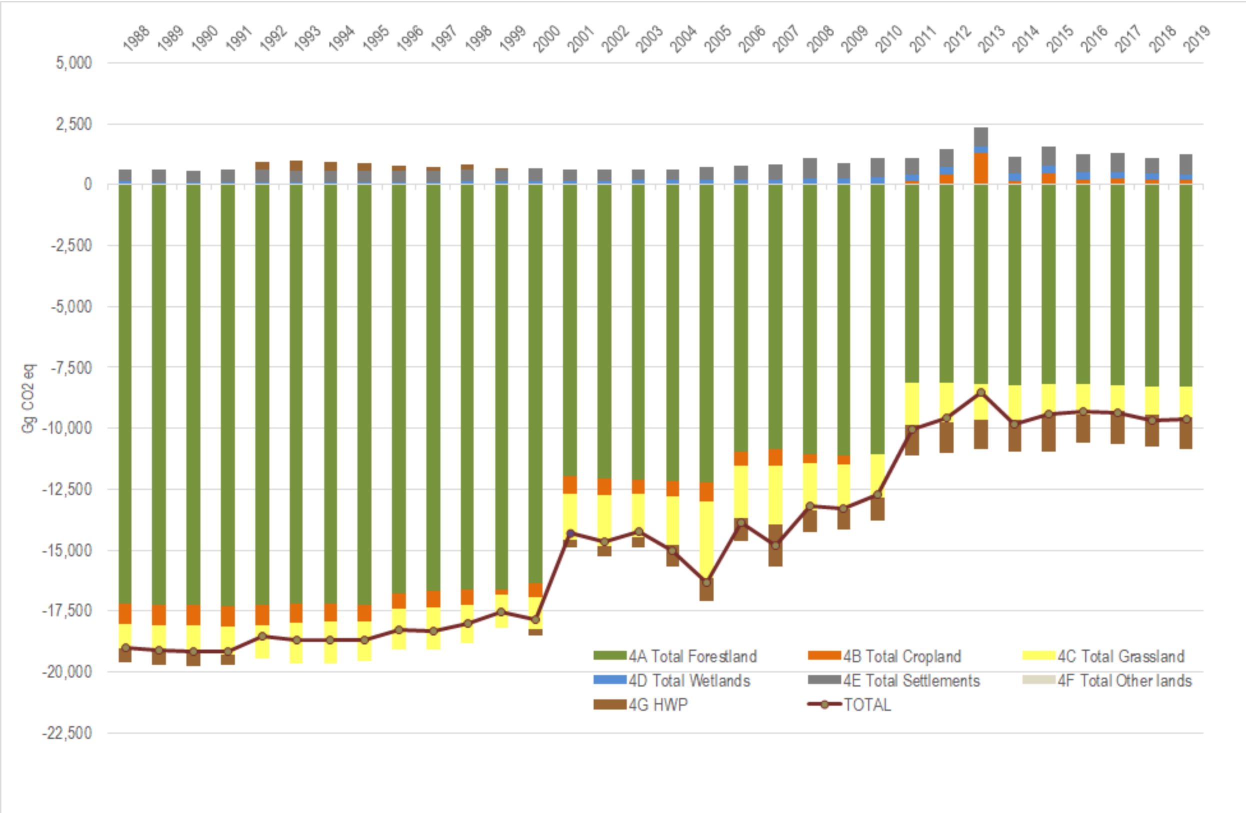


Figure 96 LULUCF emissions and removals 1988 – 2019 CO_2 eq.

The figure shows that the LULUCF sector is serving as a sink of greenhouse gases for Bulgaria. The category "Forest land" is a sink of CO_2 during the whole time series. The contribution of the HWP, Cropland, Grassland and Other Land categories to the emissions/removals from LULUCF category is in both directions – as source and as a sink of emissions. All remaining categories (Settlements and Wetlands) are sources of CO_2 emissions. The trend of net CO_2 removals (CO_2 eq) from LULUCF decreases by 31% compared to the base year. The main reason for the overall decrease of the uptakes of CO_2 emissions from LULUCF is due to the drop in removals from category Forest land and the slight increase in emissions from CL, WL and SM categories. The key driver for the trend of emissions in LULUCF is the FL category. The major reason behind this dramatic decline is that in Bulgaria, since 2000, there is a constant increase in harvesting. Although the increase in the wood removals, the harvesting in these years is still below to what was planned to be harvested. In 2019 the harvesting is by 20% higher than 2010 as since 2012 it reaches the planned quantities according to FMPs. The increase in harvesting since 2011 is in response to the market demand and also to the fact that since the adoption of the new Forest Act (2011) there was an organizational change in the management of the forestry operations and in most cases the planned harvesting according to FMP is fulfilled. Although such an absolute increase in harvesting, the growing stock in Bulgaria is increasing during the years and it is expected to increase in the next 20-30 years.

Despite the decrease observed, the share of the removals from the total GHG emissions (in CO_2eq) is still remarkable. The reason for this is that the emissions in the other sectors have dropped dramatically. The share of the removals in the base year has the figure of – 16.5% from the total GHG emissions in CO_2eq, while in the inventoried year the share is - 17%.

Comparing with the base year an increase in the emissions in croplands, settlements and wetlands is observed. The total emissions from croplands fluctuate during the whole time series. The emissions from Settlements increase last couple of years due to changes from other land- uses to Settlements according to the risen infrastructural activities since Bulgaria's joined the EU.

In GHGI Submission 2021, all the emissions from N mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils, has been included. More information on the estimations is presented in the relevant chapters.

6.1.4 METHODOLOGY

The inventory follows the methodologies and principles envisaged in the IPCC 2006 and 2013 KP Supplement. All land-use changes have been traced down and reported for a transition period of 20 years after which they are reported in the respective categories.

Table 206 Summary of the methodological tier applied in LULUCF sector

IPCC Categories	Carbon pools					Non-CO2	
	Living biomass	Dead wood	Litter	Mineral Soil	Organic soil	CH4	N2O
4A1 FLrFL	Tier 2	Tier 2	Tier 1	Tier 1	NO	Tier 1	Tier 1
4A2 LUC to FL	Tier 2	NO	Tier 2	Tier 2	NO	Tier 1	Tier 1
4B1 CLrCL	Tier 1	Tier 1		Tier 2	NO	NO	
4B2 LUC to CL	Tier 1, Tier 2	Tier 1		Tier 2	NO	NO	Tier 1
4C1 GLrGL	Tier 1	Tier 1		Tier 2	NO	NO	Tier 1
4C2 LUC to GL	Tier 1, Tier 2	Tier 1		Tier 2	NO	NO	
4D1 WLrWL	NO	NO		NO	NO	NO	Tier 1
4D2 LUC to WL	Tier 1, Tier 2	Tier 1, Tier 2	Tier 1, Tier 2	Tier 2	NO	NO	
4E1 SMrSM	Tier 1	Tier 1		Tier 1	NO	NO	
4E2 LUC to SM	Tier 1, Tier 2	Tier 1, Tier 2	Tier 1, Tier 2	Tier 2	NO	NO	Tier 1
4F OL							

6.1.4.1 Activity data

In accordance with the 2006 IPCC Guidelines, Bulgaria reports the LUC areas within the LUC categories for a transition period of 20 years. Therefore, activity data back to 1968 is needed to report the LUC areas adequately. Due to the lack of data, it is assumed that the trends of LUCs in the first years after 1988 were the same as in the years before. Consequently, the averages of the trends of the first years of the reporting period were extrapolated back to 1968 (1988-2000 or 1988-1999 depending on the split of the time series).

6.1.4.2 Emission Factors

The calculation of the emission factors follows to a great extent the methods, described in the 2006 IPCC Guidelines and IPCC 2019. In those cases, where possible, the emission factors are determined considering the specific conditions of the country. To calculate them data from national statistical sources and studies are used - the official reports of the forestry fund, the national system for environmental monitoring, the scientific research database in Bulgaria and other European countries.

6.1.5 UNCERTAINTY

The uncertainties of gas emission estimations (CO_2 and other contaminants) were determined by IPCC categories ("Forest land", "Cropland", "Grassland", "Settlements", "Wetlands", "Other land") and sub-categories, and sources within sub-categories using empirical data, expert judgments and recommended by FAO (FAO, 2006) reference values (Table below). Efforts towards uncertainty reduction were made by extending the empirical data range to derive country-specific activity data and emission factor input values. Additional sources of CO_2 emissions and removals (e.g. Dead wood in Forests) and other gases (e.g. N_2O from soils), not taken in consideration earlier, were also accounted for. Uncertainty data were aggregated, according to the error propagation formulae, separately for the emission factors and for the activity data, and combined uncertainties by sub-category and source were calculated and analysed as percentages of the overall uncertainty. Trend uncertainties of the gas emissions due to activity data and emission factors and their combined effect on the uncertainty of the predicted tendency were estimated. Inferences by sub-categories and sources as well as general conclusions about the IPCC categories "Forest land", "Cropland", "Grassland", "Settlements", "Wetlands", "Other land" were derived.

Table 207 Uncertainties of the emission factors and the activity data and sources of information

Activity/Emission factor	Uncertainty %	Source of information
Forest land remaining forest land, ha	3	for industrial countries, 2006 IPCC GNGGI
Cropland remaining cropland, ha	3	expert judgment
Grassland remaining grassland, ha	5	expert judgment
Land use changed to forest land, ha Land use changed to cropland, ha Land use changed to grassland, ha	10	expert judgment
Merchantable growing stock, m^3 ha^{-1}	Conifers, Broadleaved – 8 Combined - 10	default, 2006 IPCC GNGGI; expert judgment
Biomass expansion factor (BEF)	20	expert judgment
Bulk density of wood (D), kg/m^3	Conifers – 12.0 Broadleaved – 12.2 Combined – 8.7	country specific data Blaskova (Wood science textbook), Belyakov et al. (Bio-productivity and wood properties of Scots pine, unpublished)
Bulk density of dead wood (D), kg/m^3	Conifers – 38.1 Broadleaved – 45.3	default, Di Cosmo et al. / Forest Ecology and Management 295 (2013) 51–58, Table 4
Ratio of below-ground biomass to above-ground biomass (R)	Conifers – 18.1 Broadleaved – 11.4 Combined – 73.1	default, 2006 IPCC GNGGI
Emission factor, g kg^{-1} dry matter burnt (Gef)	CO_2 - 16.7 CH_4 – 80.9 NO_2 – 53.8	default, 2006 IPCC GNGGI
Dead wood stock, m^3 ha^{-1}	Conifers – 9.5 Broadleaved – 6.6	empirical data
Mass of the fuel available for combustion, t ha^{-1}. combustion factor * (Mb.Cf)	CO_2 - 63.6 CH_4 – 63.6 NO_2 – 63.6	default, 2006 IPCC GNGGI
Half-life (HL)	50	default, 2006 IPCC GNGGI
Production, import, export of wood products	15	for countries with systematic census or surveys since 1961, 2006 IPCC GNGGI
Carbon content (CF), (tonne d.m.)$^{-1}$	Conifers – 7.8 Broadleaved – 4.2 Combined – 5.3	default, 2006 IPCC GNGGI
Yield biomass from grassland (pastures and meadows) (B cut), tonnes d.m	32.5	empirical data
Biomass of the growth in the grassland (pastures and meadows) (B peak), tonnes d.m	75	default, 2006 IPCC GNGGI
Annual accumulation of C in the aboveground biomass of grassland (pastures and meadows), tonnes Cyr^{-1}	79.4	empirical data
Annual accumulation of C in the aboveground biomass of grassland	50	default, MediNet Project

Activity/Emission factor	Uncertainty %	Source of information
(shrubs and grasslands), tonnes Cyr^{-1}		
Maximum above-ground biomass carbon stock at harvest of perennials (tonnes C ha^{-1})	28.1	MediNet, 2019 Refinement to the 2006 IPCC GNGGI
Accumulation rate ABG biomass of perennials, t/ha/yr	13.3	MediNet, 2019 Refinement to the 2006 IPCC GNGGI
Aboveground biomass of other land(tonnes C ha^{-1})	75	default, 2006 IPCC GNGGI
Aboveground biomass of settlements (tonnes C ha^{-1})	35	country specific data Zhiyanski et al. / Journal of Chemical, Biological and Physical Sciences 5(3) (2015), 3114-3128, Table 5
Annual accumulation of C in the aboveground biomass of perennials, tonnes C yr^{-1}	25	default, 2019 Refinement to the IPCC GNGGI
Annual accumulation of C in the aboveground biomass of annuals, tonnes C yr^{-1}	23.0	empirical data
C stock in litter pool, tonnes C	29.8	empirical data
Soil C stock in forestland, tonnes C	4.3	empirical data
Soil C stock in annual cropland, tonnes C	0.04	empirical data
Soil C stock in annual cropland remaining annual, tonnes C	3.2	empirical data, 2019 Refinement to the 2006 IPCC GNGGI
Soil C stock in perennial cropland, tonnes C	1.2	empirical data
Soil C stock in perennial cropland remaining perennial cropland, tonnes C	3.1	empirical data, 2019 Refinement to the 2006 IPCC GNGGI
Soil C stock in other land, tonnes C	75	expert judgment
Soil C stock in settlements, tonnes C	51.5	country specific data Zhiyanski et al. / Journal of Chemical, Biological and Physical Sciences 5(3) (2015), 3114-3128, Table 2
C:N ratio of the soil organic matter	Forest Land, Other Land – 66.7 Cropland, Grassland - 35	2006 IPCC GNGGI
Emission Factor - N2O-N, kg N2O-N/kg N	85	2006 IPCC GNGGI

More information on the category-specific uncertainty assessment is presented in the respective subchapter of each category.

6.1.6 QA/QC

The input data, estimates and results are checked as follows.

- Bottom-up check
- Input data
- Check for the plausibility of the activity data and their trend
- Check for plausibility of the emission factors as well as the related input data and their trends
- Check of input data for completeness
- Estimations
- Check of the correctness of all equations in the estimate files
- Check of the correctness of all interim results
- Check of the plausibility of the results and their trends
- Check of the correctness of all data and results transfer
- Top-down check
- Check of the consistence of the total area for Bulgaria.

Comparison of the activity data used with those from other statistics. Comparison of the used emission factors and underlying input data with those of other data sources (e.g. from literature, results in NIRs of other comparable regions, IPCC default values).

In terms of QA/QC of the activity data, the correctness of the data on the areas and the tree stock is controlled during the preparation, the adoption and the execution of the Forest Management Plans (FMP). The quality control is exercised by the Executive Forest Agency and its subdivisions. Quality control could be exercised by other institutions, e.g. the Ministry of Environment and Waters, municipal authorities as well as by forest landowners. Quality control is exercised at every phase of the preparation of the FMP and the results of the check are documented and the mistakes are corrected.

Concerning the agrostatistical data, from the Agrostatistics (BANCIK) and Strategies Directorate of MAFF together with the Regional Directorates "Agriculture and forestry" and Municipal Services on agriculture and forestry at MAFF organized and conducted the agricultural census in Bulgaria. Around 4000 surveyors participated in the data collection process. Around 400 controllers supervised the work of the surveyors and provided methodological assistance. The controllers delivered the checked questionnaires to the agrostatistics experts from the Regional Directorates "Agriculture and Forestry" according to a previously adopted schedule. The operators did the data entry in the census software spread in the regional offices. The regional data bases are aggregated on national level by Agrostatistics and Strategies Directorate of MAFF. The data entry from the filled in questionnaires into computer software was followed by crosschecks and coherence control in order to ensure the data quality.

6.1.7 RECALCULATIONS

There are several recalculations in the sector which affected the estimates of emissions and removals in most categories:

1) Recalculations due to identification of some calculations error in the calculation's sheets – for example, a wrong reference to cell in a formula or to activity data information. Such errors have been found in area calculations for CL and WL. Another error of this type was found in the estimation sheet for an average carbon stock in soils under Shrubs and grasslands subcategory, which resulted in recalculation of the average stock and its decrease from 100.95 tC/ha to 86.96 tC/ha.
2) Recalculations in LUC matrices due to changes in area of land-use changes before the base year. For all categories the land-use changes have been reported as an average of the LUC for the period 1988-1998, which was not the case in the previous submissions. The only difference applies for GL category, where a different approach was used.
3) Recalculations in relation to some updates of the information from the activity data. It is about perennial CL area and GL area since 2008. The area of FL-FL was corrected for 2018 due to a found error.
4) Recalculations in estimates of the emissions/removals from dead wood in FL-FL due to refinement of the calculation model.
5) Recalculations in CSC in living biomass pool for subcategory FL-FL.

More information for the recalculations in forest living biomass and dead wood is provided in Chapter 6.3.5.

6.1.8 IMPROVEMENTS

1. Update of the land representation by collecting additional information on LUC between annual and perennial crop, pastures and shrubs, as well as by CL and GL.
2. Collect data information (from National Statistical Yearbooks) on the total of each category and sub-category for the years before 1988 in order to better represent the land use pattern before the base year.
3. Update the information for LUC to FL for the period 2012-2020.
4. Collect information to disaggregate the area of lands converted to FL to respective subcategories of coniferous and deciduous forests to better estimate the CSC in LUC to FL.
5. Estimate country-specific management factors in soils of croplands.

6.2 LAND-USE DEFINITIONS AND THE CLASSIFICATION SYSTEMS USED AND THEIR CORRESPONDENCE TO THE LULUCF CATEGORIES

6.2.1 LAND-USE DEFINITIONS AND CLASSIFICATION SYSTEMS

Forest land

For defining forest, Bulgaria uses the definition in the Bulgarian Forest Act (last amendment 07.08.2012, SG №60):
"***Area over 0.1 ha, covered with forest tree species higher than 5 meters and tree crown cover over 10% or with trees which can reach these parameters in natural environment***".
Areas of natural forest regeneration outside urban areas with a size of more than 0.1 ha also represent "forest". City parks with trees, forest shelter belts, and single row trees do not fall under the category "forests.
According to their functions, forests are divided into: forests for timber production, protective and recreation forests and forests in protected areas.
Forests are also:

- areas which are in a process of recovering and are still under the parameters, but it is expected to reach forest crown cover over 10% and tree height 5 meters;
- areas, which as the result of anthropogenic factors or natural reasons are temporarily deforested, but will be reforested;
- protective forest belts, as well as tree lines with an area over 0.1 ha and width over 10 meters;
- cork oak stands."

All forests in Bulgaria are managed.

Cropland

Category Cropland consist of two subcategories - **annual and perennial crops**.

Under the subcategory "annual crops" we define arable lands which are regularly ploughed and regularly cultivated under a system of crop rotation. These lands are occupied by cereals and dry pulses, industrial crops, fodder and other field crops or vegetables. Arable lands which are laying fallow as well as cornfields and kitchen gardens are defined as annual croplands as well.
Perennial crops include orchards, vineyards, fruit and berry plantation, other permanent crops, nurseries for wine, fruits, ornamental plants etc. The orchards are uniformly kept plantations (by annual pruning and regular treatment for protection from diseases and insects) of fruit trees (pip-trees, stone-trees and nut-trees). The orchard production may be used for direct consumption or processing. The density of plantation is at least 10 trees per 0.1 ha and therefore the maximum distance between the trees a 10x10m.

Grassland

As grasslands are defined herbaceous lands which are not classified as croplands. These lands are further stratified into two subcategories:

1) Pastures and Meadows and
2) Shrubs and grasslands.

The subcategory Pastures and Meadows includes lands which are subject to grazing or mowing - permanent pastures, high mountain pastures and natural meadows.
The subcategory Shrubs and Grasslands includes low productive grasslands and secondary lawns, areas with scattered thorns and shrubs, abandoned arable land, naturally covered with thorns, grasses and herbs, unsuitable for grazing.

Wetlands

The Wetlands category includes lands covered with water or water saturated lands (throughout the year or partially in the year) which does not fall in the other categories. These are natural or artificial watercourses serving as water drainage channels, natural or artificial stretches of water, coastal lagoons, wetlands areas and peatbogs.

Settlements

The Settlements refer to all classes of urban formation - buildings, roads, streets and areas with artificial surfaces, roads and railways, their facilities and the appropriate area, mines, landfills and construction sites, city parks, gardens, cemeteries, sport facilities. These areas are functionally or administratively associated with public or private lands in cities, villages or other settlement types.

Other land

Other land category includes bare lands, rock, sands, sparsely vegetated areas and all area that do not fall into any of other five land-use categories.

6.2.2 SOURCES OF ACTIVITY DATA

There are different data sources available in the country which collect and store information on area, land cover and land use. These sources represent information systems which are usually maintained by different administrative institutions and serve to monitor and manage the resources for which the respective administration is responsible. Very often there is little or lack of synchronization between the different information systems which is their main disadvantage. However, we could assume that the quality of the information that any single institution manages and maintains is good enough to provide the overall picture of the land area representation. The main challenges here are related to:

1. the lack of systematically collected information on land use changes between different land use classes during the years;
2. the discontinuity of some statistics;
3. the use of different definitions and terms.

For example, some institutions store and maintain the information based on the designation of the land parcels whereas others work with the actual land use. All these specifics are considered in the process of land representation to ensure the consistency in definitions and land use classes. The activity data was threatened in hierarchical order when LUC matrices were elaborated to ensure the accuracy as much as possible.

Activity data on forest land

The Forest Inventory (FI) and the information from the Forest Management Plans (FMP) are the main sources of information for the area of forest land and its land-use changes. The FI in Bulgaria covers assessments for the entire country territory in 10 years' cycles. Therefore, all forest stands are surveyed once in every 10 years. The stand-wise inventory in Bulgaria measures the main data as tree composition, origin, age, management purpose, tree height and diameter; annual increment, yield class, density of stand, tree growing stock etc. Forest inventory presents collection of qualitative and quantitative data about the investigated area. On the other side, the management planning gives recommendations about the silvicultural operations and activities for the next 10 years period. The plans contain data for forests' territorial division and management, basic characteristics of the forest stands; complex of activities for protection, regeneration and optimal utilization of the forest resources; economic justification, considering ecological and social effects from the implementation of the planned activities. These plans are prepared in accordance with Regulation № 8/2015 for conducting the forest inventory and planning in forest areas in Bulgaria (before 2015 the Regulation № 6 on the structure of the forests and land included in the forest fund and the hunting reserves of Republic of Bulgaria have been into force).

Activity data on Agricultural lands

BANCIK – Bulgarian Survey of the Agricultural and Economic Conjuncture, is a large-scale survey carried out throughout the territory of Bulgaria and aiming at the implementation of a unified data system showing the agricultural production and conjuncture. Basically, the survey is oriented to the agriculture, but since its character of a universal device, it also offers opportunities for throwing light on both environmental and urban set-up issues. The BANCIK survey studied the land use and cover over more than 111000 points identified on the grounds of 3123 square segments spread over 1410 km of the country area and containing 36 points each, the distance between these points being 234 m. The sample is based on the implementation of a network of North-South, East-West oriented straight lines with 6 km of distance between them. Each point of intersection of the network stands for the centre of a segment, supposedly considered as random. A zone 827m large separates the borders of Bulgaria in order to correct possible inaccuracies of the standard cartography.
The annual evaluation under BANCIK is based on two detailed nomenclatures – physical nomenclature (providing information on the land cover and vegetation of the observed point and functional nomenclature providing information on the land use (socio-economic dimension of the observed territory.

IACS-LPIS - The Agricultural Land Parcel Identification System (LPIS) is a part of the Integrated Administration and Control System (IACS), which has been developed in all Member States of the European Union following the main EU regulations. The LPIS in Bulgaria is developed based on a digital orthophoto map of aerial/satellite photography. The reference plot is a physical block. LPIS information is available since 2007 covering in a "wall to wall" the entire territory of Bulgaria. In case of LPIS, one-fourth of the country is systematically updated every year. From 2020 onwards, it is expected that one-third of the country will be updated each year. The main benefits of the dataset are the accurate spatial representation (1:5000 scale), the explicit management of temporal information and the thematic accuracy (classification correctness) of agricultural area (managed cropland and managed grassland).

National Statistical Institute – owns information on Cropland and Grassland areas for the years before 1998. The information is not georeferenced, and it is stored in the National Statistical Yearbooks.

Activity data on other non-agricultural lands

As these data sources store information for the entire country territory and not only on agricultural lands, they are also used to present information on WL, SM and OL.

Additional data on land cover

Data from Corine Land Cover is used to verify the assumptions regarding the land use changes and to double check some of the information regarding specific classes of land use which could be classified differently into the varied information systems in the country.

6.2.3 INFORMATION ON APPROACHES USED FOR REPRESENTING LAND AREAS AND ON LAND-USED DATABASES USED FOR THE INVENTORY PREPARATION.

As it was mentioned above, the LULUCF sector consists of the following categories: Forest land, Cropland, Grassland, Wetlands, Settlements and Other land. All land areas within a country should be assigned to one of these categories.

The land area representation is assembled based on data from different statistical sources (Table 208). Therefore, when compiling the data available for land area representation, the following hierarchical treatment of the data sources has been performed, from top to bottom:

- Top priority is given to the most reliable data which comes from systematically measured statistics and orthophotos. This data is used to present the total area of each particular land use category for the whole time series. When there is a discontinuity of the statistical information appropriate splicing techniques were applied.
- Concerning estimation of LUCs between categories, priority is given to estimates based on specific information on land-use changes rather than to estimates of LUCs based on expert judgement.
- Estimates of LUCs between categories based on expert judgement are with a higher priority than estimates of LUCs based on data gaps
- Data gaps

Table 208 Information on data sources and providers

Land use category	Main data source		Data provider	
	1988-1997	1998-2019	1988-1997	1998-2019
4A Forest land	Forest Inventory, Forestry Management Plans and their Forestry fund reporting forms		Executive Forest Agency (ExFA)	
Coniferous				
Deciduous				
forests out of yield				
4B Cropland	National Statistical Yearbooks	BANCIK and LPIS	National Statistical Institute (NSI)	Ministry of agriculture, food and forestry (MAFF)
annual cropland				
perennial cropland				
4C Grassland	National Statistical Yearbooks	BANCIK and LPIS	National Statistical Institute (NSI)	Ministry of agriculture, food and forestry (MAFF)
4D Wetlands	Cadastral maps of the agricultural fund for single years 1994 and 1996; LPIS, CLC		Cadastre Agency, MAFF, Executive Environment Agency	
4E Settlement				
4D Other land	Forest Inventory		Executive Forest Agency (ExFA)	

Major problem in presenting the land use pattern is the limited information on the land-use changes between particular categories. The activity data providers identify the total area for each individual land-use category, but they do not provide detailed information on changes of area between each category. Thus, a combination of approach 1 and 2 according to the 2006 IPCC Guidelines has been used for representing the area. When data for completing the information is missing, information from available statistics as well as probability assumptions of known pattern on land-use changes have been used.

The area representation in FL for the whole time series is based on data from Executive Forest Agency (EFA) and their aggregated statistics (RF1) on forest land which is updated on annual basis. However, an adjustment in the annual data is necessary to obtain more accurately the net changes in area for the inventory period. More information on that is provided in chapter 6.3.2. The LUC from FL to other LUs are reported based on annual data from EFA on forest territories subject to change in designation of lands. The LUCs to FL are reported based on a study of the former land use on the new forest areas conducted in 2012 and 2014. The assessment of the former land use on the identified new forest areas is based on expert judgment on basis of likelihoods and/or combining information from other sources like Cadastre.

The area representation in CL and GL for the whole time series is based on data from NSI, BANCIK and LPIS. NSI data is used for the year 1988-1998, when the information published in the National Statistical Yearbooks represent the only information on agricultural activities i.e. agricultural areas. The agricultural statistic methodology has changed since 1998 when BANCIK was introduced. To ensure the time series consistency the totals of CL and GL area from 1988 to 1998 was adjusted by interpolation. Like this any differences between the methods in the statistics were eliminated. As regards LUC to and from CL and GL, activity data and probability assumptions are used. All LUC from agricultural lands (including CL and GL) to other land uses are known and reported. However, information on whether the change in the designation of the agricultural lands happened on CL or GL is not known explicitly but calculated based on the relative share of these land categories to the total agricultural lands. Concerning the gains in the area it was assumed that it is mostly due to exchange between CL and GL. This assumption is confirmed by the agricultural statistics and when comparing the annual gross changes in the area of CL and GL. In addition to changes from CL to GL it considered that other possible change is from OL to GL. Any conversions and re-conversions from wetlands and settlements are considered as unlikely.

LUCs to wetlands have been assumed to stem from grasslands and other land. The determination of these land-use categories, as the possible land-use changes where the increase in wetlands may stem from, is based on the last step from the hierarchical treatment of the data sources – that is data gaps. It has been considered that the shares of these individual land use categories to the observed increase in wetlands behave like the ratios of the total areas of these land use categories in Bulgaria. In its previous submission Bulgaria reported LUCs from forestland to wetlands due to probability reasons. It was assumed that the observed increase in wetlands suggests also deforestation for wetlands. This forest loss to wetlands was estimated as a share of forest land in the totals of forest land, cropland plus grassland (it was supposed that the increase in wetlands comes from such lands). Actually, the reported LUC from forest land to wetlands in the previous submissions of Bulgaria represented an overestimation of deforestation activity since all the information for forest loss due to changes in designation of forest was reported under LUCs to settlements (SM). Since the improvements in area representation made for the Submission 2014 LUCs from forest land to wetlands were not calculated. According to experts from the ExFA, the changes of designation of forest in the years 1988-2012 have been associated with conversion only to SM. There is only one new dam lake (Tsankov kamak) which was built up in recent years, but the forest loss associated with its construction works has been already reported in the 70's. Therefore, Bulgaria reports all information provided by the ExFA for forest loss across the time series as LUC associated with conversion to SM. The reported estimates of land-use changes from cropland to other land use categories (FL and GL), which are based on specific data and expert judgment, fit very well to the observed decrease in the total grassland area since the base year. Therefore, no land-use changes from cropland to wetlands have been assumed and reported.

Concerning the LUCs to settlements there is information for LUCs from forest land to settlements, which is available for the period 1990-1994 and for the years 2001 to 2019. The annual forest loss to settlements for the years 1988, 1989 and 1995-2000 is estimated as an average value of forest loss in the period 1990-1994. Information for LUCs from agricultural lands (e.g. cropland and grassland) to settlements is available for the years 2001 to 2019. The share of annual cropland, perennial cropland and grassland within the available figure for the total area, which is changed to settlement between 2001 and 2019 was assumed to be the same as the share of the totals of these land-use categories. LUCs from arable lands to settlements for the years before 2001 are estimated using the data gaps approach. The reported land-use changes to settlement fit very well to the increase in settlement area.

Considering the definition of the OL, only conversions from OL to other LU categories is reported. In most cases these changes are estimated to fit the trend in the land use changes between categories.

Additional information in details on the methodologies and assumptions used in the estimation of land use over the reporting period is presented in the chapters for the different types of land-use.

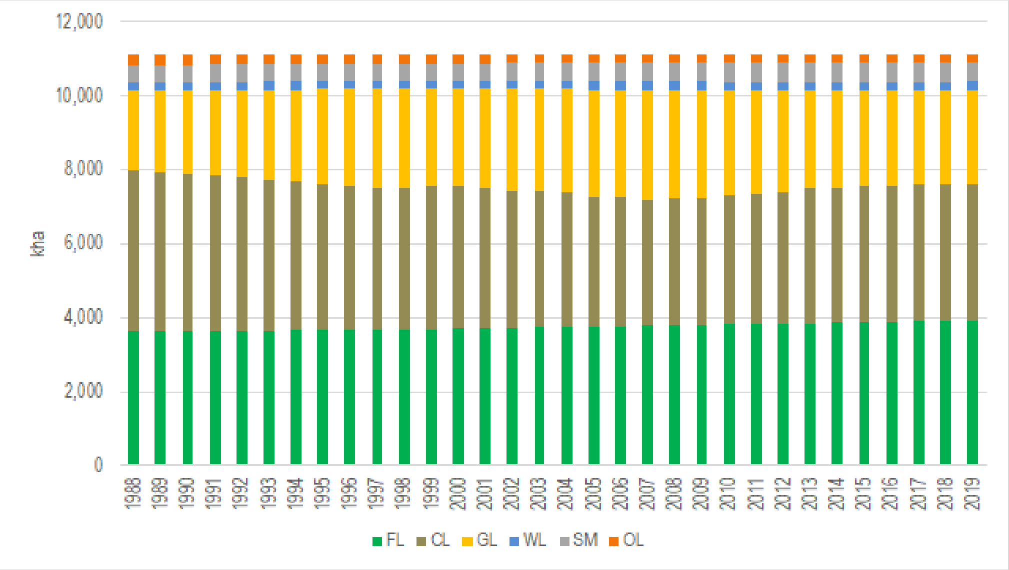


Figure 97 Annual land representation by land-use categories

Table 209 Area by type of land use and land-use changes for the base year and the last year of inventory (20 years)

Area in kha	1988	2019	2019 -1988
4.A Forest Land - Total	**3620.39**	**3934.71**	**314.32**
4A1. Forest land remaining forest land	***3480.21***	***3691.17***	***210.95***
4A1. Forest land remaining forest land - coniferous	1198.91	1044.44	-154.47
4A1. Forest land remaining forest land - deciduous	2259.78	2624.49	364.71
4A1. Forest land remaining forest land - out of yield	21.52	22.24	0.72
4A2. LUC in forest land	***140.18***	***243.54***	***103.36***
4A2.1.a Annual CL to FL	18.40	26.69	8.29
4A2.1.b Perennial CL to FL	1.20	1.35	0.16
4A2.2.a Pastures and meadows to forest land	85.98	120.04	34.05
4A2.2.b Shrubs and grasslands to forest land	33.08	94.60	61.51
4A2.3 Wetland to forest land	0.00	0.00	0.00
4A2.4 Settlement to forest land	0.00	0.00	0.00
4A2.4 OL to FL	1.51	0.86	-0.65
4.B Cropland - Total	**4363.20**	**3671.57**	**-691.63**
Cropland annual – Total	*4067.40*	*3518.83*	*-548.57*
Cropland perennial – Total	*295.80*	*152.74*	*-143.06*
4B1. Cropland remaining cropland - total	***4315.21***	***3361.87***	***-953.34***
4B1a annual cropland remaining annual cropland	3964.78	3163.95	-800.84
4B1b perennial cropland remaining perennial cropland	227.96	75.63	-152.33
4B1c LUC perennial cropland in annual cropland	57.34	58.20	0.86
4B1d LUC annual cropland in perennial cropland	65.13	64.10	-1.03
4B2. LUC in cropland	***47.99***	***309.69***	***261.71***
4B2.1a Forest land in annual cropland	0.00	0.00	0.00
4B2.1b Forest land in perennial cropland	0.00	0.00	0.00
4B2.2a Pastures and meadows in annual cropland	28.46	159.19	130.73
4B2.2b Pastures and meadows in perennial cropland	1.70	7.00	5.30
4B2.2a Shrubs and grasslands in annual cropland	16.81	137.49	120.68
4B2.2b Shrubs and grasslands in perennial cropland	1.01	6.01	5.00
4B2.3a Wetlands in annual cropland	0.00	0.00	0.00

Area in kha	**1988**	**2019**	**2019 -1988**
4B2.3b Wetlands in perennial cropland	0.00	0.00	0.00
4B2.4a Settlements in annual cropland	0.00	0.00	0.00
4B2.4b Settlements in perennial cropland	0.00	0.00	0.00
4B2.4a Other land in annual cropland	0.00	0.00	0.00
4B2.4b Other land in perennial cropland	0.00	0.00	0.00
4.C. Grassland -Total	**2175.91**	**2551.29**	**375.38**
Pastures and meadows total	*1798.90*	*1408.48*	*-390.42*
Shrubs and grasslands total	*377.01*	*1142.81*	*765.79*
4C1. Grassland remaining grassland	***1928.78***	***2078.82***	***150.03***
4C1.a Pastures and meadows remaining pastures and meadows	1533.92	1060.37	-473.55
4C1.b Shrubs and grasslands remaining shrubs and grasslands	248.14	854.64	606.50
4C1.c LUC Shrubs and grasslands to Pastures and meadows	105.12	91.93	-13.19
4C1.d LUC Pastures and meadows to Shrubs and grasslands	41.59	71.87	30.28
4C2. LUC in grassland	***247.13***	***472.47***	***225.34***
4C2.1 Forest land in grassland	0.00	0.00	0.00
4C2.2.a Annual cropland in Pastures and meadows	143.87	230.56	86.69
4C2.2.b Perennial cropland in pastures and meadows	15.99	25.62	9.63
4C2.2.a Annual cropland in Shrubs and grasslands	30.15	161.71	131.56
4C2.2.b Perennial cropland in Shrubs and grasslands	3.35	17.97	14.62
4C2.3 Wetlands in grassland	0.00	0.00	0.00
4C2.4 Settlements in grassland	0.00	0.00	0.00
4C2.4 Other land in PGM	0.00	0.00	0.00
4C2.4 Other land in MGL	53.77	36.62	-17.15
4 D Wetlands - Total	**213.50**	**231.99**	**18.49**
4D1. Wetlands remaining wetlands	***206.20***	***217.50***	***11.30***
4D2. LUC in wetlands	***7.30***	***14.50***	***7.20***
4D2.1 Forest land in wetlands	0.00	0.00	0.00
4D2.2.a Annual Cropland in wetlands	0.00	0.00	0.00
4D2.2.b Perennial Cropland in wetlands	0.00	0.00	0.00
4D2.3.a Pastures and meadows in wetlands	0.00	0.00	0.00
4D2.3.b Shrubs and grasslands in wetlands	5.91	12.38	6.46
4D2.4 Settlement in wetlands	0.00	0.00	0.00
4D2.4 Other land in wetlands	1.39	2.12	0.73
4 E Settlements - Total	**461.71**	**535.85**	**74.14**
4E1. Settlements remaining settlements	***423.08***	***483.52***	***60.44***
4E2. LUC in settlements	***38.63***	***52.33***	***13.70***
4E2.1 Forest land in settlements	1.43	5.53	4.11
4E2.2.a Annual Cropland in settlements	21.66	28.35	6.69
4E2.2.b Perennial Cropland in settlements	1.40	1.51	0.12
4E2.3.a Pastures and meadows in settlements	9.93	9.13	-0.80
4E2.3.b Shrubs and grasslands in settlements	4.15	6.05	1.90
4E2.4 Wetlands in settlements	0.00	0.00	0.00
4E2.4 Other land in settlements	0.07	1.76	1.69
4 F Other land- Total	**265.48**	**174.79**	**-90.69**
4F1. Other land remaining other land	***265.48***	***174.79***	***-90.69***
4F2. LUC in other land	***0.00***	***0.00***	***0.00***

Area in kha	1988	2019	2019 -1988
Total area Bulgaria	11100.19	11100.19	0.00

The data shows that over the period 1988-2019 the areas in the categories “Forest land”, “Grassland”, “Wetlands”, “Settlements” have increased by 314.32, 375.38, 18.49 and 74.14 kha respectively, while they have decreased in the categories “Croplands” and “Other land” by 691.63 kha and 90.69 kha, respectively.

6.3 FOREST LAND (4.A)

6.3.1 DESCRIPTION OF THE CATEGORY

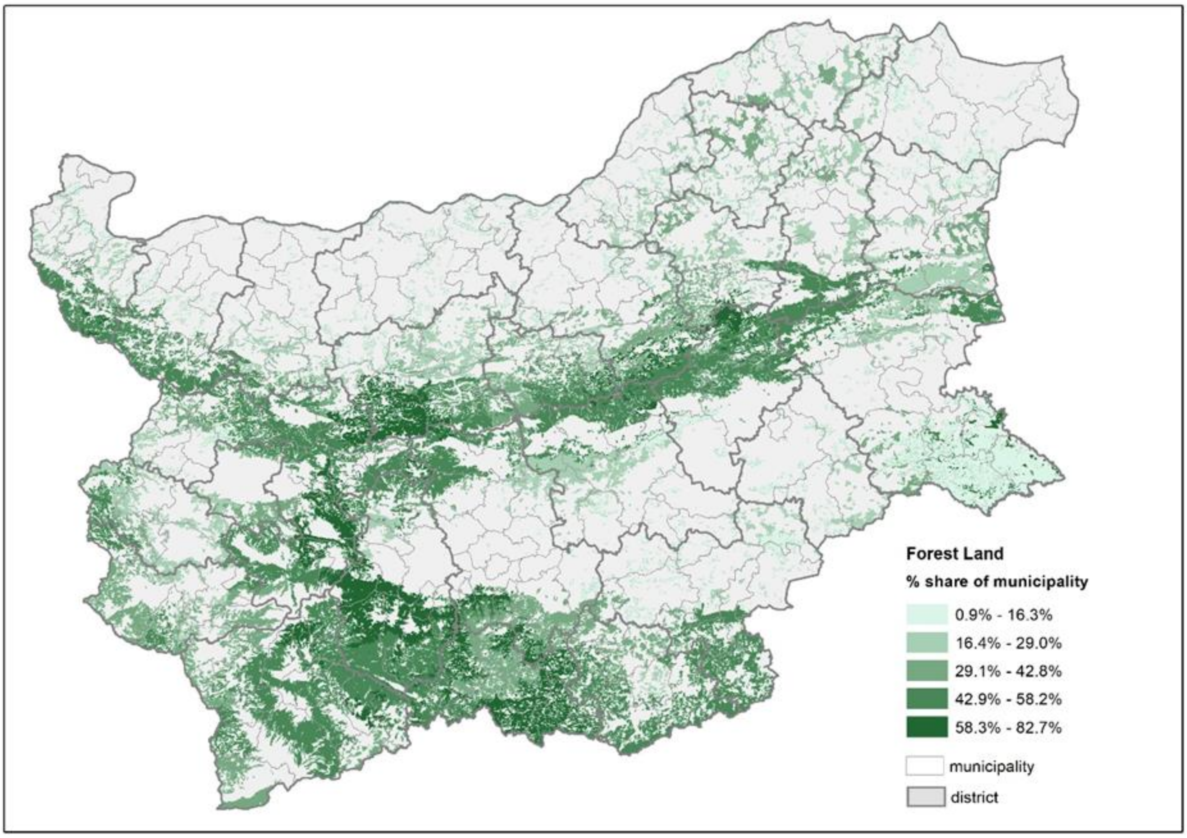


Figure 98 Share of municipality area occupied by Forest land. The map is elaborated based on CLC, 2018

In 2019, forests in Bulgaria cover an area of 3923 kha which represents 35.3% of the country's territory. Over the reporting period, a steady increase in forest territory is observed. In 2019 the forests cover is by 9% more compared to the base year.

Most of the forest territory in Bulgaria is state own – 73% (according to data from 2015). The municipalities and religious organizations own around 13% of the forests. The share of the private forests in Bulgaria has increased in recent years and it is around 11% from the total forest area. 94% of these private forests are properties with an area up to 2 ha.

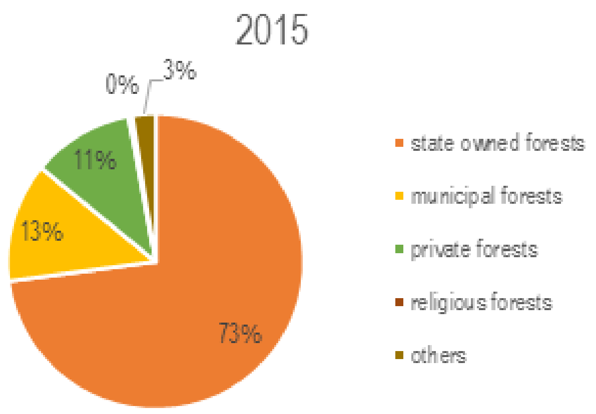


Figure 99 Breakdown of forest ownership in 2015, Source: EFA

According to the Law on Forests 2011 (art.13, 16, 19) for the forest territories – state and Municipal property, as well as for the private forest territories with land property above 50 hectares, forestry plans shall be developed. For the private forests with total area of their land up to 50 hectares a forestry programmes shall be developed. The forestry plans and programmes shall be drawn up on the basis of forestry maps, cadastre maps, maps of the restores property and performed inventory of the forest territories. The forestry plans and programmes for the private forests with total of land up to 2 ha are conducted together with forest inventory and is funded by the state. The data of the forest inventory shall be public and the procedure for access to them shall be determined by the ordinance. The Executive Forest Agency shall create and maintain an information system about the forest territories and about the activities in them. The state forestry and the state hunting reserve, the owners and users of forest territories shall be obliged to provide free information to the Executive Forest Agency and to its structures, needed for maintaining the information system. The activity data used for the reporting of the emissions/removals from Forest land category is provided by the ExFA and it covers both the state and private forests.

In accordance with the IPCC Guidelines the evaluation of the emissions/removals from Forest land category includes an assessment of the changes in the carbon stock in 3 pools – living biomass (above- and below-ground biomass), dead organic matter (dead wood and litter) and soil.

For subcategory FL-FL Bulgaria provides estimates for carbon stock changes in living biomass and dead wood at Tier 2 - with country specific data and emission factors. The carbon stock change in litter and soil pools for subcategory FL-FL is reported under T1 assuming that the pool is not a source. All the calculations in FL-FL on carbon stock changes in the living biomass and dead wood are carried out at level of tree species and then summed up to coniferous and deciduous strata for the reporting in CRF tables. To fully cover the forest definition in Bulgaria and to be consistent in terms of area there is a need to have an additional stratum – so called "out of yield". This stratum includes areas covered by Mountain pine (*Pinus mugo*) which is common for the high elevation habitats in Bulgaria. Most of the area covered by the mountain pine are part of protected areas – as part of the territory of National Parks or Natural Reserves. These forests are included in the Forest management planning in Bulgaria, they are mapped and monitored, but no data on growing stock of these forests is available in the country. There is no commercial use of the wood, therefore, it is assumed that all the gains are equal to the losses and T1 approached in reporting emissions and removals from biomass in "out of yield" stratum is used – NA.

Concerning the **subcategory LUC to Forests**, Bulgaria estimates and reports carbon stock changes in all pools – living biomass, DOM (only litter) and soil.

Non-CO_2 emissions from wildfires (Figure 105) are allocated between the subcategory 4.A.1 and 4.A.2 according to their area share in total forest land. N_2O emission from N mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils are estimated in the sub-categories where loss of carbon is reported.

There is no fertilization on forest land in Bulgaria; therefore, direct N_2O emissions from fertilization are reported as NO (not occurring). Non-CO_2 emissions associated with drainage of organic soils are reported as NO, since such activity is not occurring in Bulgarian forests.

6.3.1.1 Trends in the emissions/removals from Forest land category

The Forest category is serving as a sink of CO_2 emissions over the entire time series. The amount of CO_2 removals from the category ranges between -17217.19 Gg CO_2 eq. for 1988 and -8298.00Gg CO_2 eq for 2019. Despite the observed increase in forest area (Figure 101), there is a drop in the amount of the removals from the category, driven by the overall decrease in the removals from living biomass in FL-FL and losses of carbon in soils of GL and CL converted to FL.

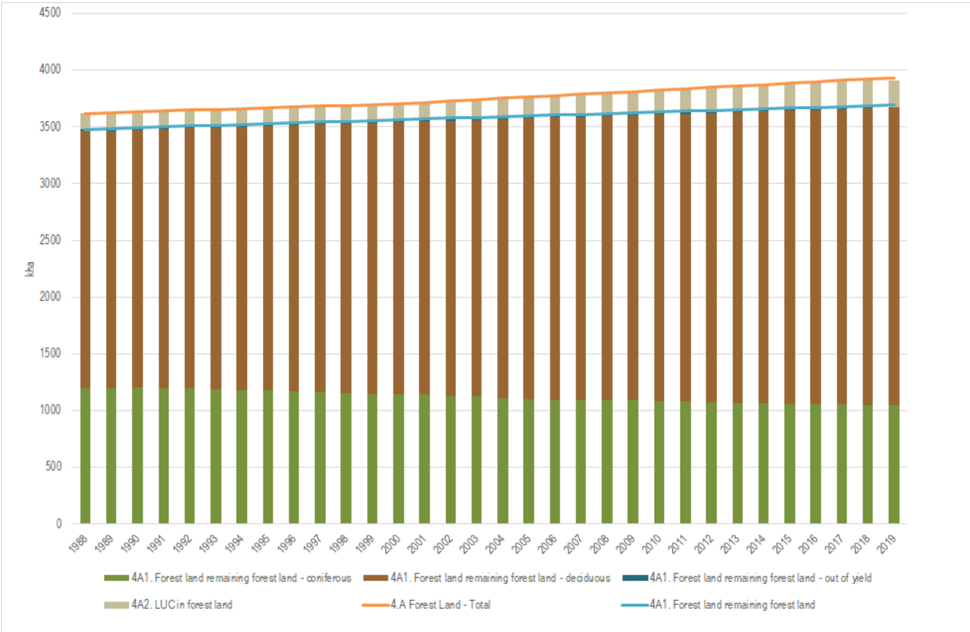


Figure 100 Trend in forest area 1988-2019

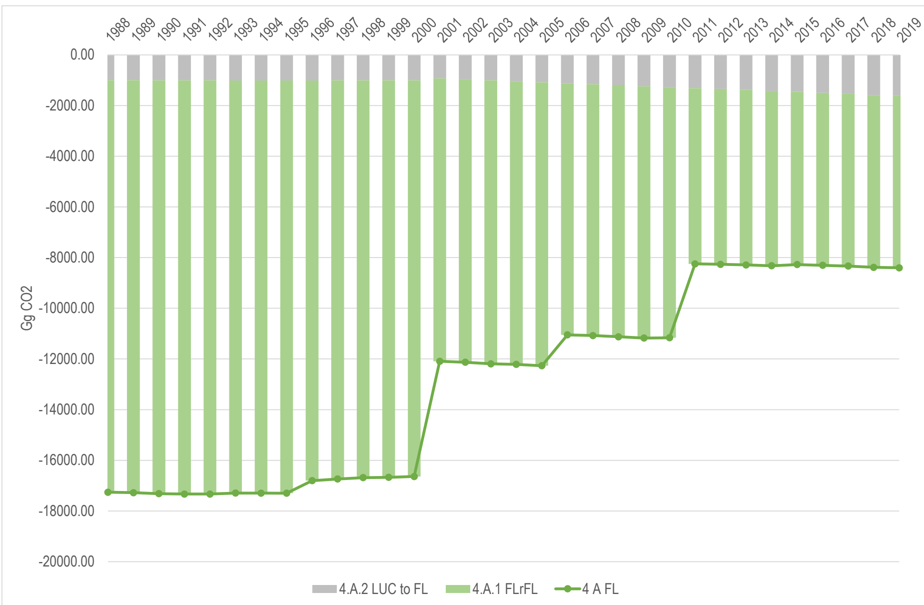


Figure 101 Trends in CO_2 removals from category Forest Land

The major reason behind this dramatic decline is that in Bulgaria, since 2000, there is a constant increase in harvesting. Although the increase in the wood removals, the harvesting in these years is still below to what was planned to be harvested. In 2019 the harvesting is by 20% higher than in 2010 as since 2012 it reached the planned quantities according to FMPs. The increase in harvesting since 2011 is in response to the market demand and also to the fact that since the adoption of the new Forest Act (2011) there was an organizational change in the management of the forestry operations and in most cases the planned harvesting according to FMP is fulfilled. Although such an absolute increase in harvesting, the growing stock in Bulgaria is increasing during the years and it is expected to increase in the next 20-30 years (Figure 103).

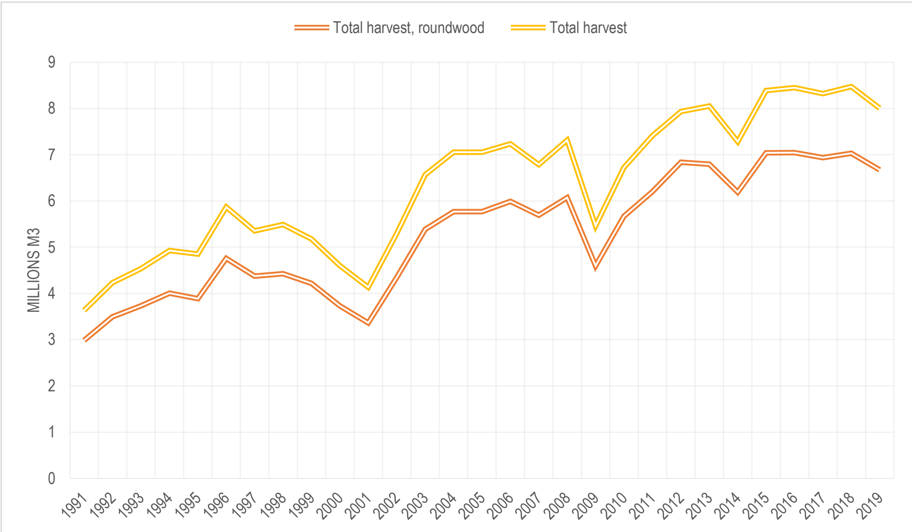


Figure 102 Trend in wood harvested vs planned harvest (mill m^3 o.b)

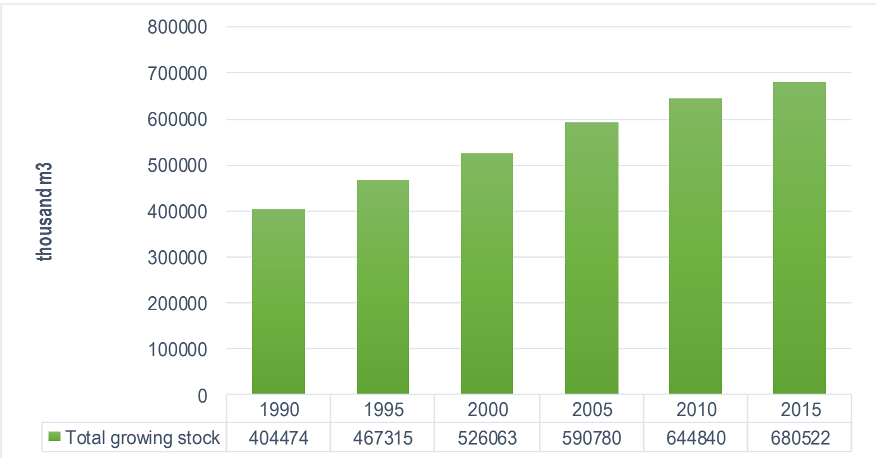


Figure 103 Standing growing stock in Bulgaria, official data

In addition to the observed increase in harvest, there are other peculiarities of Bulgarian forest which could affect the rate in biomass accumulation. Concerning the broadleaves, these are the big shares of coppice forest (>40 years). Coppice forests make up 35% of forests in Bulgaria. 80% of them are aged over 40 years and 40% are over 60 years, which is the result of a long-lasting policy to convert them into seed forests. In most cases the policy was not implemented successfully and any of these forests have lost their ability to regenerate through offshoots, and seed undergrowth is often crowded by the shrub vegetation under the canopy of coppice forests (Popov et al., 2019). These stands do not grow intensively and are now subject to harvest activities. Regarding coniferous forests, the peculiarities are related to the big share of the coniferous plantations (60% of coniferous forest). Many of these plantations (almost 40%) have been planted on lower altitude (below 1000 m a.s.l.) before

40-50 years (90% of plantations are at age of the stands 30-60). Now, these stands are not in a good condition. They suffer from droughts, pathogens and insects. Their productivity is not intensive anymore and they are slowly declining (Popov et al., 2013, 2014, 2018). Thus, these stands are intensively thinned now.

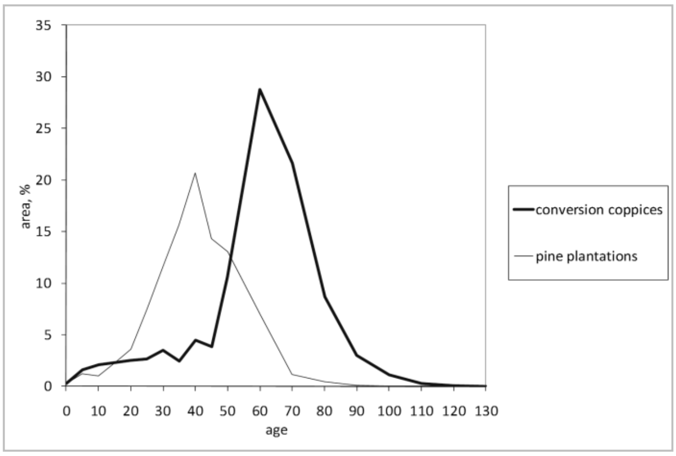


Figure 104 Forest area of pine plantations and conversion coppices by age

Trend in Non-CO_2 emissions from biomass burning (wildfires) are shown on the figure below. Only emissions of CH_4 and N_2O are reported here as the emissions of CO_2 are included in the living biomass pool as Bulgaria applies the stock-change method in estimating the carbon stock changes living biomass pool.

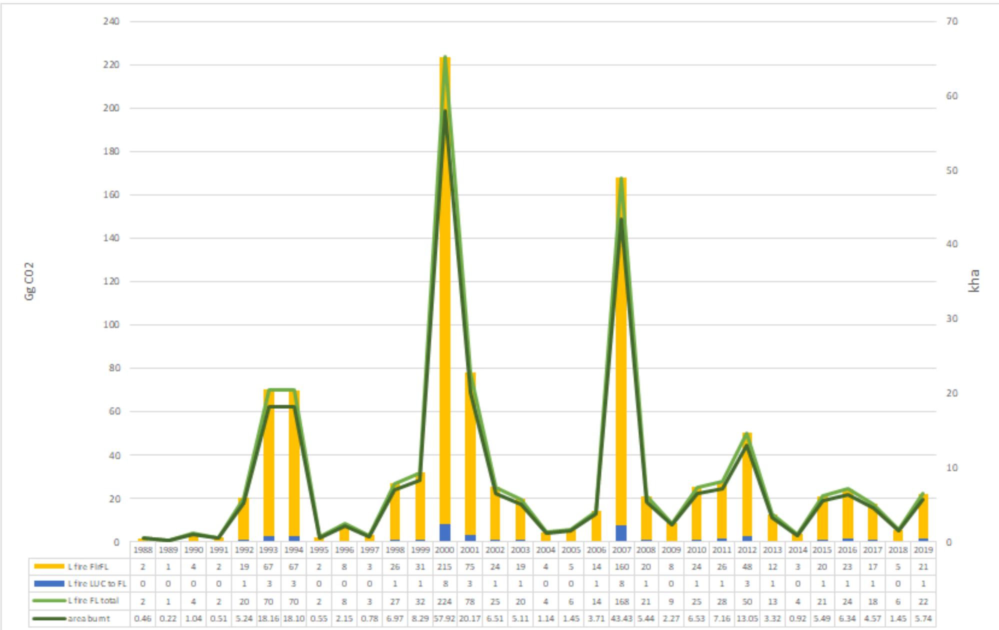


Figure 105 Non-CO_2 emissions associated with biomass burning from wildfires

Table 210 Total N_2O emissions from N mineralization associated with loss of soil organic matter in CO_2 eq

Year	4.A.2.1 Cropland converted to Forest land (N_2O converted into CO_2 equivalents)	4.A.2.2 Grassland converted to Forest land (N_2O converted into CO_2 equivalents)	4.A.2 Total
1988	2.60	38.63	41.23
1989	2.60	38.45	41.05

Year	4.A.2.1 Cropland converted to Forest land (N_2O converted into CO_2 equivalents)	4.A.2.2 Grassland converted to Forest land (N_2O converted into CO_2 equivalents)	4.A.2 Total
1990	2.60	38.29	40.89
1991	2.60	38.19	40.79
1992	2.60	38.14	40.75
1993	2.60	38.10	40.70
1994	2.60	38.11	40.71
1995	2.60	38.15	40.75
1996	2.60	38.21	40.81
1997	2.60	38.33	40.93
1998	2.60	38.49	41.08
1999	2.60	38.66	41.26
2000	2.60	38.83	41.43
2001	2.65	40.76	43.41
2002	2.71	42.79	45.50
2003	2.77	44.83	47.59
2004	2.82	46.84	49.67
2005	2.88	48.86	51.74
2006	2.94	50.90	53.84
2007	2.99	53.05	56.05
2008	3.06	55.58	58.65
2009	3.12	57.97	61.09
2010	3.18	60.37	63.55
2011	3.23	62.66	65.90
2012	3.29	64.93	68.22
2013	3.35	67.32	70.67
2014	3.41	69.56	72.97
2015	3.47	71.90	75.37
2016	3.54	74.14	77.68
2017	3.60	76.31	79.91
2018	3.66	78.33	81.98
2019	3.72	80.48	84.20

6.3.2 INFORMATION ON THE APPROACHES USED FOR PRESENTING THE DATA FOR THE AREAS AND THE DATABASE ON THE LAND-USE USED FOR THE INVENTORY

Sources of activity data

The main sources of quantitative information about forests in Bulgaria are the Forest Management Plans (FMP) and the forestry fund reporting forms (RF). For the elaboration of the continuous time series on the total forest land reporting form 1 (RF1) has been used. RF1 provides annual information on the distribution of the area by land types (forested land, bare land for afforestation and non-productive bare land) and forest types (conifer forests, broadleaved high-stem forests, conversion coppice forests and low-stem forests). RF1 also gives some other details about the site and vegetation. The aggregated data in RF1 is the sum of the data at the level of sub-compartments. Land use changes to forest lands are traced and reported according to Forest Management Plans.

Area data and Forest area adjustment

When compiling the data on forest areas, data from the forestry reporting form 1 (RF1) have been used. Although the high reliability of the gathered data, some adjustments of the original data have been made. In the Submission 2011 it was identified that the net increase in forest land was not only due to afforestation/reforestation (AR) activities but also due to inclusion of area, which were forested before 1990. In order to distinguish those new forest areas which were forested before 1.1.1990 from the total increase in forest area, Bulgaria submitted a plan for improvement of the estimation of AR units of land. In its submission 2014 Bulgaria continues to follow this plan as accepted by the ERT team as answer to the related Saturday paper issue of the 2011 review. The plan has been implemented in stages starting in Submission 2012 and completed for the Submission 2014. According to this plan the following improvement steps have been implemented:

Bulgaria examined the Forest Management Plans (FMPs – see below) for all State Forest Enterprises (SFE), which were inventoried for the period 1991-2012. Like this all changes since 1992 in forest area for each and every SFE has been traced and identified. For those SFE, where there is an increase in the forest area since 1990, the increase is derived into:

- New forest areas which are included in the forest total, but which were forested before 1990, so new forests with stands of older age classes.
- And the new forested areas with stands of the youngest age class, which are due to afforestation and reforestation activities (planting and seeding) on arable lands and barren areas or afforestation and reforestation activities (planting, manual and natural seeding) on grassland or on croplands.

These improvement steps have been performed by the experts from Executive Forest Agency, by using the following sources of information:

- Forest Inventory and FMPs;
- Forestry Fund Reporting Form 1FF (forest area) for the 1990;
- Forest maps

The observed increase in forest area due to AR activities for every single SFEs is given for two periods - 1992-2000 and since 2000. The amount of the "new" forest areas since 1.1.1990 which were forested before 1990 (point a) was added to the total forest area in 1991 and the years after according to Forestry Fund Reporting Form 1FF (forest area). Like that the total forest area (particularly those of forest land remaining forest land) in 1991 and in the years after has been adjusted by using interpolation. The new forest areas between 2012 and 1992 according to point b represent the net increase in forest due to planting or seeding (manually or naturally) activities. Changes in forest area for the years 1988 – 1991 are based on extrapolation using the same forest change as in the year 1992.

In order to get information for the former land uses that became forests, an expert judgement has been used. Land use (cropland, grassland, other land) typically follows ecological site condition. The experts going through the FMPs know the dominating land uses in the SFE region, so they made an expert judgement of former land use on basis of likelihoods. For example, there are regions where grassland (GL) dominates, because growth/site conditions are not good enough for cropland (CL) plants or CL management or, site conditions are so good that CL dominates. Similarly, other land (OL) can be found in extreme site conditions where FL, CL, GL cannot grow.

6.3.3 METHODOLOGY

Sources of information

<u>Forest Stand Descriptions (Description sheets)</u>

The Forest Management Plans (FMP) and their forest stand descriptions are the most detailed and accurate information on forests available in Bulgaria. The FMP are updated in a 10-years period – i.e.

one tenth of the territory is surveyed each year. Practically all forest stands are surveyed once in every 10 years. The survey produces detailed maps, as well as description of the forest stands (e.g. species composition, age of the stand, yield class, mean height, volume of growing stock, stocking rate, etc.). The survey (stand-wise forest inventory) is made for each sub-compartment or each forest stand. According to the latest available data on forest Management plans, the sub-compartments are currently 1.340 million with an average area of 3.15 ha. They are distributed into 176 territorial units or state forest enterprises for which a Forest management Plan is prepared. The data from forest stand descriptions are stored in a national database which is publicly available on the website of the Executive Forest Agency. Although, the description sheets are the most detailed data on forest stands, they have drawback of being updated on a 10-years period. They also do not contain data on the current activities of the territorial units.

The information in FMP serves as a basis for producing more aggregated data (statistics) for operational use such as reporting forms (RF 1-7) for the state of the forests in Bulgaria.

Aggregated data

Another source of data used in the estimation of emissions and removals from FL category is forestry fund reporting forms (RFs). These are aggregated data (overview tables) that are updated and collected in a national database maintained by EFA. On basis of these reporting forms, data for the national statistics and for the internal use of EFA are provided.

The RF represents 7 reporting forms (tables), prepared by the territorial units, which have been collected since 1960 in the same format. Since 1991, they are collected via an electronic data bank and are available electronically.

Forms are known with the traditional designations RF1, RF2, ..., RF7. Forms RF1 – on forest territories and RF5 – on wood removals, are collected annually. The other forms are collected over 5 years. In electronic form, they are available for the years 1995, 2000, 2005, 2010 and 2015.

RF1 is the distribution of the area by land types (forested land, bare land for afforestation and non-productive bare land) and forest types (conifer forests, broadleaved high-stem forests, conversion coppice forests and low-stem forests). RF1 also gives some other details about the site and vegetation. The aggregated data in RF 1 is the sum of the data at the level of sub-compartments. For example, the area of a sub-compartment in which the conifers predominate will be added in the row of "conifers", although it may contain some deciduous species. The main purpose of RF1 is to monitor the "development of the forest fund" – i.e. the inclusion of new forests in the forest territory and the transfer of land from one territorial unit to another.

RF2 and RF3 are distributions of area and growing stock according to forest types, tree species and age. Areas in RF2 and volumes in RF3 are parcelled - each tree species in a forest stand has assigned area and stock to and in RF2 and RF3 they are added to the row of these tree species. RF2 and RF3 do not provide information about the site and do not provide some necessary details about the origin, in particular, what part of the areas are covered by natural stands and what are plantations. Since RF1 works with the area of whole stands, and RF2 - with parcelled areas, there are unavoidable differences in the area of the conifers according to RF1 and RF2, and also of the other forest types.

RF4 is a distribution of area and stock by function (wood production land, protective forests, recreation forests, protected forests).

RF5 is a comparison of the planned wood removals with the actual wood removals throughout the year. It gives the total cutting areas and the quantity of wood extracted. For state forests EFA also has more detailed data that feeds RF5, but for non-state forests RF5 is the only source. RF5 works with simplified lists of tree species (high-stem beech, oak and poplar, conversion coppices, conifers) and fellings (final fellings and thinnings). In Bulgaria, RF5 is the only data source for actual timber harvesting.

RF6 is a distribution of the area by forest types (conifers, etc.), stand age and stocking rate. It served as information on the average stocking rate of the renewed areas.
RF7 is the distribution of the area by tree species composition (pure pine stands, mixed stands dominated by beech, mixed stands dominated by other broad-leaved tree species, etc.) and site index. Its aim was to monitor a practice that is currently abandoned - the replacement of non-productive stands with productive ones in order to improve productivity.
RF4, RF6 and RF7 work with the area of whole stands and their areas are aligned with RF1.
Updating RF is done manually, without considering the increment. In the year of a forest inventory, the reporting forms of forested area for a given territorial unit are taken from its plan. In the year, the employees register their activity - there is a letterhead for each purpose in each description sheet. Based on the recorded data, they subtract from the RF tables the harvested wood (in m^3) and hectares and add the afforested hectares to them. They do not measure nor calculate any increment. Therefore, all growing stocks in the RFs are slightly underestimated - they should be added to about 9/10 of the 5-year current increment.

Table 211 Description of the content of the wooded area reporting forms (RF)

Reporting form №	Description	Update period
1	Forest area (forested and non-forested lands inside the forest fund)	Annually
2	Forested area distributed by age classes	Every 5 years since 1960; data used for the years 90-95-00-05-10-15
3	Growing stock by age classes	Every 5 years since 1960; data used for the years 90-95-00-05-10-15
4	Forested area distributed by forest functions	Every 5 years since 1960; data used for the years 90-95-00-05-10-15
5	Harvested amounts	Annually, separately for regeneration fellings and thinning
6	Forested area distributed by canopy cover and age classes	Every 5 years since 1960; data used for the years 90-95-00-05-10-15
7	Forested area distributed by age classes and yield classes	Every 5 years since 1960; data used for the years 90-95-00-05-10-15

Data on forest litter and soil

The source of information about the physical and chemical properties of the forest soils is The International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests). ICP Forest has been launched in 1985 under the Convention on Long-range Transboundary Air Pollution (Air Convention, formerly CLRTAP) of the United Nations Economic Commission for Europe (UNECE) to monitor forest condition at two monitoring intensity levels – Level I, which aims gaining insights into the geographic and temporal variations in forest condition and Level II, which monitors selected forest ecosystems with the aim to clarify cause-effect relationships.
In Bulgaria, the Programme started in 1986. There are three sample plots at Level II. The observation plots part of Level I have been first established at 16x16 km grid, with focus on the coniferous plantations as these forests have been considered as more vulnerable to the atmospheric pollution. For these sample plots where pollution have been found, additional sampling plots have been set at 8x8 km or 4x4 km grid. Thus, the number of the plots in the beginning have reached almost 360. Throughout the first years of the programme the number of the sample plots has been reduced based on expert judgement and circumstances related with the terrain. Thus, a shift in the grid have been introduced, so the grid became randomly distributed among the forest territories in the country and the sample plots was reduced at 256 until 2009. Since 2009, the sample plots have been revised in connection to the implementation of the EU project FUTMON after which the observation network numbers 159 permanent plots.

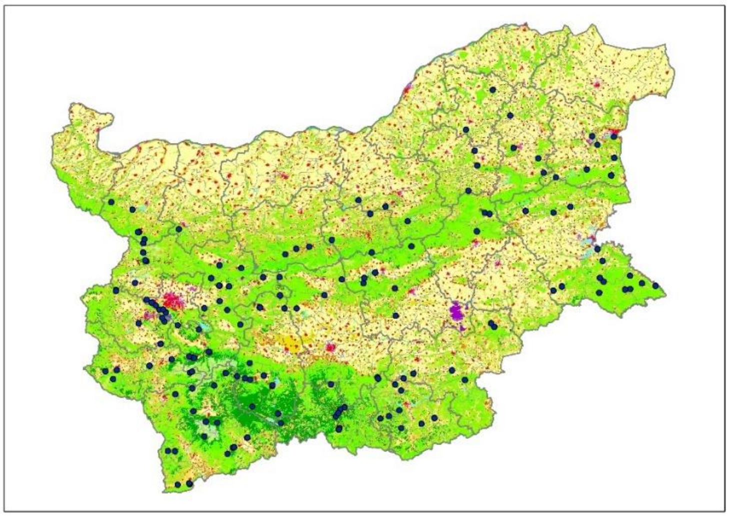


Figure 106 Distribution of the 159 sample plots at Level I since the FutMon project

Throughout the years, all the sample plots at Level I are monitored annually and an expert assessment of the crown condition and phytosanitary observations is conducted, as well as analysis of other damaging factors, incl. windbreaks, snowbreaks and icebreakers, droughts, fires etc. Once in every 5 years a full inspection of the sample plots is conducted. The full survey includes, assessment of soil conditions, nutritional status, dendrometircal assessments of the stands, phytoceanotic characteristics and floristic composition. All the information from the annual assessments of the sample plots is stored in a specific database maintained by the Executive Environment Agency. The information from the full surveys incl. also data on soil carbon content are stored as part of the expert's reports on hard copies and/or electronically. Currently, these data are the only data source information about the carbon content in forest's soil and litter gathered from systematically measured and monitored sample plots for long enough period, which encompasses most of the inventory period as well.

6.3.3.1 Forest Land remaining Forest Land (4.A.1.)

6.3.3.1.1 Changes in the carbon stock in the living biomass

Bulgaria follows IPCC Guidelines 2006 and applies the stock-difference method when defining carbon stock changes in living biomass. Conversion coefficients used are specific for Bulgaria and the ones given in the IPCC 2006 tables. The main database includes: forest area by type (coniferous and deciduous), forested area by tree species and age-class structure, and the volume stock (stem wood and branches) by forest type and tree species obtained from the reporting forms (1, 2 and 3 RFs). To calculate the changes in the carbon stock of the living biomass Method 2 is used.

$$\boldsymbol{C_B = (C_{t2} - C_{t1})/(t_2 - t_1)}$$

The carbon stock in the biomass is calculated using the equation:

$$\boldsymbol{C = A \cdot V \cdot BCEF_s \cdot (1 + R) \cdot CF}$$

Where:

A – area of land remaining in the same land-use category

V – tree stock (stemwood and branches) m^3. ha-1

$BCEF_S$ – biomass conversion and expansion factor for expansion of merchantable growing stock volume to above-ground biomass, tonnes above-ground biomass (m^3 growing stock volume)

$$\boldsymbol{BECF_s = BEF_2 \cdot D}$$

Where:

BEF_2 - expansion factor for conversion of the stem wood plus branches into a total aboveground tree biomass (stem, branches, leaves),D - basic wood density, tonnes m^{-3}

R – root to shoot ratio

CF – carbon fraction in the dry matter in tonnes C (tonnes d.m.)$^{-1}$

For Submission 2019, Bulgaria improved its estimation of emissions and removals from living biomass in FLrFL subcategory. The changes affect the level at which calculations are made and consequently the emission factors applied. At the current submission the emissions and removals are reported for coniferous and deciduous forests, but the reported figures are the sum of the most common tree species from these forest types. Thus, the strata used in the calculations is as follow:

1. Coniferous:
    - Scots pine
    - Norway spruce
    - Black pine
    - Silver fir
    - Other conifers

2. Deciduous:
    - Oak
    - Beech
    - Poplar
    - Others

This stratification reflects the main tree species distribution in Bulgaria. The reason to put the poplars into a separate stratum is that these forests are fast growing forests and are managed in a completely different way from the rest of the broadleaved forests.

The forest inventory in Bulgaria assesses not only the stemwood volume (o.b) but also the volume of the branches of the trees. Such data have been published on a regular basis in the reporting forms over a five-year period since 1965. For this inventory, data on the wood volume by tree species are used for the years 1990, 1995, 2000, 2005, 2010 and 2015.

Table 212 Growing stock (o.b) - stemwood and branches by stratum

Stratum	unit	1990	1995	2000	2005	2010	2015
Scots pine	m3/ha	151.54	184.56	216.15	230.29	248.84	259.93
Norway spruce	m3/ha	225.92	242.40	285.88	306.54	344.86	371.06
Black pine	m3/ha	71.60	125.07	184.16	214.19	244.18	268.52
Silver fir	m3/ha	328.85	342.51	372.32	383.41	405.65	453.31
Other conifers	m3/ha	148.25	187.59	213.31	194.71	285.47	322.08
Oak	m3/ha	83.04	88.42	95.73	102.63	103.98	102.84
Beech	m3/ha	194.37	213.63	223.76	240.69	251.07	265.19
Poplar	m3/ha	86.36	89.08	82.46	96.99	115.73	117.52
Others	m3/ha	69.22	77.81	79.61	83.45	89.03	90.63

To convert the volume stock into aboveground biomass, Bulgaria applies conversion factors – BEF_2 to add the leaf biomass and D (wood density). There are no country-specific values for BEF_2 which has only to add the leaf biomass as the data on growing stock in Bulgaria contains also the volume of the branches. To estimate this specific BEF_2 data from literature sources on results from ecosystem studies for Spruce, Scots pine, Beech and Oaks were used (compiled in *Korner, C., Schilcher B. und Pelaez-Riedl S. 1993: Vegetation und Treibhausproblematik: Eine Beurteilung der Situation in Österreich unter besonderer Berücksichtigung der Kohlenstoff- Bilanz. In: ÖAW (Hrsg.): Anthropogene Klimaänderungen: Mögliche Auswirkungen auf Österreich – mögliche Maßnahmen in Österreich. Dokumentation, Österreichische Akademie der Wissenschaften, Wien, 6.1-6.46*). BEF_2 values are age-dependent. The BEF_2 for each tree species is calculated as a weighted mean value considering the actual volumes of the individual age classes for each of the major tree species. The BEF_2 values used are presented in the table below. It also shows information on which species from the literature source we used to end up with BEF_2 value for the main tree species.

Concerning basic wood density (D) national data is used. The calculations are based on values determined for Bulgaria for shrinkage and the density of the absolutely dry wood (Bluskova, G., 1994; Enchev, E., 1984). Density and shrinkage of the main Bulgarian tree species are available (Norway spruce, Scots pine, Silver fir, Oaks, Common beech, Ash, Willow, White birch, Common hornbeam, Elm).

Table 213 Calculated BEF_2 values used in the emission/removals estimates

Tree species	BEF_2 estimated based on the actual age-class distribution	BEF_2 literature
Scots pine	1.07	Scots pine
Norway spruce	1.15	Spruce
Black pine	1.07	Scots pine
Silver fir	1.13	Spruce
Other conifers	1.12	Average of Scots pine and Spruce
Oak	1.02	Oak
Beech	1.01	Beech
Poplar	1.015	Average of oak and beech
Other broadleaves	1.015	Average of oak and beech

The tree specific values for basic wood density are presented in the table below.

Table 214 Wood density (D)

Tree species	kg/m3
Scots pine	0.432
Norway spruce	0.381
Black pine	0.479
Silver fir	0.364
Other conifers	0.430
Oak	0.661
Beech	0.562
Poplar	0.360
Other broadleaves	0.604

Due to the lack of specific data for the ratio of the below-ground to above-ground biomass (R) for Bulgaria, coefficients presented in the 2006 IPCC Gls have been used according to the quantity of the aboveground biomass of each stratum during the time series.

Table 215 Root to shoot ratio (R)

Tree species	R	R	R
Above-ground biomass	*<50 tonnes d.m ha^{-1}*	*50-150 tonnes d.m ha^{-1}*	*>150 tonnes d.m ha^{-1}*
Scots pine	0.40	0.29	0.20
Norway spruce	0.40	0.29	0.20
Black pine	0.40	0.29	0.20

Tree species	R	R	R
Above-ground biomass	*<50 tonnes d.m ha^{-1}*	*50-150 tonnes d.m ha^{-1}*	*>150 tonnes d.m ha^{-1}*
Silver fir	0.40	0.29	0.20
Other conifers	0.40	0.29	0.20
Above-ground biomass	*<75 tonnes d.m ha^{-1}*	*75-150 tonnes d.m ha^{-1}*	*>150 tonnes d.m ha^{-1}*
Oak	0.46	0.23	0.24
Beech	0.46	0.23	0.24
Poplar	0.46	0.23	0.24
Other broadleaves	0.46	0.23	0.24

The carbon fraction in the dry matter (CF) is adopted by default form the 2006 IPCC Guidelines (Table 4.3). It is 0.51 tonnes C for coniferous and 0.48 for deciduous.
The annual stock changes in biomass pool are obtained by estimating the difference between the years for which biomass stock by tree species is estimated divided by 5 (1990,1995, 2000, 2005, 2010, 2015). Then the stock changes by tree species are multiplied by their respective area in order to estimate the annual emissions/removals from the pool.

6.3.3.1.2 Changes in the carbon stock in the dead organic matter

In Submission 2017 and 2018 Bulgaria reported emissions and removals from DOM – litter and dead wood, by using results from a study on application of CBM-CFS model at EU level (Pilli et al, 2016). Back in 2017, this was the only option to report CSC from these pools in response to the encouragements of several ERT's to apply higher tier in FL-FL for these pools, as BG does not have proper data to account for the changes in soil pool of the remaining lands. Subsequently, we acknowledged that this leads to a methodological inconsistency in the methods and tools in assessing the CSCs from forest carbon pools (e.g CBM for DOM and SOC, and own calculations from biomass). In addition, the Pilli's results on CSC in soil and DOM for Bulgaria have not been validated or verified and come from a non-adjusted model for the Bulgarian conditions.
As there were no proper data to accurately estimate the emissions and removals in that pools, there was not any other alternative than to apply again T1 approach in Submission 2019 for these pools until proper data and/or model are available.
Referring to the dead wood pool, Bulgaria developed its own calculations on emissions and removals for Submission 2020 based on own model, which approximate the dead wood stock to the ratio of the mortality and age class. The model was revised and improved for the Submission 2021. More information on the estimation approach and model description are provided in the next sub-chapter.
Referring to the litter pool, it is still reported under Tier 1 approach. In response to a recommendation to *"Develop a method to accurately estimate litter C stock changes on FL-FL or provides a robust justification demonstrating quantitatively that emissions from litter on Forest Land remaining Forest Land are insignificant as required per para 37 (b) of the UNFCCC Annex I reporting guidelines",* Bulgaria dedicated time and efforts to analyse properly the soil and litter information available in the country. More information on the results of that work is presented in chapter 6.3.3.1.2.2.

6.3.3.1.2.1 Changes in carbon stock in dead wood

The dead wood includes coarse woody debris like downed woody debris, standing dead trees, stumps. Litter includes mostly the leaves/needles, twigs and small woody materials (including bark, fruits etc.)
There is no systematically collected quantitative data on dead wood in BG which could enable us to derive CSCF (carbon stock change factors) for DW in FLrFL from official statistics. Based on national and international data on average stock of dead wood, a provisional estimate of the total amount of dead wood and its stock change could be estimated. For better results such estimates needed to be

differentiated by tree species and age. For doing so, the data of dead wood stock from the bibliography available in Bulgaria have been approximated to the ratio of mortality to the standing volume per tree species and age class, which can be determined from available growth and yield tables. In doing so, we assume that forests that produce more dead trees also have more remaining dead wood. The model we used to determine mortality is the classic growth and yield tables.
The following equations were derived from the growth tables to perform the calculations:

$$p = \frac{a}{e^{kt} - 1},$$

Where p is the percentage of mortality (the volume of mortality mass, expressed as a percentage of the volume of the entire standing mass), t is the age of the forest in years, a and k are regression coefficients.
Such an equation is derived through regression for each tree species represented in the total forest land. Hence, the mortality in the forests was determined by multiplying the stock of the living biomass (derived by the reporting form 3-RF3) by the appropriate percentage:

$$M_{ij} = p_{ij} V_{ij}$$

where M_{ij} is the amount of mortality i in the forest age j, p_{ij} is the percentage of mortality as defined above, and V_{ij} is the standing biomass of the species and age reported by RF3.
The obtained model coefficients are presented in the table below. The quality of the approximation is demonstrated in the following figure.

Table 216 DW Model coefficients

Tree species	*a*	*k*
Pinus peuce	0.002048888	0.002125
Scots pine	0.001659772	0.002329
Spruce	0.017467732	0.014025
Fir	0.076737258	0.026636
Black pine	0.010731931	0.017589
Duglas fir	0.025102229	0.017036
European larch	0.005978804	0.006899
Beech	0.004459419	0.00533
Beech coppices	0.00008442	0.000153
Oak	0.006509801	0.00985
Oak coppices	0.02413713	0.021924
Birch	0.012103951	0.018783
Linden	0.000129637	0.000207
Ash	0.033223041	0.026642
Alder	0.004337363	0.009891
Aspen	0.047494468	0.041061
Poplar	0.000260787	0.000887
Locust	0.000106149	0.000142
Oriental hornbeam	0.004894046	0.008702

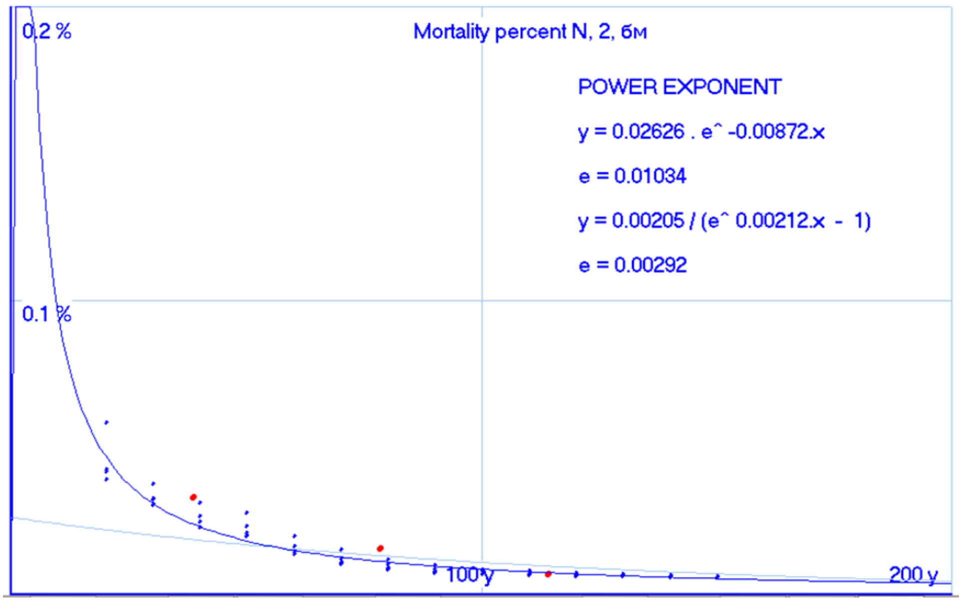


Figure 107 Annual mortality rate according to yield table for Pinus peuce

In the formula the dependence of the mortality rate from the yield class is ignored, which is a weakness. This is mainly due to the available data (RF3) which does not account for the yield class. The coefficients are obtained by a regression according to the tables, which covers all yield classes and corresponds approximately to the yield class III, which is the most common in natural conditions. An illustration of the approach is given in the figure below. It demonstrates that the obtained model curve is average with respect to the output data.

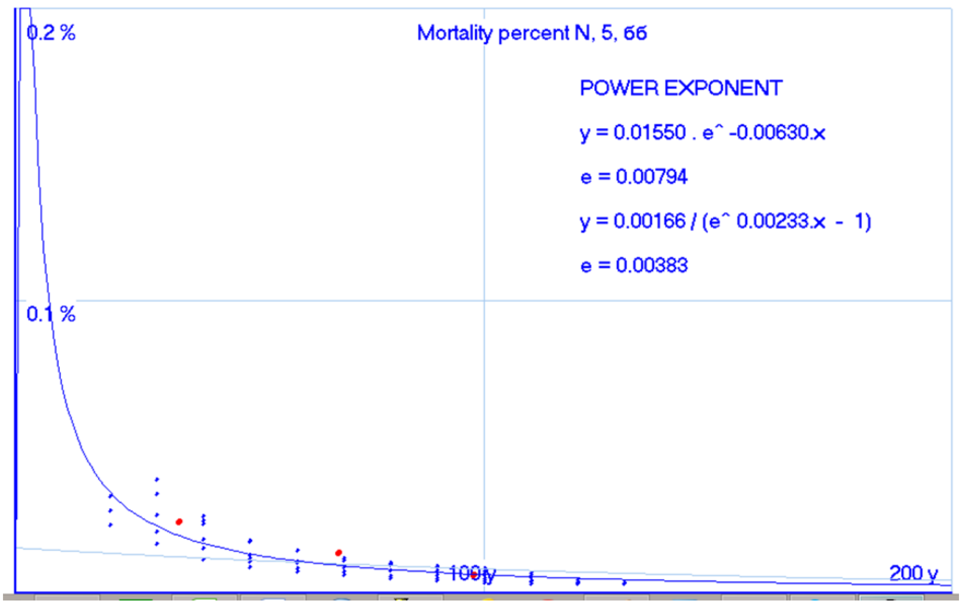


Figure 108 Annual mortality rate coefficient approximated to yield class III, (example for Pinus sylvestris)

To estimate the dead wood stock in forest lands, information on dead wood stock in m^3 per ha have been derived from local scientific studies aiming at defining a complex index for identification and evaluation of old-growth forests (Zlatanov et al., 2013). The studies have been conducted in coniferous and deciduous forests across the country (n=99 for Rodopi mountain, n=56 for Stara Planina). The report of the study provides ranges for dead wood stock for the main tree species in Bulgaria based on their own observations or based on other studies (Panayotov, Alexandrov, Zlatanov, not published).

Table 217 Dead wood stock in forest stands

Tree species	Year of stands	DW stock, m3/ha	Range
Norway spruce, Silver fir, Other conifers	<100	70	100-150
Scots pine, Black pine	<140	50	50-100
Oak	<140	50	50-100
Beech	<140	70	40-140
Other broadleaves	<140	35	30-40
Oak, coppice	<61	30	30-60
Beech, coppices	<61	40	30-50

Table 218 Dead wood stock in forest stands

Tree species	Year of stands	DW stock, m3/ha	Range, m3/ha
Norway spruce, Silver fir, Other conifers	>100	150	100-180; 200-300
Scots pine, Black pine	>140	60	50-100
Oak	>140	110	110-140
Beech	>140	120	100-180
Other broadleaves	>140	45	30-60
Oak coppices	>61	40	30-60
Beech, coppices	>61	45	30-60

To convert the data on volume stock to carbon content the following conversion factors have been used.

Table 219 Factors used for convertion of the biomass volume stock to carbon content

Conversion factors	coniferous	broadleaves	Source:
Density, t/m3	0.362	0.427	L. Di Cosmo et al., 2013
CF	0.510	0.480	IPCC 2006

Table 220 Carbon stock in dead wood per tree species and age of stands

Tree species	Year of stands	Carbon stock in DW, tC/ha	Year of stands	Carbon stock in DW, tC/ha
Norway spruce, Silver fir, Other conifers	<100	13	>100	28
Scots pine, Black pine	<140	9	>140	11
Oak	<140	10	>140	23
Beech	<140	14	>140	25
Other broadleaves	<140	7	>140	9
Oak, coppice	<61	6	>61	8
Beech, coppices	<61	8	>61	9

The average stock of dead wood (tC/ha) then was differentiated by age classes by using the mortality ratio derived for the years 1995, 2000, 2005, 2010, 2015. Changes in the carbon stock of DW for FLrFL are estimated based on stock change approach. The annual carbon stock change for the inventory year is obtained by dividing the change in carbon stock by the period (years) at two points in time. Calculating carbon stock changes as the difference of carbon stocks at two points in time requires that the area at time t1 and t2 is identical to ensure that reported carbon stocks are not the result of changes in area. That is why the 2015 data on area is used to calculate the DW stock in all years. Therefore only the changes due to shift in the age classes and its mortality rate is reported and the change is not affected by the increase in the FL area. The results showed an increase in the accumulation of the dead wood stock which is normal taking into consideration that the forest management in the country follows the sustainable management practices. Over the years there has been a steady decrease of the amount of extracted (harvested) dried and fallen mass (figure below). In the recent past, it was mandatory to remove all usable dead wood from the forest. The scattered, naturally occurring dry and fallen mass was sold to the population at symbolic prices but nowadays due to financial and environmental reasons these quantities remain in the forests. This is because the harvesting and removal of this wood is economically unprofitable. In addition, there is a regulatory requirement on the minimum amount of dead wood in forests to maintain biodiversity.

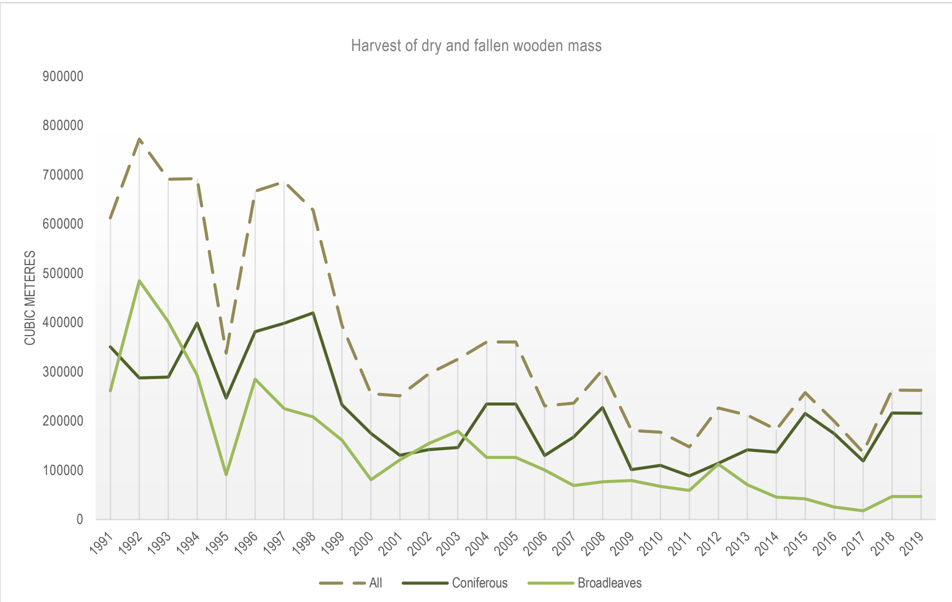


Figure 109 Harvest of dry and fallen mass.

6.3.3.1.2.2 Changes in carbon stock in litter

Since the last ERT review in 2020 a lot of efforts and resources are dedicated to collect and analyse appropriate data and to quantitatively provide evidence that the pool is not a source of emissions. For that the information from ICP Forest programme at Level I since 1998 until today was gathered, processed, and analysed as this represents the only data source of monitoring for that pool in the country.

According to IPCC definition, litter pool includes all non-living biomass in a various state of decomposition, so this means – litter layer (fresh dead plant material), fumic and humic layers.

Referring to the ICP Forests Manual the definition of litter is (methodological approach http://www.icp-forests.org/pdf/FINAL_soil.pdf (see Annex 7 Soil horizon designation p.195)):

OL-horizon (Litter, Förna): this organic horizon is characterised by an accumulation of mainly leaves/needles, twigs and woody materials (including bark), fruits etc. This sub layer is generally indicated as litter. It must be recognized that, while the litter is essentially unaltered, it is in some stage of decomposition from the moment it hits the floor and therefore it should be considered as part of the humus layer. There may be some fragmentation, but the plant species can still be identified. So, most of the original biomass structures are easily discernible. Leaves and/or needles may be discoloured and slightly fragmented. Organic fine substance (in which the original organs are not recognisable with a naked eye) amounts to less than 10 % by volume.

According to IPCC-GPG definition this represents the "litter layer" (a horizon consisting of relatively fresh dead plant material). For Bulgaria there are no data gathered for the carbon content in this layer during the soil surveys. However, since the changes in biomass fully account for all leaves and needles (the tree biomass estimates accounts for these pools) that represent the material of the litter layer within one year any further accounting of this material would end in double accounting.

OFH horizons (OH+OF, the fumic and humic layers which are the further parts of the "litter pool" in sense of IPCC GPG definition).

OF-horizon (fragmented and/or altered) is a zone immediately below the litter layer. This organic horizon is characterised by an accumulation of partly decomposed (i.e. fragmented, bleached, spotted) organic matter derived mainly from leaves/needles, twigs and woody materials. The material is sufficiently well preserved to permit identification as being of plant origin (no identification of plant species). The proportion of organic fine substance is 10 % to 70 % by volume. Depending on humus form, decomposition is mainly accomplished by soil fauna (mull, moder) or cellulose-decomposing fungi. Slow decomposition is characterised by a partly decomposed matted layer, permeated by hyphae.

OH-horizon (humus, humification): characterised by an accumulation of well-decomposed, amorphous organic matter. It is partially coprogenic, whereas the F horizon has not yet passed through the bodies of soil fauna. The humified H horizon is often not recognized as such because it can have friable crumb structure and may contain considerable amounts of mineral materials. It is therefore often misinterpreted and designated as the Ah horizon of the mineral soil and not as part of the forest floor as such. To qualify as organic horizon, it should fulfil the FAO requirement, as described above. The original structures and materials are not discernible. Organic fine substance amounts to more than 70 % by volume. The OH is either sharply delineated from the mineral soil where humification is dependent on fungal activity (mor) or partly incorporated into the mineral soil (moder).

First, the data about soil and litter was collected form the ICP Forest yearly reports. Information about the carbon content in litter layer have been reported since 2001. All the available information from the ICP Forest reports consists of data for 163 sample plots and 254 observations. The data have been split into two periods – 1998-2008 and 2009-2019. The periods have been defined in connection with the number of the samples analysed through the years and by taking into consideration that the observation network have been revised since 2009 in according to the implementation of the FUTMON project. This enabled us to extract only these paired samples which have been analysed at least once in each period – 54 plots in total and 111 observations. For 3 observation plots there are more than 1 observation per period, so for this plots the average carbon stock have been used. The carbon stock change in each plot have been obtained as a difference in the carbon stock for each plot and divided by the number of years between the beginning of the first period and at the end of the second period. The obtained CSCs have been checked for outliers (greater than twice the standard deviation of the CSC). Like this, 4 outliers have been detected and removed from the sample size. The remaining data have been further analysed with paired difference test to assess whether their population means differ. The carbon stock in litter among the sample size of these 50 plots does not follow the normal distribution (Figure 110 and Figure 111), thus the Wilcoxon signed-rank test has been used to compare whether their population mean ranks differ. The outcome of the test confirms the null hypothesis (p-value = 0.1156), that difference in means is not significant. Thus, Tier 1 approach assuming that the pool is at equilibrium has been used. The summary statistics for the carbon stock and the carbon stock changes for the plots for the two periods are presented below.

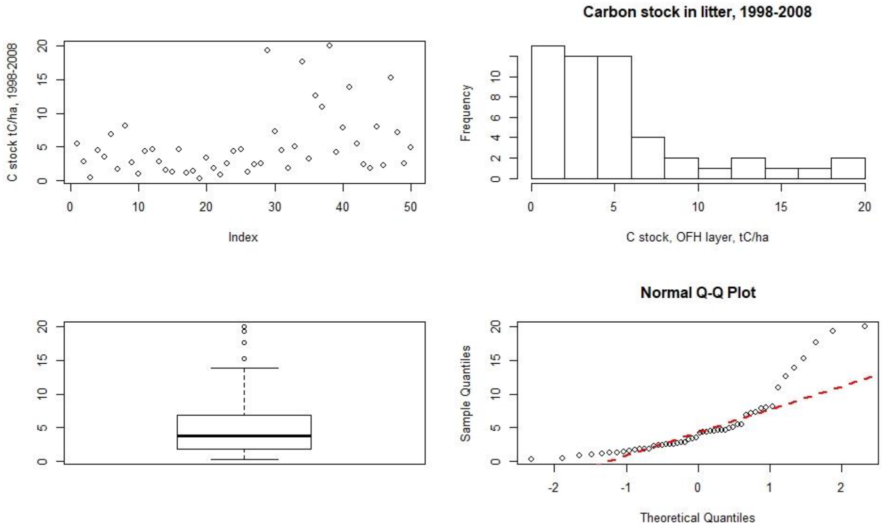


Figure 110 Distribution of the carbon stock in litter layer for the period 1998-2008, n=50

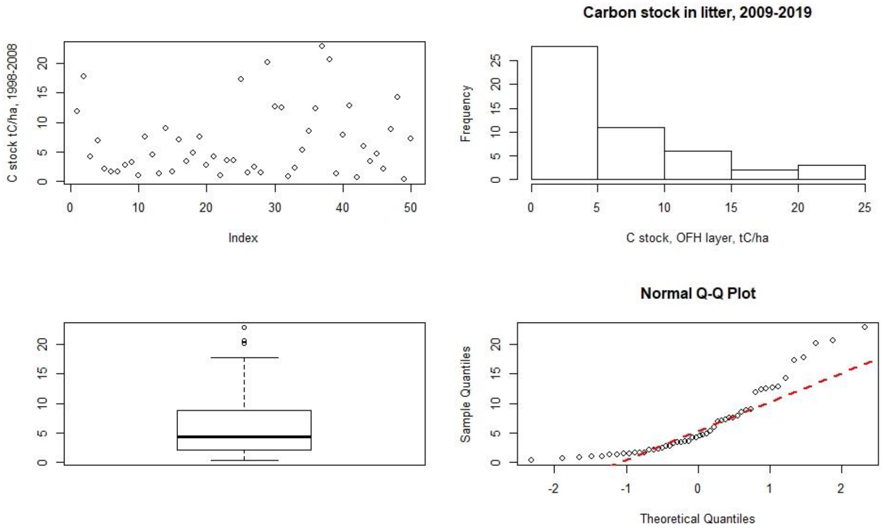


Figure 111 Distribution of the carbon stock in litter layer for the period 2009-2019, n=50

Table 221 Summary statistics of the carbon stock in forest litter and the carbon stock changes between the two periods

litter	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
P1, 1998-2008	0.37	1.95	3.84	5.21	6.54	19.90
P2, 2009-2019	0.37	2.03	4.32	6.47	8.66	22.86
CSC	-0.615	-0.051	0.009	0.063	0.166	0.751

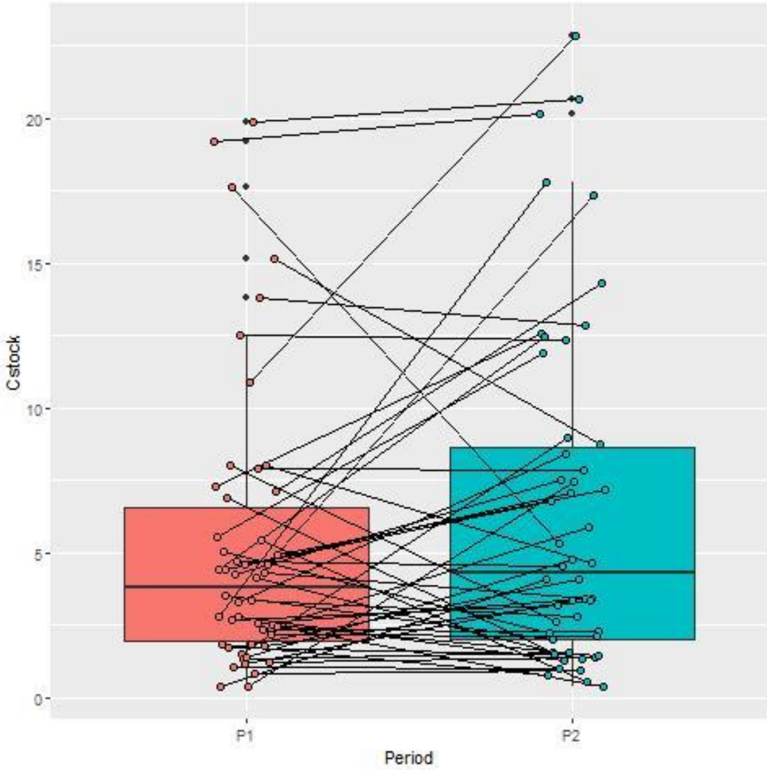


Figure 112 Distribution in the C stock in litter layer for the two periods and the change in the stock, n=50.

6.3.3.1.3 Changes in carbon stock in soils

Mineral soils

In Submission 2017 and 2018 Bulgaria reported emissions and removals from soil by using results from a study on application of CBM-CFS model at EU level (Pilli et al, 2016). Back in 2017, this was the only option to report CSC from these pools in response to the encouragements of several ERT's to apply higher tier in FL-FL for these pools, as BG does not have proper data to account for the changes in soil pool of the remaining lands. Subsequently, we acknowledged that by using the CBM results, there is a methodological inconsistency in the methods and tools in assessing the CSCs from forest carbon pools (e.g CBM for DOM and SOC, and own calculations from biomass). In addition, according to Pilli's study, the soils in FL-FL of Bulgaria are source of emissions, which we assumed not possible taking into consideration the development of the forestry in Bulgaria in the past 20-30 years. The rationale behind our conclusion that the soil is not a source of emissions is that the standing biomass stock of the Bulgarian forests steadily increased in the last years by >50 %, which means that there is increasing C flux to the litter and soil pool accordingly from dead leaves and branches and dead fine and coarse roots. In addition, the harvest in the Bulgarian forests has also increased in the last years, which means that also the C flux from harvest residues (leaves, branches, roots, stumps, non-extracted stemwood) to the litter and soil pool increased accordingly. All these suggested that the use of the CBM results for soil was not appropriate as the simulation in that study was mostly designed for simulating the biomass development and there is a large uncertainty associated with the estimates in soils. The Pilli's results on CSC in soil and DOM have not been validated or verified and come from a non-adjusted model for the Bulgarian conditions.

As there were no proper data to accurately estimate the emissions and removals in that pools, there was not any other alternative than to apply again T1 approach in Submission 2019 and 2020 assuming that the pools are not a source. Since the last ERT review in 2020 a lot of efforts and resources are dedicated to collect and analyse appropriate data and to quantitatively provide

evidence that the soil pool is not a source. For that the information from ICP Forest program at Level I since 1998 until recently was gathered, processed and analysed.
First, the soil data was collected form the ICP Forest yearly reports. Soil information for 171 sample plots have been gathered and stored in electronic format. The data encompasses the years since 1998 until 2019. It contains information on the carbon content per depth ranges of 0-10 cm, 10-20 cm, and 20-40 cm, information on bulk density, coarse fraction, pH etc. Information of bulk density for all layers is available for the sample plots, which have been analyzed since 2008. For the soils analyzed before 2011, the bulk density is available for certain plots and in most cases only for the 0-10 layer. Missing data on bulk density in that cases has been gap-filled by data from later observations for these plots. The bulk density for the deeper layers has been estimated using the Alexander B (1980) PTF function 4:

$$\rho b = 1.72 - 0.294 * (org.C, \% 0.5))$$

The data on coarse fraction is also available for almost all layers and depths since 2011. For the years before that, the data is not available for all samples, thus a gap-filling approach has been implemented – for the paired plots, the data from later observations have been used, whereas for other plots – an average value.
The SOC contents is obtained by summing the SOC contents of the constituent soil layers; the SOC content of each layer is calculated by multiplying the concentration of soil organic carbon in a sample (g C (kg soil)$^{-1}$), with the corresponding depth and bulk density (Mg m^{-3}) and adjusting for the soil volume occupied by coarse fragments.

$$SOC = \sum_{horizon=1}^{horizon=n} SOC_{horizon} = \sum_{horizon=1}^{horizon=n} \left([SOC] \bullet BulkDensity \bullet Depth \bullet (1 - frag) \bullet 10 \right)_{horizon}$$

The total number of the soil carbon stock calculations for the 0-30 cm depth is 418 from 171 sample plots. In that dataset some of the plots have been measured more than twice, whereas others only once. This is because throughout the years of the forest monitoring programme in Bulgaria there are changes in the monitoring grid and sampling design (6.3.3). Thus, the dataset has been split into two periods 1998-2008 and 2009-2019 taking into consideration the change in the observation network of sample plots in connection with the FUTMON project. Further analysis has been done to extract only the paired sample plots, which have been observed at least once for both periods. At the end, data for 90 paired sample plots have been sorted and analyzed. It includes 305 calculated SOC stock in total for 0-30 cm depth. For each observation plot the average carbon stock in litter has been estimated as for some plots there are more than one measurement in a period. Then, the carbon stock change in each plot have been obtained as a difference in the mean value on carbon stock for each plot and divided by the number of years from the beginning of the observed period until the end of it – 23 years. The resulted CSCs have been checked for outliers via double standard deviation ($x \pm 2\sigma$) and removed (7 outliers in total). Like this the sample size of the paired plots have been reduced to 83. The remaining data have been further analysed with paired difference test to assess whether their population means differ. The soil organic carbon stock among the sample size of these 83 plots does not follow the normal distribution (Figure 112 and Figure 113), thus the Wilcoxon signed-rank test has been used to compare whether their population mean ranks differ. The outcome of the test confirms the null hypothesis (p-value = 0.8899), that difference in means is not significant. Thus, Tier 1 approach assuming that the pool is at equilibrium has been used for reporting.
The summary statistics for the soil organic carbon stock and the carbon stock changes for the plots for the two periods are presented below.

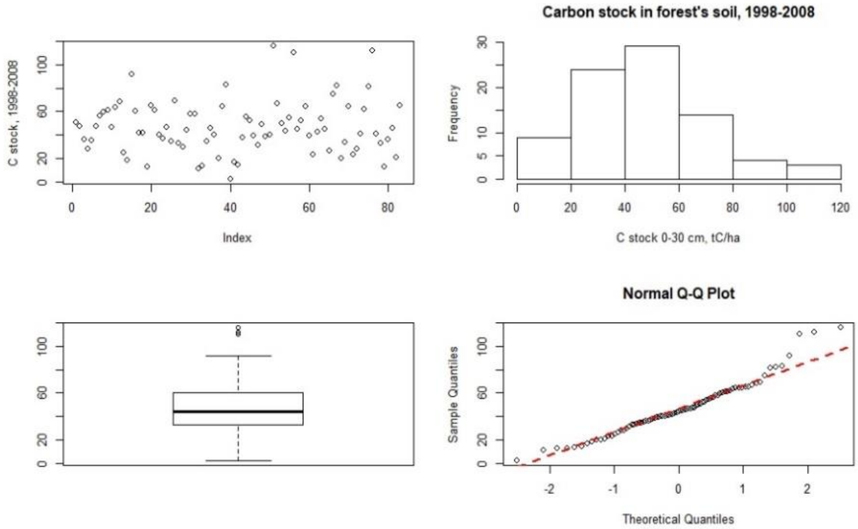


Figure 113 Distribution of the soil organic carbon stock for 0-30 cm for the period 1998-2008, n=83

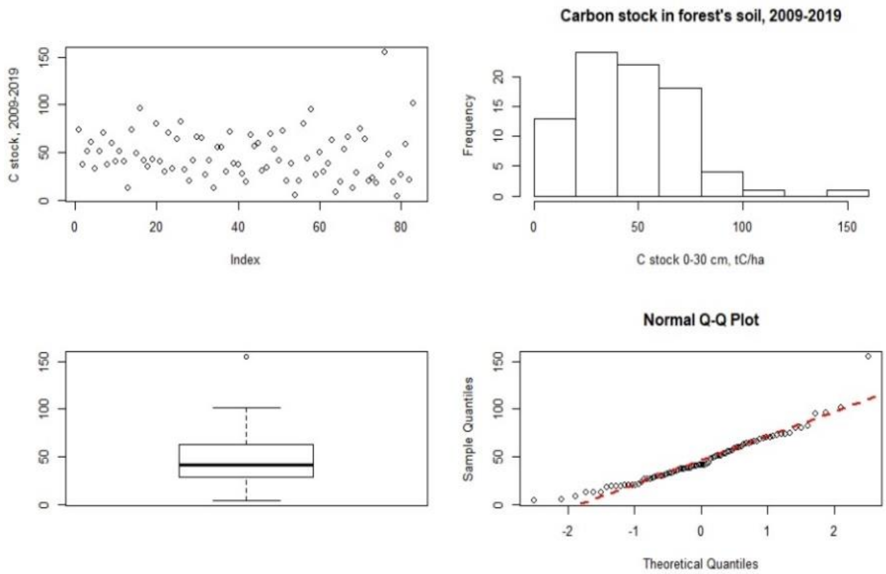


Figure 114 Distribution of the soil organic carbon stock for 0-30 cm for the period 2008-2019, n=83

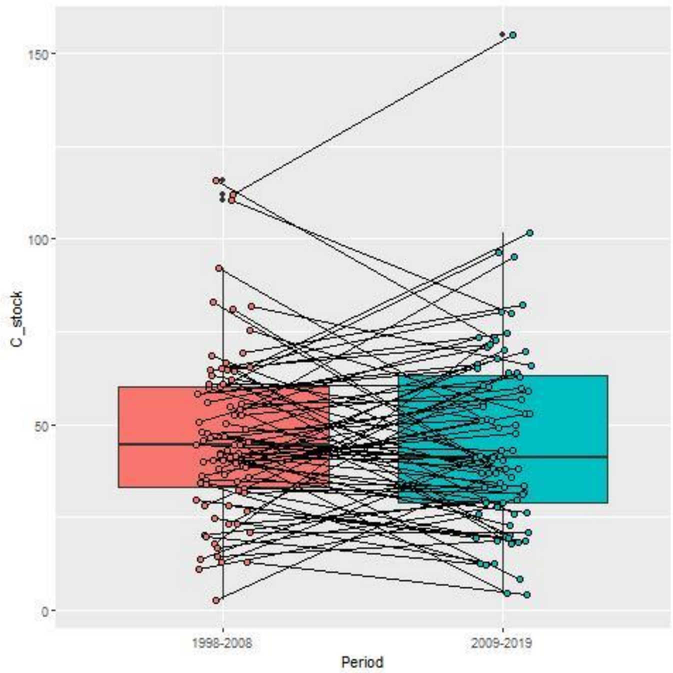


Figure 115 Distribution in the C stock in soil for the two periods and the change in the stock, n=83

Table 222 Summary statistics of the soil organic carbon stock and the carbon stock changes between the two periods

soil	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
SOC, P1	2.628	33.264	44.493	46.663	60.008	115.683
SOC, P2	4.185	29.002	41.34	46.276	63.343	154.856
CSC	-2.03447	-0.52936	-0.0217	-0.01679	0.6122	2.41211

Organic soils

Histosols cover 0.05% of the total area of Bulgaria and are mostly in protected areas, where all anthropogenic impacts are forbidden. Therefore, there is no peat extraction, draining of soils or other anthropogenic activities that affect the water regime, the temperature on soil's surface and the species. Due to these reasons Histosols are not subject to evaluation.

6.3.3.1.4 Forest fires

There is no biomass burning as in Bulgarian forests the controlled fires are forbidden by law. Therefore, in the current report only emissions of CH_4 and N_2O from wildfires have been calculated and reported. CO_2 emissions from wildfires are reported as IE to avoid double accounting as Bulgaria applies Stock-difference method in its GHGI estimates. For the calculation, Tier 1 has been applied, equation 3.27 of IPCC 2006:

For the mass of fuel, available for combustion (Mb) a value of 19.8 tonnes/ha has been used (2006 IPCC Guidelines). The values of the emission factors (G) have been taken from Table 2.5 from the 2006 IPCC Guidelines (for CO2- 1569, for CH_4 - 4.7 and for N_2O - 0.26).

Annual data for the areas affected by fires (A) has been obtained from the Executive Forest Agency and the National Parks in Bulgaria – Rila, Pirin and Central Balkan. Thus, all forest areas were covered by these data. Since the reporting system for wildfires in forests cannot define whether the wildfire happens in AR units of land or not, Bulgaria has shared these emissions between sub-category Forest lands remaining forest land and LUCs to forest land (Afforestation/reforestation areas). Therefore, the emissions from wildfires between these two sub-categories have been estimated according to their area share in total forestland.

The total emissions from wildfires (e.g. 4.A.1 and 4.A.2) are presented in Figure 105

6.3.3.2 Lands converted to forests (4.A.2.)

This subcategory includes activities related to the conversion of other land-use to forests. The changes in the carbon stocks in living biomass, litter and soil of lands converted to forests have been estimated. Changes to FL come from GL, CL and OL. The biggest share of all LUCs to FL (85-89%) has the LUC from GL to FL, followed by annual CL (13%), perennial CL and OL.
The total emissions from wildfires (e.g. 4.A.1 and 4.A.2) are presented in Figure 105

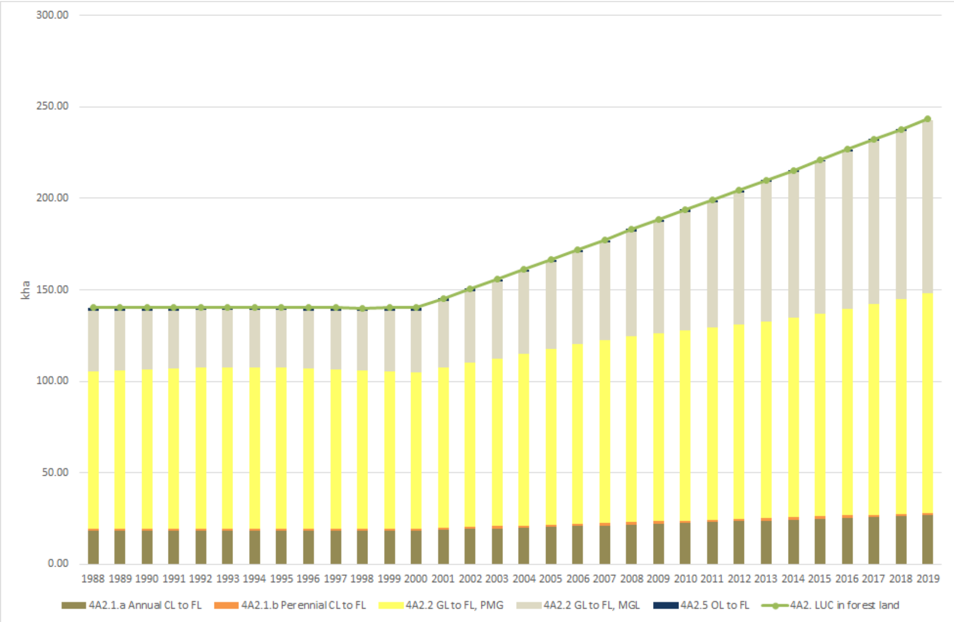


Figure 116 Area of LUCs to FL (20 years)

6.3.3.2.1 Changes in the carbon stock in the living biomass

Changes in carbon stock in living biomass in Lands converted to forest are estimated at tier 2 level with application of some default emissions factors. Tier 2 method uses country-specific data on annual changes and allows to for more precise estimates of changes in carbon stocks in biomass. The net annual CO_2 removals are calculated as a sum of increase in biomass due to biomass growth on converted lands, changes due to actual conversion (difference between biomass stocks before and after conversion) and losses on converted lands (Equations 15 and 16, Chapter 2, 2006 IPCC GIs)

$$\Delta C_B = \Delta C_G + \Delta C_{CONVERSION} - \Delta C_L$$

Where:

ΔC_B = annual change in carbon stocks in biomass on land converted to other land-use category, in tonnes C yr^{-1}

ΔC_G = annual increase in carbon stocks in biomass due to growth on land converted to another land-use category, in tonnes C yr^{-1}

$\Delta C_{CONVERSION}$ = initial change in carbon stocks in biomass on land converted to other land-use category, in tonnes C yr^{-1}

ΔC_L = annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to other land-use category, in tonnes C yr^{-1}

$$\Delta C_{CONVERSION} = \sum \{(B_{AFTER_i} - B_{BEFORE_i}) \bullet \Delta A_{TO\ OTHERS_i}\} \bullet CF$$

Where:

$\Delta C_{CONVERSION}$ = initial change in biomass carbon stocks on land converted to another land category, tonnes C yr^{-1}

B_{AFTERi} = biomass stocks on land type i immediately after the conversion, tonnes d.m. ha-1

$B_{BEFOREi}$ = biomass stocks on land type i before the conversion, tonnes d.m. ha^{-1}

$\Delta A_{TO\_OTHERSi}$ = area of land use i converted to another land-use category in a certain year, ha yr^{-1}

CF = carbon fraction of dry matter, tonne C (tonnes d.m.)$^{-1}$

i = type of land use converted to another land-use category

To determine the annual increase in carbon stock in biomass due to growth on lands converted to FL (ΔC_G), data on growing stock (stemwood and branches) for the first age class (1-20 years) has been used. The growing stock of the stands of Ist age class for coniferous and deciduous forests was divided by the average age of 10 years. This was done for all years when data on volume per age-class and area (RF2 and RF3) are available – 1995, 2000, 2005, 2010, 2015. Once we obtained the weighed mean by forest type (coniferous and deciduous) for these years an average of them equals to 6.03 m^3/ha/y, which represents the average current increment. In order to convert the average annual increment of the Ist age class to an average annual biomass growth, biomass conversion and expansion factors have been used as shown in the table below. To estimate the carbon stock, the coefficient for carbon content as shown in the table has been used.

Table 223 Expansion and conversion factors used to convert the average annual increment into average annual biomass growth

	BEF2	D	R	CF
Coniferous	1.09	0.48	0.40	0.51
deciduous	1.02	0.62	0.46	0.48
weighted mean	1.07	0.52	0.42	0.50

BEF_2 coefficient adds the biomass of the leaves and needles. The values of BEF_2 for coniferous and deciduous forests are estimated as a weighted mean considering the volumes of different coniferous and deciduous species. To estimate the average $BEF_{2,}$ data from literature sources on results from ecosystem studies for Spruce, Scots pine, Beech and Oaks for the Ist age class stands were used (compiled in Korner et al.,1993).

Basic wood density for the Ist age class of coniferous and deciduous forests is estimated as a weighted mean considering the share of the volume of coniferous and deciduous species. Country-specific data on the basic wood density of the main tree species were used (compiled by Bluskova, G., 1994; Enchev, E., 1984).

The coefficient for the ratio of the below-ground biomass to above-ground biomass is estimated as a weighted mean considering the share of the volume of coniferous and deciduous forests. The estimates are based on the default values for R (table 4.4 2006 IPCC GIs) for the biomass stock <50 tonnes d.m per ha for coniferous and <75 tonnes d.m per ha for hardwoods.

The carbon fraction is again estimated as a weighted mean.

Like this, the calculated ΔC_G equals to 2.39 tC/ha.

The biomass stocks on land converted to FL immediately after the conversion, tonnes d.m. ha-1 (B_{AFTER}) is assumed to be 0. The biomass stock on lands before the conversion depends on the type of land and its vegetation. The average biomass stock for the respective land types converted to FL is:

- Annual cropland – 3.56 tC/ha
- Perennial cropland – 4.84 tC/ha
- Pastures and meadows – 6.58 tC/ha
- Shrubs and grasslands – 5.24 tC/ha
- Other land – 0 tC/ha

More information on how the average biomass stocks of these lands have been estimated can be found in the respective chapters.

The annual decrease in biomass carbon stocks due to losses (ΔC_L) on lands converted to FL is assumed to be insignificant (zero) because the thinning start in older age classes, which is implicitly accounted for within the category Forest Land remaining Forest Land.

6.3.3.2.2 Changes in dead organic matter

6.3.3.2.2.1 Changes in the carbon stock in dead wood

Due to the young age of the forests in the area converted to forests it is assumed that there is no dead wood and there is no change in this carbon stock.

6.3.3.2.2.2 Changes in the carbon stock in litter in lands converted to forests

According to IPCC definition litter pool includes all non-living biomass in a various state of decomposition, so this means – litter layer (fresh dead plant material), fumic and humic layers. As it was explained in chapter Forest remaining forest, the data on forest litter is the ICP Forest Programme. According to the ICP Forests Manual samples are taken separately for the different depth OL, OH, OF. OL data is not available in Bulgaria. Data for OH and OF is available. The estimation for the average carbon stock in litter pool is based on database for carbon content in OFH layers available for 116 sample plots, analysed in the period 2011-2016. According to the data available it was estimated that the carbon stock in litter is 10.23 tC/ha.

6.3.3.2.3 Changes in the carbon stock in soils

The changes in soil organic carbon pool followed the land-use conversion from other land-use to forests have been estimated based on calculated stock of the soil organic carbon from the soil under different land-use type using the equation:

$$\Delta \boldsymbol{C}_{\boldsymbol{mineral\ soil}} = \left[(\boldsymbol{SOC}_{\boldsymbol{ref}} - \boldsymbol{SOC}_{\boldsymbol{non\ forest\ land}}) \cdot \boldsymbol{A}_{\boldsymbol{Aff}} \right] / \boldsymbol{T}_{\boldsymbol{Aff}}$$

where:

$\Delta C_{mineral\ soil}$ - annual change in the carbon stock in mineral soils in the year of assessment, tonnes C/yr

SOC_{ref} – reference carbon stock in forest's, tonnes C/ha

$SOC_{non\ forest\ land}$ - stable carbon stock in the soil in a previous type of land-use (croplands, grasslands and other lands), tonnes C/ha

A_{Aff} - total afforested area after the conversion, ha

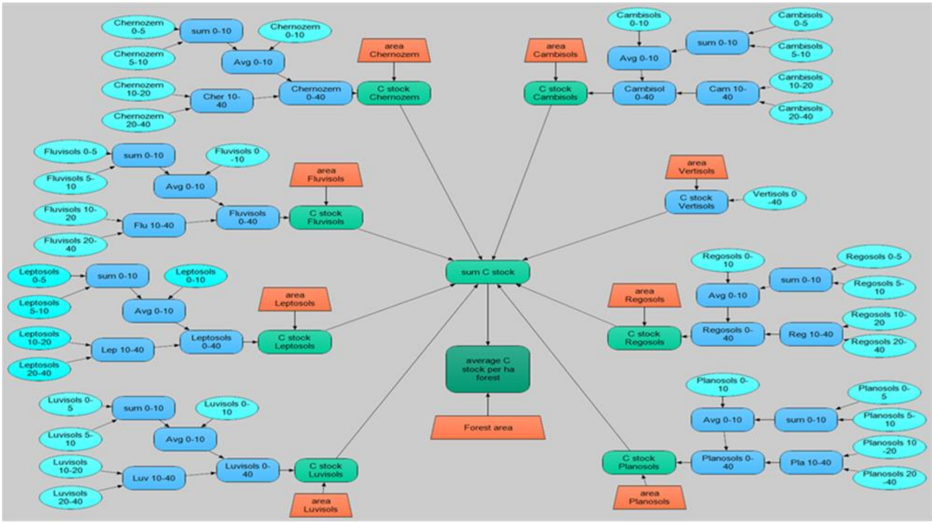
T_{Aff} - duration of the transition from non-forest land to forest, yr

The used transition period is 20 years according to 2006 IPCC Guidelines.

Source of information for the contents of organic carbon in forest soil is the database of the ICP Forest. Taking into account the representativeness of the data and the purpose of the estimate, the reference soil organic carbon stock in forest's soil has been evaluated based on dataset since 1998. The dataset on soil contains information on the soil chemistry and physical parameters. The measurements of the soil's parameters are made for layers (0-5 cm, 5-10 cm, 0-10 cm, 10-20 cm, 20-40 cm). The content of organic matter is presented in percentage. In order to estimate the organic carbon stock (tC/ha), data on bulk density is needed. However, the data on bulk density is not available for all layers. Therefore, the bulk density of the soil from different layers has been estimated using the Alexander B (1980) PTF function 4:

$$\boldsymbol{\rho_b} = \mathbf{1.72} - (\mathbf{0.294} * (\boldsymbol{org.C}, \%)^{\mathbf{0.5}}))$$

Thus, the organic carbon stock has been calculated for all samples from the dataset. Then, the samples have been grouped by soil type and an average value for carbon stock in the different soil types has been derived. Data on the area of the particular soil types under forest land-use is available according to Soil map of Bulgaria (1:400 000) and Corine land cover data (1:100 000). Therefore, the reference soil organic carbon stock in forest's soil has been derived as a weighted mean from the averages SOCs of every particular soil type which are presented in Bulgarian forests. The procedure to derive the reference carbon stock in forest soils, which has the value of 61.86 tC/ha (0-30 cm) is presented in the figure below.



Note: the procedure is applied for soil depth of 0-30 cm

Figure 117 Procedure to derive the organic carbon reference stock in forest's soils

For the stable stock of organic carbon in soils (0-30 cm) of previous types of land-use the following country specific values for annual and perennial cropland, grassland and other land have been used:

- Annual crops: 67.74 t C/ha
- Perennial crops: 67.49 t C/ha
- Pastures and meadows: 72.77 t C/ha
- Shrubs and grasslands: 86.96 t C/ha
- Other land: 51.8 (IPCC 2006)

Following the recommendation from the ERT Bulgaria estimated the reference organic carbon stock in soils under other land use. This has been done by using the default SOC reference level as described in table 2.3 in 2006 IPCCC Guidelines. In order to choose the most appropriate default SOC reference level Bulgaria did the following:

According to "Classification scheme for default climate regions" (IPCC, 2006) Bulgaria is in the "warm temperate dry" (appr. 60%), "cool temperate dry" (appr. 20%) and "cool temperate moist" (appr. 20%) regions (please see the map from the link below).

http://forest.jrc.ec.europa.eu/media/cms_page_media/122/BGR_Climate_1.pdf

Concerning the soil type, more than 80% of the territory is under high activity clay soils (please see the map from the link below). http://forest.jrc.ec.europa.eu/media/cms_page_media/123/BGR_Soil.pdf

Therefore, Bulgaria estimated a weighted mean value for the SOC reference level in soils taking into account the SOC reference levels for HAC soils (table 2.3 from the2006 IPCC Guidelines) for the respective climate regions. The result for the 0-30 cm depth is 51.8 tC/ha.

A description of the methods of deriving these soil C stocks can be found in the respective chapters.

6.3.3.2.4 N_2O emissions from N mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils

Emissions has been estimated for all situations where C losses in mineral soils occur (according 2006 IPCC Guidelines), based on equations 11.1, 11.2, 11.8.

The ratio C/N in mineral soils of Forest lands is the default value from 2006 IPCCC Guidelines – 15, whereas the C/N ratio of CL and GL is derived based on data from soil inventory in BG (since 2005). N_2O emissions from N mineralization associated with a loss of soil organic matter are presented in the table below.

Table 224 N2O emissions associated with loss of soil organic carbon when other lands are converted to FL

Year	4A (III) CL to FL, CO2 eq	4A (III) GL to FL, CO2 eq
1988	2.599	38.630
1990	2.598	38.293
1995	2.602	38.151
2000	2.599	38.833
2005	2.879	48.857
2010	3.178	60.371
2015	3.472	71.896
2016	3.535	74.140
2017	3.598	76.314
2018	3.656	78.327
2019	3.720	80.476

6.3.4 UNCERTAINTY ASSESSMENT

The overall uncertainty in estimation of gas emissions and removals over a year for the category "Forests" is **161** %. The trend uncertainty due to activity data and emission factors amounts to 738 % (Table 224).

The combined uncertainty for the sub-category "Forest land remaining forest land" is **198** % and the uncertainty in the trend of the gas emissions is **18** %.

The uncertainties for the sources "Living biomass", "Forest fires", and "Dead wood" within the sub-category "Forest land remaining forest land" were determined.

Annual change in carbon stocks in “Living biomass” was estimated using the stock-difference method. The overall uncertainty over a year for the “Living biomass” is **213** %. The trend uncertainty due to activity data and emission factors amounts to **14**%.

The combined uncertainty for „Forest fires“ is **70** % and the uncertainty in the trend of the gas emissions is **37** %.

Annual change in carbon stocks in “Dead wood” was estimated using the stock-difference method. The overall uncertainty over a year for the “Dead wood” is **134** %. The trend uncertainty due to activity data and emission factors amounts to **123** %.

The combined uncertainty for the sub-category „Land use changed to forest land” is **49** %. The trend uncertainty in gas emissions is **34** %.

The uncertainties of gas emission estimations from “Living biomass”, “Litter” and “Soil” for the sources “Crop land (annuals and perennials) changed to forest land”, “Grassland (permanent pasture and meadows, PPM and marginal grasslands and lawns, MGL) changed to forest land” and “Other land changed to forest land” as well as for the emissions from “Forest fires” within the sub-category „Land use changed to forest land” were estimated.

The combined uncertainty for “Living biomass” is **40** %. The trend uncertainty due to activity data and emission factors amounts to **29** %.

The overall uncertainty over a year for „Litter“ is **20** %. The trend uncertainty due to activity data and emission factors is **241** %.

The combined uncertainty for „Soil“ is **16** %. The uncertainty in the estimated tendency for the gas emissions is **21**%.

The overall uncertainty over a year for “Forest fires under changed land use” is **71** %. The trend uncertainty due to activity data and emission factors amounts to **203** %.

Table 225 Uncertainties in the gas emissions from the IPCC category “Forests”

IPCC sub-category	Pool	Level of estimation	Gas	Base year emissions	Current year emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total in the current year	Uncertainty in trend introduced by emission factor uncertainty	Uncertainty in trend introduced by activity data uncertainty	Uncertainty introduced into the trend
Forest Land remaining Forest Land	Living biomass	conifers	CO2	-9570.21	-4209.39	3	230.25	230.27	13644.49	429.23	2.15	184239.16
		broadleaved	CO2	-6312.16	-2051.15	3	448.32	448.33	12281.43	592.27	1.05	350786.16
	Forest fires		CH4	1.03	12.53	3	102.89	102.93	0.02	0.13	0.01	0.02
			N2O	0.68	8.26	3	83.36	83.41	0.01	0.07	0.00	0.00
	Dead wood	conifers	CO2	-250.59	-32.88	3	1652.34	1652.34	42.87	96.95	0.02	9400.08
		broadleaved	CO2	-129.85	-490.83	3	90.23	90.28	28.52	2.41	0.25	5.86
Land use changed to forest land	Living biomass	new forest biomass	CO2	-1228.91	-2135.09	10	32.69	34.18	77.36	1.63	3.64	15.90
		conversion of cropland with annuals	CO2	11.92	18.34	10	23.03	25.11	0.00	0.02	0.03	0.00
		conversion of cropland with perennials	CO2	1.08	0.99	10	25.00	26.93	0.00	0.00	0.00	0.00
		conversion of	CO2	118.80	150.63	10	79.35	79.98	2.11	0.92	0.26	0.91

IPCC sub-category	Pool	Level of estimation	Gas	Base year emissions	Current year emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total in the current year	Uncertainty in trend introduced by emission factor uncertainty	Uncertainty in trend introduced by activity data uncertainty	Uncertainty introduced into the trend
		grassland (PPM)										
		conversion of grassland (MGL)	CO2	19.82	97.28	10	50.00	50.99	0.36	0.34	0.17	0.14
		conversion of other land	CO2	0.00	0.00	10	75.00	75.66	0.00	0.00	0.00	0.00
	Litter	conversion of cropland with annuals	CO2	-34.48	-50.01	10	29.84	31.47	0.04	0.08	0.09	0.01
		conversion of cropland with perennials	CO2	-2.24	-2.53	10	29.84	31.47	0.00	0.01	0.00	0.00
		conversion of grassland (PPM)		-161.10	-224.91	10	29.84	31.47	0.73	0.39	0.38	0.30
		conversion of grassland (MGL)	CO2	-61.99	-177.25	10	29.84	31.47	0.45	0.17	0.30	0.12
		conversion of other land	CO2	-2.83	-1.62	10	29.84	31.47	0.00	0.02	0.00	0.00
	Soil	conversion of cropland with annuals	CO2	19.84	28.77	10	44.74	45.84	0.03	0.07	0.05	0.01
		conversion of cropland with annuals	N2O	2.60	3.72	10	116.92	117.35	0.00	0.02	0.01	0.00
		conversion of cropland with perennials	CO2	1.23	1.39	10	49.05	50.06	0.00	0.01	0.00	0.00
		conversion of grassland (PPM)	CO2	171.98	240.09	10	24.20	26.19	0.57	0.34	0.41	0.28
		conversion of grassland (PPM)	N2O	38.63	80.48	10	110.70	111.15	1.16	0.00	0.14	0.02
		conversion of grassland (MGL)	CO2	152.27	435.40	10	10.49	14.49	0.58	0.15	0.74	0.57
		conversion of other land	CO2	-2.79	-1.59	10	386.92	387.05	0.01	0.20	0.00	0.04
	Forest fires		CH4	0.04	0.83	10	102.89	103.38	0.00	0.01	0.00	0.00
			N2O	0.03	0.55	10	83.36	83.96	0.00	0.00	0.00	0.00
		Total emissions		**-17800.46**	**-9636.61**	**Overall uncertainty in the year (%)**			**161**	**Trend uncertainty (%)**		**738**

6.3.5 CATEGORY-SPECIFIC QA/QC AND VERIFICATION, IF APPLICABLE

More information on the QA/QC procedures are provided in Chapter 6.1.6 QA/QC

Referring to an ERT's recommendation from previous reviews to "*Provide estimates of changes in carbon stock in living biomass by applying the gain–loss method in future annual submissions for verification purposes",* Bulgaria has conducted in 2019 a pilot assessment of the emissions and removals form forest biomass calculated by applying Gain-Loss method. The official statistics in Bulgaria do not include information on the net annual increment, so for the pilot assessment the increment has been determined based on a growth model according to growth tables and information on growing stock of the stands per tree species and age class. The growth model has been applied on the aggregated data – reporting forms (RF 1-7). In RF3 the growing stock is not differentiated by yield class, so the growth rate was calculated as a weighted average of its value for the various yield classes, assuming a normal distribution of the area of the tree species by yield class with a maximum for the average yield class III. To perform the calculations on the increment, the growth tables were modelled with the Chapman-Richards equation

$$y = a\left(1 - e^{-kx}\right)^{-n}$$

where *y* is the stock of 1 ha, *x* is the age of the stand, and *a, k*, and *n* are regression constants. When modeling the stock with this equation, the growth rate has the form

$$p = \frac{kn}{e^{kx} - 1}$$

Although the model used provides estimates of the increment at a level of tree species the emissions and removals from forest biomass by using gain-loss method have been performed at aggregated level – by forest type (coniferous and deciduous) and not by tree species. The model used to derive the current increment provides information from 1995-2015 per five-year period. For 1990 the value for 1995 has been applied. The increment has been converted to biomass by applying the conversion factors from the table below. The BCEFs are lower than the IPCC defaults because the current increment is derived from the standing growing stock which include branches and stem tops, so we do not expand for branches and tops.

	BCEF (D*BEF)	R	CF
Coniferous	0.464	0.29	0.51
Deciduous	0.621	0.24	0.48

Losses have been calculated based on the information from reporting form 5 (RF5), which provides the annual harvesting amount for coniferous and deciduous species. The form contains information on harvested amounts from different type of loggings including also harvesting from salvage logging. Thus, losses associated with disturbances have been accounted for under losses associated with harvesting. The harvested amounts have been converted to biomass by applying the respective conversion factors as indicated in IPCC 2006 Guidelines.

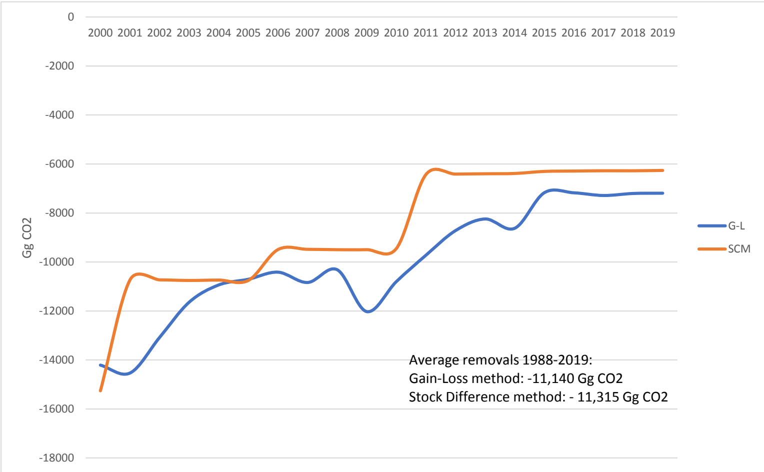


Figure 118 Comparison between the emissions and removals estimates – gain-loss method vs. stock difference method

When comparing the results from the both methods – stock difference and gain-loss, it shows that both estimates have a decreasing trend in removals. It should be noted that estimates differ at the level of stratification which could explain some of the differences in the trend. Although there is not a good match between the estimates during the time series, the average emissions are similar because the large discrepancy in the beginning of the time series between the two estimates levels out the difference between the methods after the year 2000. Uncertainty assessment of the gain-loss estimates shows that it is much lower (35% for biomass in FLrFL) than the uncertainty of the estimates based on the SD method (>300%). This shows that a change in the method would reduce the uncertainty for the category. However, there are some technical issues that should be resolved before this step as follow:

1. To carefully revise and consider any specifics of the official forestry statistics which could affect the estimation of increment data as the calculation are based on the aggregated data on the growing stock.
2. To analyse other possibilities to calculate increment which could be more accurate.
3. To apply the gain-loss method at more disaggregated level.

6.3.6 CATEGORY-SPECIFIC RECALCULATIONS

The recalculations in FL are as follow:

1. Small changes in the time series of lands converted to FL which are related to the recalculations in area estimation explained in Chapter 6.1.7 .
2. Correction of the FL-FL coniferous, deciduous, and out of yield forests for 2018 due to found error, which resulted in omitting the temporary unstocked area in coniferous forests. This error did not affect the total FL-FL, but the area of deciduous and out of yield forest. The error is corrected in Submission 2021.
3. Recalculation of the CSC in the period 1988-2000 which was necessary in order to adjust the official data on volume stock per hectare for the years 1990-1995-2000. The need for adjustment come as the fact that the data on growing stock comes from RF 2 on forested area by tree species and age class and RF 3 on growing stock per tree species and age class which are updated every 5 years. For the period 2000-2005 there is an increase in forested area in the RF 2 by almost 300 kha, which is associated with administrative change within forest territories – transfer from one balance to another. It is about the forest territories with a stocking rate below <0.4, which have not been included under forested lands in the years before 2000. These area (approx.107 kha) have been reported in forest territories as they are forests according to the Forest Law in the country, and therefore in GHGI, but have not been

included in the balance of the forested land in RF2 and RF3 which are the source for estimating the average growing stock per hectare. This resulted in overestimation of the growth in the years before 2000. After noticing this, we adjusted the official data for growing stock and area by tree species (RF2 and RF3) by adding the area of these lands to the forested area of broadleaves forests in 1990-1995-2000, because the change we described here affected mostly the broadleaves forests and to be more precise low-stem forests, this was considered when we did the adjustment. After adding the area, we also adjusted the growing stock by adding the respective volume, calculated by multiplying the area to an average growing stock for unstocked forests estimated to 41.5 m^3/ha. As it is explained in 6.3.2, there was another adjustment in area in the past, which also did not account for the growing stock. Thus, we adjusted the data on growing stock also to account for this change in area. The approach was almost the same. As these lands are more diverse, the area in question was distributed by tree species according to their share. Then, we multiply the area by tree species with their respective average growing stock for the years 1990-1995-2000. These recalculations have resulted in reduction of the removals from living biomass for the base year and for the period 1988-2000 as a whole.

4. Recalculations in the estimates of the emissions and removals in DW in FL-FL. This recalculation comes as a result of some changes in our calculation approach. The approach we used in Submission 2020 is based on a model which quantify the mortality. However, in our calculation for the emissions and removals from DW pool in Submission 2020 we used only the amount of the mortality to account for the CSC in DW. This error was identified, and it is corrected in Submission 2021. For the estimates of emissions and removals form dead wood we used information from scientific study carried in Bulgarian forests aiming at defining a complex index for identification and evaluation of old-growth forests. The study provides ranges of dead wood volume in the forests of the main tree species in Bulgaria. The average stock of dead wood (tC/ha) was differentiated by age classes by using the mortality ratio derived for the years 1995, 2000, 2005, 2010, 2015. More information is included in Chapter 6.3.2.1.2

6.3.7 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

See Chapter 6.1.8 PLANNED IMPROVEMENTS

6.4 CROPLAND (4.B)

6.4.1 DESCRIPTION OF THE CATEGORY

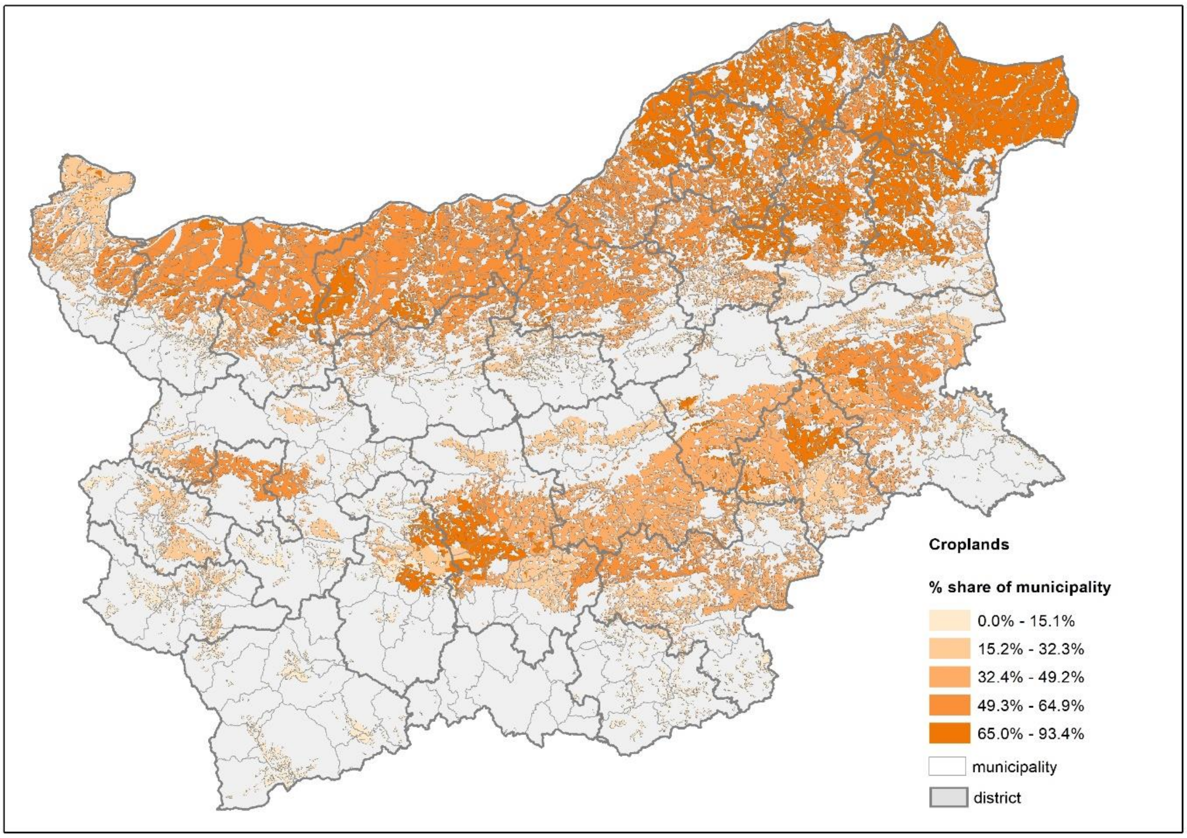


Figure 119 Share of municipality area occupied by Cropland. The map is elaborated based on CLC, 2018

Table 226 Categories assessed for emissions/removals

Categories
4 B. Cropland- total
4.B.1 Cropland remaining cropland
- carbon stock change in living biomass of perennial cropland and LUC between annual and perennial cropland
- carbon stock change in soils of annual remaining annual, perennial remaining perennial, and LU between annual and perennial
4 B 2 Land converted to cropland
4 B 2 2 Grassland converted to cropland
- carbon stock change in living biomass of annual/perennial cropland
- carbon stock change due LUC to cropland
4 (III) N Mineralization associated with C loss in soils

Croplands in Bulgaria cover an area of 3676.21 kha in 2019 which represents 33% of the country's territory.

Annual crops have a share of 95% from the total cropland's territory and the rest 5% are referred to perennial crops. Since the latest recalculations in the land representation (Submission 2020) there is a change in the whole time series as some of the issues related to methodological changes in the agricultural statistics (between, before and after 2000) and some differences in definitions have been addressed by interpolation between the data in 1988 (before the land reform which started since 1991) and the year 1998 (which is the first year of the new statistics BANCIK). The present representation of the Croplands includes only the utilized (managed) croplands as all secondary lawns and marginal croplands are reported under GL category. The trend in the areas of cropland category is presented in the figure below.

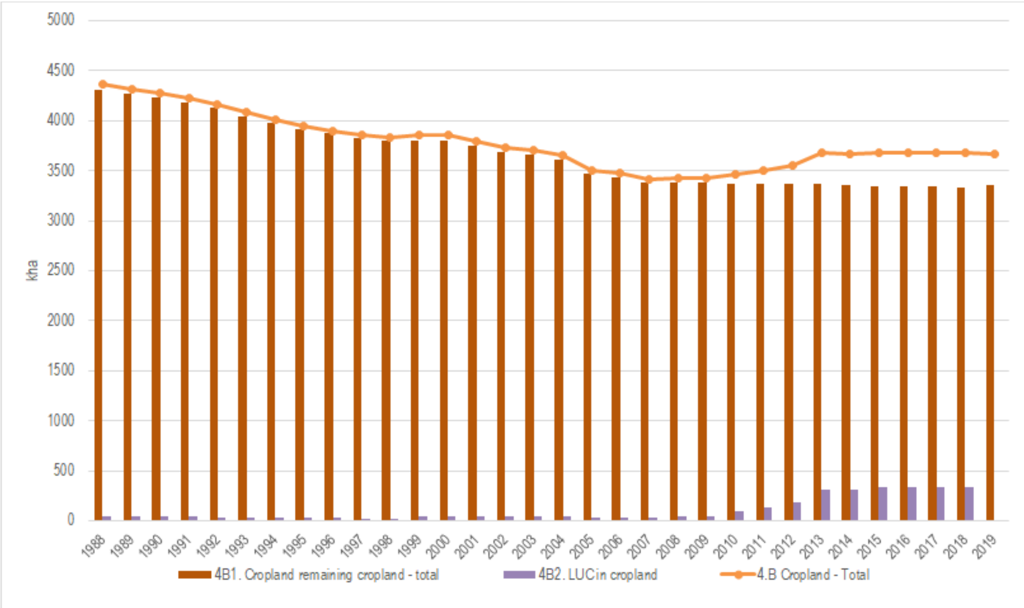


Figure 120 Trend in the areas within Cropland category

Steady decrease in croplands is observed due to abandonment of agricultural lands after the socioeconomic and political changes in the 90's in the country and the subsequent land reform related to restitution processes which led to inefficient land use in agricultural lands (e.g. CL and GL). Since the accession of Bulgaria to the EU, there is slight increase in CL areas which due to implementation of the Common Agricultural Policy (CAP). The use of the mechanisms of the CAP and the increase in access to finance are driving new one operator in the agricultural business and to more efficient land use.

The evaluation of the emissions/removals from Cropland category is based on estimates of the changes in the carbon stocks in living biomass and soil. The changes in biomass stock are estimated only for perennial crops. For annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year - thus there is no net accumulation of biomass carbon stocks.

The immature perennial crop area accumulates carbon at a rate of approximately 0.43 t C/ha/yr for orchards and 0.28 t C/ha/yr for vineyards. For Bulgaria's conditions the default accumulation rate purposed in 2019 Refinement to the 2006 IPCC GNGGI was applied (Ch. 5.2.1.2., table 5.3).

The assumption in Tier 1 (according 2006 IPCC Guidelines) is that the DOM carbon stock in all cropland remaining cropland and land converted to cropland are insignificant or are not changing and therefore no emission/removal factors and activity data are needed.

Non-CO_2 emissions associated with the management of permanent agricultural lands are estimated as part of Agriculture Chapter from this report. N_2O emissions from land-use conversions to cropland as a result of soil oxidation are reported under LULUCF sector.

There is no agricultural lime application in Bulgaria during the reporting period so CO_2 emissions from liming are reported as NO (not occurring).

The cropland's emissions over the reporting period range from - -833.20 Gg CO_2 eq. to 103.43 Gg CO_2 eq. As it can be seen from the table below, emissions from subcategory Cropland remaining cropland have a high level of inter-annual variability. The reason for the variation in the emissions is that Bulgaria reports changes in carbon stock within cropland category (e.g. change from perennial to annual, annual crops to perennial and perennials remaining perennials). Major source of the emissions within subcategory Lands converted to croplands is the carbon stock change in the soil pool when converting grassland to cropland.

Table 227 Emissions and removals from Cropland category, Gg CO2 eq.

Year	4 B Total cropland	4.B.1 Cropland remaining cropland	4.B.2 Land converted to Cropland	4.B.2.2.a Grassland Pastures and meadows converted to Cropland	4.B.2.2.b Grassland Shrubs and grasslands converted to cropland	4.B.2.5 Other land converted to cropland	4.B.2.2 Grassland converted to cropland (N2O converted into CO2 equivalents)
1988	-833.20	-920.50	87.30	25.72	61.58	NO	10.81
1989	-839.95	-922.65	82.70	24.37	58.33	NO	10.24
1990	-833.23	-911.34	78.11	23.01	55.09	NO	9.67
1991	-837.56	-911.07	73.51	21.66	51.85	NO	9.1
1992	-832.80	-901.72	68.92	20.31	48.61	NO	8.54
1993	-803.23	-867.55	64.32	18.95	45.37	NO	7.97
1994	-734.70	-794.43	59.73	17.60	42.13	NO	7.4
1995	-666.83	-721.96	55.13	16.24	38.89	NO	6.83
1996	-650.03	-700.57	50.54	14.89	35.65	NO	6.26
1997	-657.28	-703.23	45.94	13.54	32.41	NO	5.69
1998	-648.37	-689.72	41.35	12.18	29.17	NO	5.12
1999	-241.12	-626.86	385.74	246.36	139.37	NO	11.21
2000	-587.55	-712.34	124.80	51.40	73.40	NO	11.38
2001	-729.91	-817.21	87.30	25.72	61.58	NO	10.81
2002	-700.78	-783.48	82.70	24.37	58.33	NO	10.24
2003	-599.68	-677.79	78.11	23.01	55.09	NO	9.67
2004	-648.93	-722.44	73.51	21.66	51.85	NO	9.1
2005	-781.48	-850.40	68.92	20.31	48.61	NO	8.54
2006	-590.27	-654.59	64.32	18.95	45.37	NO	7.97
2007	-676.83	-736.56	59.73	17.60	42.13	NO	7.4
2008	-401.42	-613.01	211.59	111.14	100.46	NO	10.59
2009	-397.55	-541.10	143.55	57.70	85.85	NO	11.87
2010	15.61	-581.40	597.01	322.34	274.67	NO	22.87
2011	85.35	-547.32	632.67	309.61	323.06	NO	32.74
2012	370.84	-559.05	929.90	456.70	473.20	NO	47.35
2013	1198.78	-530.83	1729.61	870.23	859.38	NO	77.72
2014	86.84	-548.18	635.02	146.74	488.28	NO	77.72
2015	381.14	-562.35	943.49	326.38	617.11	NO	84.66

2016	126.00	-566.04	692.04	159.42	532.62	NO	84.66
2017	163.88	-554.74	718.62	175.23	543.38	NO	85.24
2018	116.04	-580.78	696.83	160.53	536.30	NO	85.24
2019	103.43	-539.60	643.03	144.64	498.38	NO	78.59

6.4.2 INFORMATION ON THE APPROACHES USED TO PRESENT THE DATA ON THE AREAS AND THE DATABASE ON THE LAND-USE USED FOR THE INVENTORY

Information on total Cropland and Grassland area is available from different data sources during the years (Chapter 6.1.4.1). The National Statistical Yearbooks provide information on CL and GL areas over the period 1988-2000. The data shows a steady increase in the CL area and a decrease in GL since 1992, when the land reform since the collapse of planned economy has actually started. No unambiguous, reliable and consistent information was found on the allocation and reallocation of land resources shares during in the period 1991 – 1997 (Yarlovska, N. 2018), when the land reform has started. So, it was assumed that the annual variability in the totals of CL and GL according to the national statistics for the years 1992-1999 could be as a result of the restitution of lands and relocation between these categories based on the information on old real boundaries of lands or parcels and past management of these lands Thus, it was decided to smooth this unrealistic trend by interpolation method between 1988-1998. The year 1998 is the first year of the BANCIK statistics which is still operating today, so the data directly from BANCIK was used to construct the time series since 1998. Like this, consistent information is used to represent the area of CL.
The balance of the territory of Bulgaria based on orthophoto images (under LPIS) has been available since 2010. This information was used to check and verify the information regarding the lands reported under Shrubs and grassland categories since the balance of the territory under LPIS has separate land cover class on shrubs and secondary lawns.

As regards reporting of LUCs, there are no LUCs from forests to CL or GL. Any conversions and re-conversions from, other lands, wetlands and settlements to CL are considered as unlikely since settlements according to the applied definition in the country encompass the artificial surfaces and other lands constitutes of bare lands and rocks. Thus, it has been considered that the only possible gain in the area of cropland, observed in the official statistic is due to change from grassland. The annual LUCs between CL and GL have been calculated based on the changes in the totals of these categories. The variations in the net changes in the area of CL and GL follow the opposite directions throughout the time series.

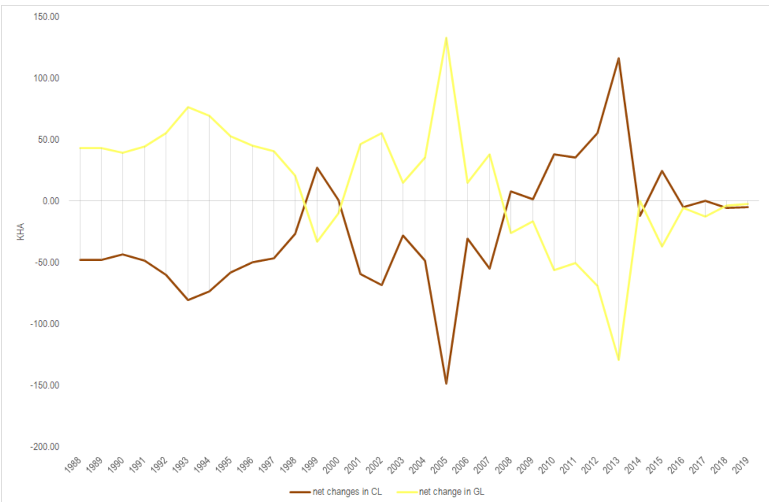


Figure 121 Net change in area of Cl and GL

The LUCs within CL category – between annual and perennial is reported according to data from BANCIK statistics since 2000. The same annual change is applied for the years before 2000.

6.4.3 METHODOLOGY

6.4.3.1 Cropland remaining Cropland (4.B.1.)

6.4.3.1.1 Changes in the carbon stocks in the living biomass

The change in biomass is only estimated for perennial woody crops. For annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year - thus there is no net accumulation of biomass carbon stocks. The estimates of the change in carbon in perennial biomass follow the approach for estimating the annual rates of growth and loss which is recognized as Tier 1 method according to 2006 IPCC Guidelines. There is no national data on the dynamics of the biomass in the perennials influenced by the changes in the land use. According to the 2019 IPCC Refinement the perennials accumulate biomass through the first 20 years. Emissions from perennials occur in the year of their clearing, assuming that annually 5% of the area of perennials are being replanted.

The area of the perennials over the time series ranges from 296 kha to 153 kha. In general, there is a trend of decrease in their area. The changes are as a result of the reorganization that took place in the Bulgarian agriculture and especially in land ownership. To determine the annual change in the biomass carbon stock of the perennials the following equation has been used:

$$\begin{aligned}\boldsymbol{Annual\ change\ in\ the\ biomass\ carbon\ stock} &= (\boldsymbol{area\ of\ the\ perennials\ remaining\ perennials} \\ &\cdot \boldsymbol{coefficient\ of\ accumulation\ of\ carbon}) \\ &- \left(\boldsymbol{area\ of\ the\ perennials\ 30\ year\ earlier^{1}} \cdot \boldsymbol{0.033}\right. \\ &\left.\cdot \boldsymbol{coefficient\ of\ accumulation\ of\ biomass}\right);\end{aligned}$$

$$^{1}\ \boldsymbol{excluding\ area\ lost\ through\ land-use\ change}$$

For the aboveground biomass stock at maturity the value 6.91 tonnes $C.ha^{-1}$ has been adopted, and for the annual accumulation – 0.35 tonnes $C.ha^{-1}.y^{-1}$ (2019 IPCC Refinement).

Table 228 Accumulation and loss of carbon in the aboveground biomass and period of clearing of perennials (calculated based on the 2019 IPCC Refinement)

Climatic zone	ABG C stock at maturity - MAX (tonnes C/ ha)	Period of clearing (years)	Annual accumulation of C in the aboveground biomass (tonnes C/ha/yr	Loss of carbon in the aboveground biomass (tonnes C/ha/yr)
Temperate (all humidity regimes)	6.91	20	0.35	4.49

6.4.3.1.2 Changes in the carbon stock in the biomass of perennials converted to annual crops

The annual change in biomass C stock is equal to the area of the converted lands ($A_{Conversion}$), multiplied by the carbon stock in the biomass of the perennials ($L_{Conversion}$) plus the changes in the carbon stock in the biomass during the first year after the conversion (ΔC_{Growth}).

$$\boldsymbol{The\ annual\ change\ \ of\ carbon\ stock\ in\ biomass} = \boldsymbol{A_{conversion}}(\boldsymbol{L_{conversion}} + \Delta \boldsymbol{C_{growth}})$$

where,

$L_{conversion} = C_{after} - C_{before}$

$A_{conversion}$ – area of the lands converted to annual crops, ha yr^{-1}

$L_{conversion}$– carbon stock in the biomass of lands which were converted to annual crops, tonnes C ha-1

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha-1

For Bulgaria ΔC_{Growth} has been calculated on the basis of the NSI's yield data for annual crops (cereals, industrial crops, vegetables, fodder crops) for 1995, 2000 and 2005, 2010, 2015. The absolutely dry weight of these crops was corrected with national coefficients (Krachunov, I, Al. Alexandrov, 2007). To obtain the total biomass of the plants for the expansion from the yield biomass to the total biomass the following coefficients[29] have been used (Table 229). The expansion factors for the rest of the aboveground biomass stem from Austria and the root–to-shoot ratios - from US. Since both countries belong like Bulgaria to the temperate region, they are considered as appropriate for Bulgarian conditions.

Table 229 Coefficients used for calculating the total biomass of the annual crops

Crop	Rest of aboveground biomass (in % of yield biomass)	Aboveground/belowground ratio	Root-to–shoot ratio
wheat	100	-	0.21
rye	140	-	NE
barley	110	-	1.02
oats	150	-	0.4
maize	140	-	0.18
fied peas	100	-	NE
rape	210	-	NE
sunflower	250	-	0.06
sugar beet	80	-	0.43
fodder beet	30	-	NE
potato	30	-	0.07
soya	150	-	0.15
corn silage	20	-	0.18
lucerne	10	-	NE
red clover	10	-	NE
cotton		0.4	0.17
rice		0.4	0.46
peanuts		0.4	0.07
tabacco		0.6	0.8

To estimate the total, the yield biomass is expanded with a coefficient for the rest of the aboveground biomass. After that the aboveground biomass is expanded to the total biomass with the root-to-shoot ratios. An average weighed mean of the cropland biomass was calculated then on basis of the yields of the individual crops in Bulgaria for single years - ΔC_{Growth} = 3 tonnes C ha^{-1}.

The calculations are based on the following steps:

$$\boldsymbol{Ba\ total_x = B\ yield_x \cdot Cdrm_x + B\ yield_x \cdot C\ drm_x \cdot F\ rab_x}$$

Where,

Ba total - Total aboveground biomass

[29] The expansion factors according to Bodenfruchtbarkeitsbeirat 2001 (pers. comm.)
Root-to-shoot ratios are published by West, T.O., 2008

B yield – yields of annual crops – cereals, vegetable crops, fodder crops, industrial crops etc., tonnes

C drm – coef. for absolutely dry matter, % (lit source: Krachunov, I, Al. Alexandrov, 2007)

F rab – factor of the rest of the aboveground biomass, %

x – any particular annual crop for which data is gathered

$$\boldsymbol{Bb\ total_x = Ba\ total_x \cdot R_x}$$

Where,

Bb total – total belowground biomass

R – root to shoot ratio

x – any particular annual crop for which data is gathered for single year

$$\boldsymbol{B\ total_x = Ba_x + Bb_x}$$

Where,

B total – total biomass (above and belowground)

Ba total - Total aboveground biomass

Bb total – total belowground biomass

$$\boldsymbol{B_{\frac{t}{ha},1995,2000,2005,2010,2015} = \sum B\ total\ x \Big/ \sum area\ x}$$

Where,

B – biomass in t/ha

B total – total biomass (above and belowground)

Area – ha

Average of B t/ha for 1995, 2000, 2005, 2010, 2015 = 3.56 t/ha

The changes in the carbon stock immediately after the conversion is assumed to be 0 as the biomass is taken away (C_{After}=0).
The value of 4.49 tonnes C/ha (C_{Before}) (2006 IPCC Guidelines) is used for the carbon stock immediately before the conversion.

6.4.3.1.3 Changes in the carbon stock in the biomass of annual crops converted to perennials

To calculate the annual change of carbon in living biomass in annual crops converted to perennial the same equation as described in chapter 6.4.3.1.2. For the annual increase of the carbon stock in the biomass of the perennials the value 0.35 tonnes C $ha^{-1}y^{-1}$ is used (for each year of the transition period) given in the 2019 IPCC Refinement. The value 3.56 tonnes C ha^{-1} (item 6.4.3.1.2.) is used for the loss of carbon from the biomass of annual crops.
The annual change in the carbon stock of the biomass is equal to the area of the converted lands for a transition period of 20 years ($A_{Conversion}$) multiplied by the annual carbon stock growth of the perennial biomass (ΔC_{Growth} = 0.35 tonnes C ha^{-1}). For the biomass losses the actual annual land use change area annual to perennial is multiplied by the biomass carbon stock of annual crops.

$$\boldsymbol{Annual\ change\ in\ carbon\ stock\ in\ biomass = \left(area\ of\ the\ converted\ lands\ for\ 20\ yeats \cdot \Delta C_{growth}\right) + \left(actual\ annual\ area\ of\ conversion \cdot L_{conversion}\right)}$$

where,

$$L_{conversion} = C_{after} - C_{before}$$

$L_{conversion}$– carbon stock in the biomass of lands which were converted to annual crops, tonnes C ha^{-1}

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha^{-1}

Change of the carbon stock immediately after the conversion is considered to be 0 as the biomass is taken away (C_{After} =0).
For the carbon stock immediately before the conversion the value calculated for Bulgaria is used: 3 tonnes C $ha^{-1}y$ (item 6.4.3.1.2).

6.4.3.1.4 Changes in the carbon stock in soils of croplands remaining croplands

The assessment of the carbon stock in soil is performed at 0-30 cm. The carbon stock of the plant residues on the surface (dead organic matter) and the changes in the non-organic carbon (in the carbonate minerals) are not estimated. The estimates of carbon stock changes in soils are carried out only for mineral soils.

The Histosols in Bulgaria covers 0.05 % (5664 ha) of the total area of the country. In the sector Agriculture there are emissions reported from organic soils. For consistency reasons we report here the area of agricultural lands (croplands and grasslands) with organic soils. The emissions of organic soils in croplands are not assessed. They are assumed to be insignificant taking in consideration the small area - 0.05 % is the total area of the Histosols in Bulgaria. Based on data from IACS we identified that less than 50 % of their total area is connected with anthropogenic impacts. In addition, there is no transition from CL or to CL of lands with organic soils. We assume that in more than 50 % of the total area including organic soils (Histosols) there is no peat extraction or other type of impact on Histosols under annual crops and perennials.

Source of information for the contents of organic carbon in cropland and grassland soils is the National System for Environment Monitoring (EAEW-MOEW). Taking into account the representativeness of the data and the purpose of the estimate, the reference soil organic carbon stock in cropland and grassland soils has been evaluated based on dataset from a full soil inventory carried out in 2010. The dataset on soil contains information on the soil chemistry and physical parameters from soils under different land use (e.g cropland and grassland). The measurements of the soil's parameters are made for layers (0-20cm, 20-40cm.). The content of organic matter is presented in percentage. In order to estimate the organic carbon stock (tC/ha), data on bulk density is needed. However, the data on bulk density is available only for the upper layer. Therefore, the bulk density of the soil from the layer 20-40 cm has been approximated using the Alexander B (1980) PTF function[30]:

$$\boldsymbol{\rho_b = 1.72 - (0.294 * (org.C, \%)^{0.5})}$$

Thus, the organic carbon stock has been calculated for all samples from the dataset. Then, the samples have been grouped by land use and soil type and an average value for carbon stock in the different soil types has been derived. Data on the area of the particular soil types under cropland or grassland management is available according to Soil map of Bulgaria (1:400 000) and Corine land cover data (1:100 000). Therefore, the reference soil organic carbon stock in soils of cropland and grassland has been derived as a weighted mean from the averages SOCs of every particular soil type under cropland and grassland categories. The average soil organic carbon stocks in cropland (0-30 cm) are 67.74 tC/ha for annual crops and 67.49 tC/ha for perennial crops.

[30]G.TAULYA et al., 2005 Validation of pedotrasfer functions for soil bulk density estimation on a Lake Victoria Basin soilscape

6.4.3.1.4.1 Changes in the carbon stock in the soils of annual remaining annual and perennials remaining perennials

For estimating the CSC in annual remaining annual and perennial remaining perennial, Equation 2.25 Formulation A (Chapter 2, IPCC 2006) is used to estimate changes in soil organic C stocks in mineral soils by subtracting the C stock in the last year of an inventory time period (SOC_0) from the C stock at the beginning of the inventory time period ($SOC_{(0-T)}$) and dividing by the time dependence of the stock change factors (D - 20 years). Default management factors have been applied but they were adjusted according to the Bulgarian climate conditions. The input factors have been assigned to 1. Land use factors have been incorporated when the average SOC content in soils of perennial and annual crops have been estimated.

MG f	Non-till	Reduced till	Full till
annual	1.06	1.01	1
perennial	1.06		

6.4.3.1.4.2 Changes in the carbon stock in the soils of lands with perennials converted to annual crops

The average annual change in the carbon stock in mineral soils of perennials, converted to annual crops (ΔSOC_{20}) has been calculated using the equation:

$$\Delta \boldsymbol{SOC_{20}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}} = \mathbf{0.0125}\ \boldsymbol{tC/ha}$$

where,
SOC_0 – carbon stocks in the soils after 20 years of transition = 67.74 t C/ha,
SOC_{0-T} – carbon stock in the soils before the conversion = 67.49 t C/ha.
To find the net change in the carbon stock in the soil, the annual change (ΔSOC_{20}) has been multiplied by the converted area.

6.4.3.1.4.3 Changes in the carbon stock in the soils of lands under annual croplands converted to perennials

The average change in the carbon stock in mineral soils of lands under annual crops converted to perennials (ΔSOC_{20}) has been calculated using the equation:

$$\Delta \boldsymbol{SOC_{20}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}} = -\mathbf{0.0125}\ \boldsymbol{tC/ha}$$

where,
SOC_0 – carbon stocks in the soils after 20 years of transition = 67.49 t C/ha,
SOC_{0-T} – carbon stock in the soils before the conversion = 67.74 t C/ha.
To find the net change in the carbon stock in the soil, the annual change (ΔSOC_{20}) has been multiplied by the converted area.

6.4.3.1.5 Liming

There is no liming after 1987.

6.4.3.2 Lands converted to croplands (4.B.2.)

6.4.3.2.1 Changes in the carbon stock in the living biomass in lands converted to annual crops

The calculation of the annual changes of the carbon stock in the living biomass in lands converted to annual crops is calculated using the following equations:

$$\boldsymbol{The\ annual\ change\ \ of\ carbon\ stock\ in\ biomass} = \boldsymbol{A_{conversion}}(\boldsymbol{L_{conversion}} + \Delta \boldsymbol{C_{growth}})$$

where,

$L_{conversion} = C_{after} - C_{before}$

$A_{conversion}$ – area of the lands converted to annual crops, ha yr^{-1}

$L_{conversion}$– carbon stock in the biomass of lands which were converted to annual crops, tonnes C ha^{-1}

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha^{-1}

The arbon stock in the living biomass after the conversion (C_{After}) is equal to 0. The biomass stock before the conversion is 6.58 t/ha for GL. The average annual biomass stock in GL is calculated on basis of statistical data (National Statistical Yearbook) for the average yield of hay from grasslands for a period of 10 years (1995-2015). The values were recalculated to the absolutely dry matter (Krachunov, I., Alexandrov, A, 2007) and expanded with the remaining aboveground stubble biomass (1.6 t ha^{-1}) (according to 2006 IPCC GL) and with a coefficient for the root-to-shoot ratio 2.8 (according to 2006 IPCC GL). The figure of average biomass carbon stock in OL is obtained from scientific paper based on case study in BG under the project Land-use and management impacts on carbon sequestration in mountain ecosystems" under the framework of the Bulgarian-Swiss Research Programme ("BSRP")

The annual accumulation of carbon in the annual cropland biomass in the first year after the conversion (ΔC_{Growth}) is = 3.56 tonnes C ha^{-1}. The approach for determining the ΔC_{Growth} is described in section 6.4.3.1.2.

The quantity of carbon in the biomass is adopted by default - 0.5 (2006 IPCC).

6.4.3.2.1.1 Changes of the carbon stock in the living biomass in lands converted to perennials.

For perennials a value for the average annual growth of the biomass has been used according to IPCC GPG (2.1 tC/ha y), for the whole period of conversion – 20 years.

$$\boldsymbol{Annual\ change\ in\ carbon\ stock\ in\ biomass} = \left(\boldsymbol{area\ of\ the\ converted\ lands\ for\ 20\ yeats} \cdot \Delta \boldsymbol{C_{growth}}\right) + (actual\ annual\ area\ of\ conversion \cdot L_{conversion})$$

where,

$L_{conversion} = C_{after} - C_{before}$

$L_{cnversion}$– carbon stock in the biomass of lands which were converted to annual crops, tonnes C ha^{-1}

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha^{-1}

To calculate the changes in the carbon stocks in the biomass the following values were used:

ΔC_{growth} = 0.35 tC/ha y (calculated based on IPCC 2019)

C_{after}= 0

C_{before} = 6.58 t C/ha calculated for Bulgaria (for GL).

6.4.3.2.1.2 Changes in the carbon stock in soils of grassland converted to annual crops

To assess the emissions/removals of carbon specific data for the country has been used. The average carbon stock in grassland soils (72.77 t C/ha for Pastures and meadows and 86.96 tC/ha for Shrubs and grassland) has been calculated as described in 6.4.3.1.4.

The average annual change in the carbon stock in the soils of lands converted to annual crops (ΔCLG_{Soils}), is calculated using the following equation:

$$\Delta \boldsymbol{C_{LGsoil}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}}$$

Where,

ΔC_{LGsoil} - annual change in carbon stock in soils in land converted to CL

SOC_0 – carbon stocks in the soils after 20 years of transition = 67.74 t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 86.96 t C/ha and 72.77 t C/ha.

T – period assessed, years (equal to 20 years),

The change in the carbon stock in soils of lands converted to annual crops was calculated by multiplying the annual change in carbon stock by the area of the converted territory.

6.4.3.2.1.3 Changes in the carbon stock in soils of lands converted to perennials

To assess the emissions/removals of carbon specific data for the country has been used.
The average annual change in the carbon stock in the soils of grassland (ΔCLG_{Soils}), converted to perennials is calculated using the following equation:

$$\Delta \boldsymbol{C_{LGsoil}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}} =$$

Where,

ΔC_{LGsoil} - annual change in carbon stock in soils in land converted to CL

SOC_0 – carbon stocks in the soils after 20 years of transition = 67.49 t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 86.96 and 72.77 tC/ha.

T – period assessed, years (equal to 20 years),

The change in the carbon stock in soils of lands converted to perennials was calculated by multiplying the annual change in carbon stock by the area of the converted territory.

6.4.3.2.1.4 N_2O emissions in grasslands converted to croplands

N_2O emissions from land-use conversions to cropland as a result of soil oxidation has been estimated based on tier 1 approach and equations 11.1, 11.2, 11.8. (2006 IPCC Guidelines).
The ratio C/N in the mineral soils is derived based on data gathered under the soil inventory in BG (since 2005).

6.4.4 UNCERTAINTY ASSESSMENT

The overall uncertainty in estimation of gas emissions and removals over a year for the category "Cropland" is **548 %**. The trend uncertainty owed to activity data and emission factors is **176%** (Table 229).

The combined uncertainty for the sub-category "Cropland remaining cropland" is **206 %** and the uncertainty in the trend of the gas emissions is **32 %.**

The uncertainties for the sources "Living biomass" and "Soil" within the sub-category "Cropland remaining cropland" were determined.

The overall uncertainty over a year for the "Living biomass" is **47 %**. The trend uncertainty for the same sub-category exceeded more than 100 times the estimated tendency in emissions, which was due primarily to high uncertainty introduced by the emission factors**.**

The combined uncertainty for „Soils" is **172 %** and the uncertainty in the trend of the gas emissions is **14 %**.

The combined uncertainty for the sub-category „Land use changed to cropland" is **17 %**. The trend uncertainty in gas emissions is **75 %**.

The uncertainties of gas emission estimations from the pools "Living biomass" and "Soil" for the sources "Forest land changed to cropland (annuals and perennials)", "Grassland (permanent pasture and meadows, PPM and marginal grasslands and lawns, MGL) changed to cropland (annuals and perennials)" and "Other land changed to cropland (annuals and perennials)" were estimated.

The combined uncertainty for "Living biomass" is **30 %**. The trend uncertainty due to activity data and emission factors is **19 %**.

The combined uncertainty for „Soil" is **17 %**. The uncertainty in the estimated tendency for the gas emissions is **71%**.

Table 230 Uncertainties in the gas emissions from the IPCC category "Cropland"

IPCC sub-category	Pool	Level of estimation	Gas	Base year emissions	Current year emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total in the current year	Uncertainty in trend introduced by emission factor uncertainty	Uncertainty in trend introduced by activity data	IPCC sub-category
Cropland remaining cropland	Living biomass	growth perennial biomass	CO2	-290.88	-96.50	3	28.13	28.28	180.55	5.74	0.50	33.16
		loss perennial biomass	CO2	284.53	208.44	3	13.26	13.60	194.67	4.51	1.08	21.50
		biomass growth annuals	CO2	-83.11	-81.79	3	23.03	23.23	87.47	2.86	0.42	8.37
		conversion of cropland with perennials	CO2	42.51	38.02	3	25.00	25.18	22.21	1.48	0.20	2.22
		biomass growth perennial	CO2	-37.43	-41.15	3	28.13	28.28	32.84	1.72	0.21	3.01
		conversion of cropland with annuals	CO2	72.06	79.23	3	23.03	23.23	82.09	2.72	0.41	7.57
	Soil	C increment in annuals	CO2	-739.31	-589.98	3	187.92	187.94	297940.16	174.97	3.04	30623.17
		C increment in perennials	CO2	-169.23	-56.15	3	58.70	58.78	263.94	6.98	0.29	48.77
		conversion of perennials to annuals	CO2	-2.63	-2.67	3	329.41	329.43	18.71	1.33	0.01	1.77
		conversion of annuals to perennials	CO2	2.99	2.94	3	329.41	329.43	22.70	1.47	0.02	2.17
Land use changed to cropland	Living biomass	growth annual biomass	CO2	0.00	0.00	10	23.03	25.11	0.00	0.00	0.00	0.00
		conversion of forest land	CO2	0.00	0.00	10	32.41	33.92	0.00	0.00	0.00	0.00
		conversion of grassland (PPM)	CO2	0.00	0.00	10	79.35	79.98	0.00	0.00	0.00	0.00
		conversion of grassland	CO2	0.00	0.00	10	50.00	50.99	0.00	0.00	0.00	0.00

		(MGL)										
		conversion of other land	CO2	0.00	0.00	10	75.00	75.66	0.00	0.00	0.00	0.00
		new biomass of perennials	CO2	-3.46	4.53	10	28.13	29.85	0.44	0.13	0.08	0.02
		conversion of forest land	CO2	0.00	0.00	10	32.41	33.92	0.00	0.00	0.00	0.00
		conversion of grassland (PPM)	CO2	0.00	0.00	10	79.35	79.98	0.00	0.00	0.00	0.00
		conversion of grassland (MGL)	CO2	0.00	0.00	10	50.00	50.99	0.00	0.00	0.00	0.00
		conversion of other land	CO2	0.00	0.00	10	75.00	75.66	0.00	0.00	0.00	0.00
		conversion of forest land to annuals	CO2	0.00	0.00	10	44.74	45.84	0.00	0.00	0.00	0.00
		conversion of grassland (PPM) to annuals	CO2	26.24	146.80	10	4.00	10.77	60.58	0.75	2.52	6.93
		conversion of grassland (MGL) to annuals	CO2	59.26	484.59	10	0.49	10.01	570.41	0.30	8.33	69.53
		conversion of other land to annuals	CO2	0.00	0.00	10	243.64	243.85	0.00	0.00	0.00	0.00
	Soil	conversion of forest land to perennials	CO2	0.00	0.00	10	49.05	50.06	0.00	0.00	0.00	0.00
		conversion of grassland (PPM) to perennials	CO2	1.65	6.78	10	16.28	19.11	0.41	0.14	0.12	0.03
		conversion of grassland (MGL) to perennials	CO2	3.59	21.46	10	4.31	10.89	1.32	0.12	0.37	0.15
		conversion of other land to perennials	CO2	0.00	0.00	10	247.64	247.84	0.00	0.00	0.00	0.00
		conversion of grasslands to croplands	N2O	10.81	78.59	10	91.93	92.47	1279.70	9.08	1.35	84.35
		Total emissions		**-822.39**	**203.14**	**Overall uncertainty in the year (%)**			**548**	**Trend uncertainty (%)**		**176**

6.4.5 DATA VERIFICATION CATEGORY-SPECIFIC QA/QC AND VERIFICATION, IF APPLICABLE

See 6.1.6. QA/QC VERIFICATION

6.4.6 CATEGORY-SPECIFIC RECALCULATIONS

See 6.1.7 RECALCULATIONS

6.4.7 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

For Cropland category it is planned to continue working on the land-use classification and representation across the time series.

6.5 GRASSLAND (4.C)

6.5.1 DESCRIPTION OF THE CATEGORY

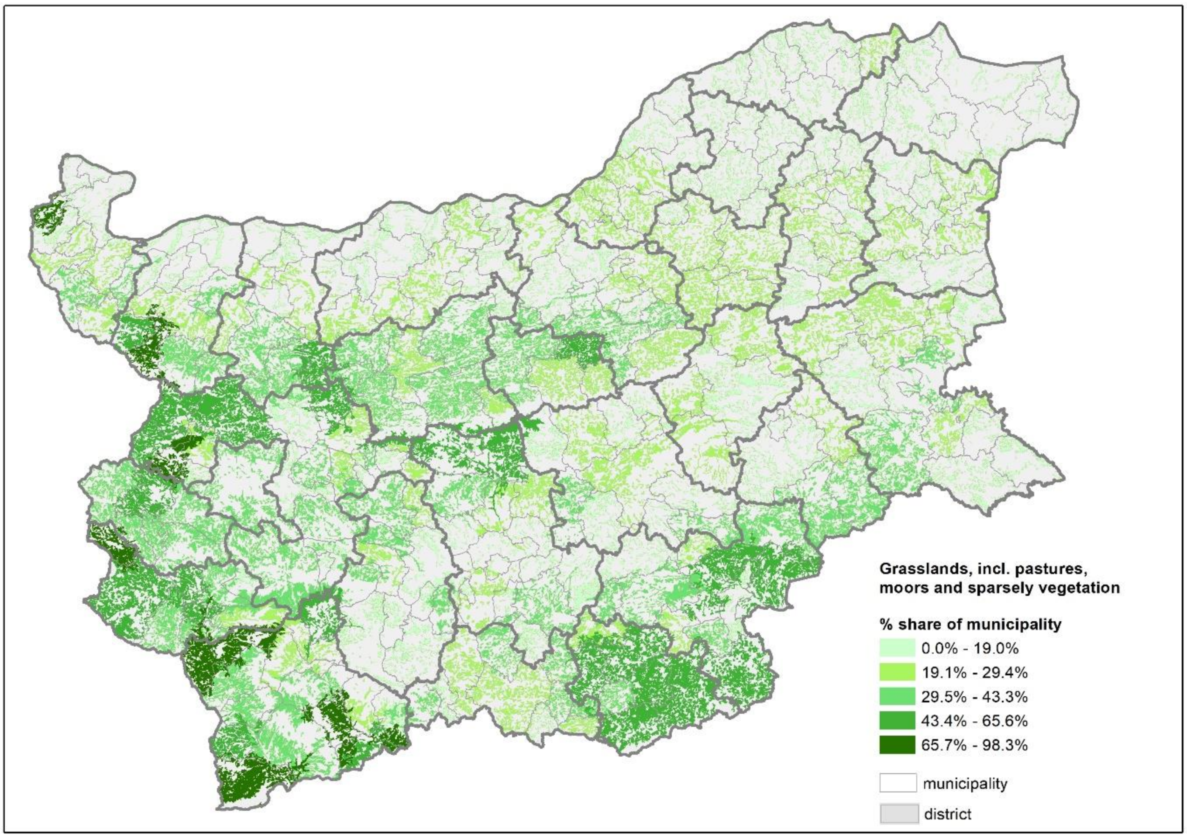


Figure 122 Share of municipality area occupied by Grasslands. The map is elaborated based on CLC, 2018.

Table 231 Categories assessed for emissions/removals

4 C. Grassland – total
4.C.1 Grassland remaining grassland
- carbon stock change in living biomass – Tier 1 NO
- carbon stock change in soils in LU between the subcategories in GL
4 C 2 Lands converted to Grassland
4 C 2 1 Cropland converted to grassland
- carbon stock change in living biomass of annual/perennial cropland converted to pastures and meadows/shrubs and grasslands
- carbon stock change in living biomass of other lands converted to shrubs and grasslands
- carbon stock change in soils of annual/perennial croplands converted to pastures and meadows/shrubs and grasslands
- carbon stock change in soils of other lands converted to shrubs and grasslands
4 (III) N Mineralization associated with carbon loss in soils

Grassland in Bulgaria cover an area of 2553.68 kha which represents 23% of the country's territory. 55% of these lands or 1408.48 kha represent managed pastures, meadows, natural lawns all of which managed by grazing or mowing. The other 45% of the Grassland category represent shrublands secondary lawns, grasslands etc.

Over the reporting period there are fluctuations in the area of GL which are in the opposite direction of the changes observed in the CL area.

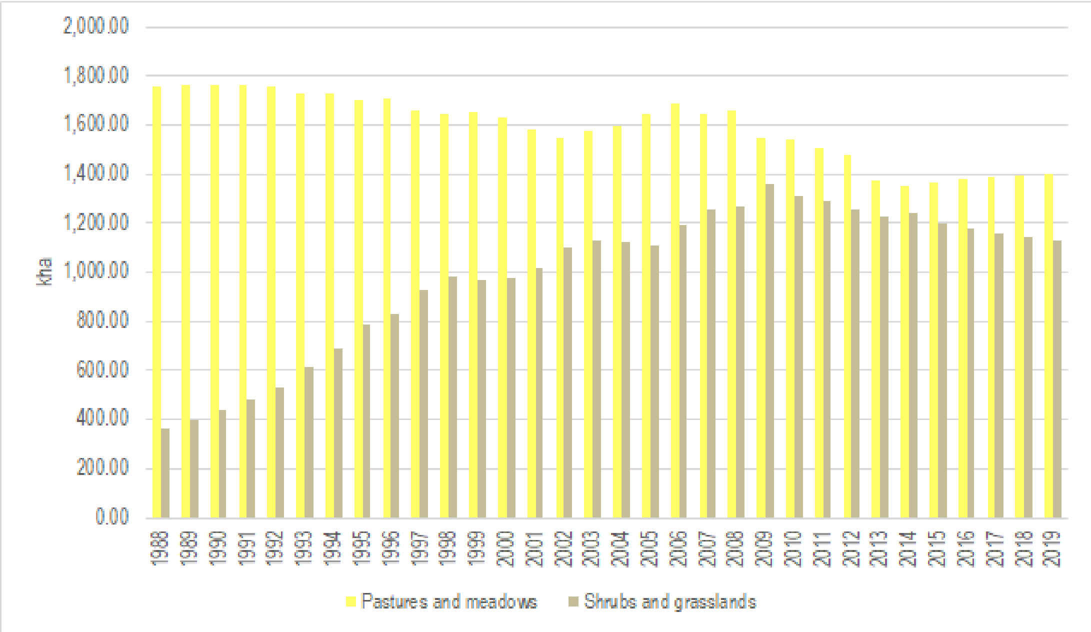


Figure 123 Annual representation for lands under GL category

The evaluation of the emissions/removals from Grassland category is based on estimates of the changes in the carbon stocks in living biomass and soil.

The assumption in Tier 1 (according 2006 IPCCC Guidelines) is that the DOM carbon stock in grassland remaining grassland and land converted to grassland are insignificant or are not changing and therefore no emission/removal factors and activity data are needed.

Some management practices, like burning of stubble-fields are forbidden in Bulgaria. There is no peat extraction, draining of peat soils or other anthropogenic activity which affects their water regime, the temperature on their surface and the species. Due to these reasons the carbon stock change in Histosols is not subject to evaluation.

The area of Grassland category (e.g. Grassland remaining grassland 4.C.1 and Lands converted to grassland 4.C.2) and its associated emissions/removals are presented in the tables below.

Table 232 Land use and land-use changes in the category Grassland (kha) (other land- use changes are not occurring)

year	4.C Grassland Total	4.C.1 Grassland remaining Grassland	4.C.2 LUC in Grassland	4.C.2.2.a Annual cropland in Pastures and meadows	4.C.2.2.b Perennial cropland in Pastures and meadows	4.C.2.2.c Annual cropland in Shrubs and grasslands	4.C.2.2.d Perennial cropland in Shrubs and grasslands	4.C.2.5 OL converted to Shrubs and grassland
1988	2175.91	1928.78	247.13	143.87	15.99	30.15	3.35	53.77
1989	2219.36	1932.64	286.72	171.54	19.06	36.54	4.06	55.52
1990	2258.62	1936.51	322.11	195.52	21.72	42.85	4.76	57.26
1991	2303.07	1940.31	362.77	222.66	24.74	50.73	5.64	59.00
1992	2358.53	1944.04	414.48	256.69	28.52	61.67	6.85	60.75
1993	2434.98	1947.86	487.12	303.07	33.67	79.09	8.79	62.50
1994	2504.44	1951.64	552.80	343.30	38.14	96.39	10.71	64.24
1995	2557.40	1955.06	602.33	371.75	41.31	111.06	12.34	65.88
1996	2602.36	1958.46	643.89	394.80	43.87	123.94	13.77	67.52
1997	2643.11	1961.16	681.95	414.53	46.06	137.07	15.23	69.05
1998	2663.86	1963.83	700.03	422.41	46.93	144.08	16.01	70.60
1999	2630.70	1936.90	693.80	416.62	46.29	142.87	15.87	72.15
2000	2620.83	1936.28	684.55	410.84	45.65	141.65	15.74	70.67
2001	2667.33	1934.83	732.50	436.30	48.48	160.64	17.85	69.23
2002	2722.91	1933.21	789.70	465.45	51.72	184.25	20.47	67.81
2003	2737.71	1931.58	806.13	473.07	52.56	192.70	21.41	66.38
2004	2773.02	1930.00	843.02	491.60	54.62	208.65	23.18	64.96
2005	2905.80	1927.47	978.33	563.60	62.62	259.70	28.86	63.54
2006	2920.78	1924.91	995.88	571.91	63.55	268.46	29.83	62.13
2007	2959.01	1921.95	1037.06	591.80	65.76	286.90	31.88	60.73
2008	2933.10	1944.81	988.29	557.86	61.98	279.79	31.09	57.58
2009	2916.53	1977.00	939.53	524.40	58.27	272.18	30.24	54.44
2010	2860.37	1965.40	894.96	494.64	54.96	264.66	29.41	51.30
2011	2809.84	1964.70	845.13	461.71	51.30	255.57	28.40	48.15
2012	2740.80	1956.59	784.22	421.89	46.88	243.42	27.05	44.98
2013	2612.03	1909.52	702.51	369.73	41.08	224.78	24.98	41.94
2014	2612.40	1974.31	638.09	328.56	36.51	210.71	23.41	38.90
2015	2575.63	1994.89	580.74	294.33	32.70	194.83	21.65	37.23
2016	2569.95	2035.16	534.79	266.91	29.66	181.95	20.22	36.06
2017	2557.38	2069.60	487.78	241.39	26.82	167.60	18.62	33.35
2018	2553.68	2086.61	467.06	229.44	25.49	160.80	17.87	33.47
2019	2551.29	2078.82	472.47	230.56	25.62	161.71	17.97	36.62

Table 233 Emissions (+)/removals of CO_2 in Grassland Remaining Grassland and Lands Converted to Grassland (Gg CO_2 equivalent) (other land use changes are not occurring)

year	4.C Grassland Total	4.C.1 Grassland remaining Grassland	4.C.2 LUC in Grassland	4.C.2.2. Cropland in Grassland	4.C.2.5 OL converted to GL
1988	-1025.85	144.33	-1170.17	-718.69	-451.48
1989	-1084.93	147.48	-1232.41	-769.68	-462.73
1990	-1097.68	150.62	-1248.30	-774.33	-473.97
1991	-1213.22	153.30	-1366.52	-881.21	-485.31
1992	-1402.42	155.75	-1558.17	-1061.49	-496.68
1993	-1717.12	158.15	-1875.27	-1367.44	-507.83
1994	-1761.87	159.63	-1921.50	-1402.36	-519.14
1995	-1697.24	160.75	-1858.00	-1331.02	-526.98
1996	-1706.50	160.25	-1866.75	-1329.00	-537.74
1997	-1747.74	160.17	-1907.91	-1362.92	-544.99
1998	-1613.65	158.39	-1772.04	-1216.78	-555.25
1999	-1399.21	155.33	-1554.54	-989.23	-565.31
2000	-1308.54	152.68	-1461.21	-978.52	-482.70
2001	-1908.45	150.24	-2058.69	-1584.23	-474.46
2002	-2099.22	147.38	-2246.60	-1781.06	-465.54
2003	-1779.35	142.96	-1922.32	-1465.88	-456.44
2004	-2036.05	138.09	-2174.14	-1726.84	-447.30
2005	-3174.05	133.07	-3307.11	-2868.90	-438.22
2006	-2174.32	129.89	-2304.21	-1874.97	-429.24
2007	-2463.20	126.42	-2589.62	-2169.26	-420.36
2008	-1953.18	118.39	-2071.58	-1671.56	-400.01
2009	-1875.38	111.96	-1987.35	-1607.29	-380.06
2010	-1804.24	102.61	-1906.85	-1547.15	-359.70
2011	-1722.66	94.37	-1817.03	-1477.61	-339.42
2012	-1621.17	86.21	-1707.37	-1388.96	-318.42
2013	-1484.67	79.45	-1564.12	-1262.16	-301.96
2014	-1461.39	72.48	-1533.87	-1251.47	-282.40
2015	-1303.15	65.75	-1368.89	-1067.07	-301.83
2016	-1260.00	59.78	-1319.78	-1013.07	-306.71
2017	-1099.88	55.34	-1155.23	-905.78	-249.45
2018	-1163.35	51.83	-1215.18	-896.49	-318.69
2019	-1254.88	48.29	-1303.17	-890.82	-412.35

6.5.2 INFORMATION ON THE APPROACHES USED TO PRESENT THE DATA ON THE AREAS AND THE DATABASE ON THE LAND-USE USED FOR THE INVENTORY

The data sources and the approach used for deriving the area information for sub-categories 4.C.1 and 4.C.2 is described in 6.4.2. The total of the strata Pastures and meadows (PM) comes from NSI and BANCIK and covers the whole time series. The information for the Shrubs and grasslands (ShG) is derived from BANCIK (since 1998), where activity data for low productive lands (secondary lawns) is reported. These lands constitute around 47 % from the total of Shrubs and grasslands subcategory. The other 53% represent Shrublands. The information on Shrublands is checked with CLC data and orthophoto images to confirm this share.

As regards reporting of LUCs, there are no LUCs from forests to GL. Any conversions and re-conversions from wetlands and settlements to CL are considered as unlikely since settlements according to the applied definition in the country encompass the artificial surfaces. Other lands

constitute of bare lands and rocks and it was assumed that a possible conversion is between OL and Shrubs and grasslands. The annual LUCs between CL and GL have been calculated based on the changes in the totals of these categories. The variations in the net changes in the area of CL and GL follow the opposite directions throughout the time series (Figure 121)
LUC between the Pastures and meadows and Shrubs and grasslands is calculated. It was defined that 3% of the territory covered by each subcategory under GL (e.g. PM, ShG) is the annual change between these two subcategories. This assumption has been confirmed by data from BANCIK statistics but it should be further discussed with the data providers.

6.5.3 METHODOLOGY

6.5.3.1 Grassland Remaining Grassland (4.C.1.)

6.5.3.1.1 Changes of the carbon stock in the living biomass

In line with 2006 IPCC Guidelines (Tier 1) the biomass in the grassland remaining grassland is not a source of emissions.

6.5.3.1.2 Changes of the carbon stock in soils of Pastures and meadows converted to Shrubs and grasslands

The average SOC of lands under category GL have been estimated based on empirical data and followed the approach described in 6.4.3.1.4.
The average annual change in the carbon stock in mineral soils of Pastures and meadows converted to Shrubs and grasslands (ΔSOC_{20}) has been calculated using the equation:

$$\Delta \boldsymbol{SOC_{20}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}} = -\mathbf{1.409}\ \boldsymbol{tC/ha}$$

$$\Delta SOC_{20} = [(SOC_0 - SOC_{0-T})] /20 = -0.7095$$

where,

SOC_0 – carbon stocks in the soils after 20 years of transition = 72.77 t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 86.96 t C/ha.

To find the net change in the carbon stock in the soil, the annual change (ΔSOC_{20}) has been multiplied by the converted area.

6.5.3.1.3 Changes of the carbon stock in soils of Shrubs and grasslands converted to Pastures and meadows

The average annual change in the carbon stock in mineral soils of Pastures and meadows converted to Shrubs and grasslands (ΔSOC_{20}) has been calculated using the equation:

$$\Delta \boldsymbol{SOC_{20}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}} = \mathbf{1.409}\ \boldsymbol{tC/ha}$$

$$\Delta SOC_{20} = [(SOC_0 - SOC_{0-T})]/20 = 0.7095$$

where,

SOC_0 – carbon stocks in the soils after 20 years of transition = 86.96t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 72.77 C/ha.

To find the net change in the carbon stock in the soil, the annual change (ΔSOC_{20}) has been multiplied by the converted area.

6.5.3.2 Lands converted to grasslands (4.C.2)

6.5.3.2.1 Forests converted to grassland

This category is not assessed as during the reporting period forests were not converted to grassland.

6.5.3.2.2 Lands converted to grassland

6.5.3.2.2.1 Changes in the carbon stock in the living biomass of lands converted to grassland

The estimates of the changes in biomass carbon stock are based on country-specific data. The average value of the aboveground and belowground biomass of the annual crops is 3.56 tC/ha (Section 6.4.3.2).

The carbon stock in the living biomass of grassland has been estimated. Source of information for the aboveground biomass in grassland is the National Statistical Yearbook, Agroststistics, where the information for the hay yield is published. To recalculate the absolute dry matter a coefficient of 0.8 was used (Todorov et al., 2007). The total biomass was calculated after a correction and adding of the rest of the aboveground stubble biomass and the root-to-shoot ratio.

The equation below has been used to aggregate the annual growth of the total stock of the biomass in grasslands (aboveground and belowground)

$$\boldsymbol{B_{total}} = \left[(\boldsymbol{B_{cut}} \cdot \mathbf{0.47}) + (\boldsymbol{B_{peak\ aboveground}} \cdot \mathbf{0.47})\right] \cdot (\mathbf{1} + \boldsymbol{R})$$

where:

B_{total} – total biomass (aboveground and belowground), tonnes d.m.

B_{cut}- yield biomass, tonnes d.m =1.8

$B_{peak\ aboveground}$ – biomass of the growth, tonnes d.m =1.6 (according to 2006 IPCC Guidelines)

R - root-to-shoot ratio = 2.8 (according to 2006 IPCC Gidelines)

To calculate the annual carbon stock changes in the living biomass of lands converted to grassland the following equation has been used:

$$\boldsymbol{The\ annual\ change\ \ of\ carbon\ stock\ in\ biomass} = \boldsymbol{A_{conversion}}(\boldsymbol{L_{conversion}} + \Delta \boldsymbol{C_{growth}})$$

where,

$L_{conversion} = C_{after} - C_{before}$

$A_{conversion}$ – annual area of the lands converted to grassland, ha yr^{-1}

$L_{conversion}$– carbon stock in the biomass of lands which were converted to grassland, tonnes C ha^{-1}

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha^{-1}

ΔC_{growth} = 6.58 tC/ha y (2006 IPCC GL)

C_{after}= 0

C_{before} = 3.56 tC/ha, for annual crops (calculated for Bulgaria)

C_{before} = 4.49 tC/ha for perennials (2006 IPCC Gudelines)

C_{before} = 0 tC/ha for Other lands (calculated based on research data on case study area)

6.5.3.2.2.2 Changes in the carbon stock in soils of lands converted to grassland

The reference carbon stock in soils of grassland and cropland has been calculated as described in 6.4.3.1.4. and 6.4.3.2.1.2. The annual change in the carbon stock in soils of lands under annual crops (ΔCLG_{Soils}), converted to grassland is calculated using the following equation:

$$\Delta \boldsymbol{C}_{\boldsymbol{LGsoil}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}}$$

where,

ΔC_{LGsoil} - annual change in carbon stock in soils in land converted to GL

SOC_0 – carbon stocks in the soils after 20 years of transition = 72.77 tC/ha for Pastures and meadows and 86.96 t C/ha for Shrubs and grasslands,

SOC_{0-T} – carbon stock in the soils before the conversion = 67.74 tC/ha for annual crops, 67.49 tC/ha for perennials and 51.8 t C/ha for other lands.

T – period assessed, years (equal to 20 years),

The change in the carbon stock in soils of lands under annual crops converted to grassland has been calculated by multiplying annual change in carbon stock in soils by the area of the converted territory.

6.5.4 UNCERTAINTY ASSESSMENT

The overall uncertainty in estimation of gas emissions and removals of over a year for the category “Grassland” is **25** %. The trend uncertainty due to activity data and emission factors amounts to **91** % (Table 233).

Larger portion of this uncertainty is accounted for by the sub-category “Grassland remaining grassland”. Its combined uncertainty is estimated to be **157** % and the uncertainty in the trend of the gas emissions is **45**%.

The uncertainties for the two principal pools “Living biomass” and “Soil” within the sub-category “Grassland remaining grassland” were determined.

The overall uncertainty over a year for the “Living biomass” is **2979** %. The trend uncertainty due to activity data and emission factors amounts to **462**%.

The combined uncertainty for „Soil“ is **38 %** and the uncertainty in the trend of the gas emissions is **13** %.

The combined uncertainty for the sub-category „Land use changed to grassland” is **22** %. The trend uncertainty in gas emissions is **69** %.

The uncertainties of gas emission estimations from “Living biomass” and “Soil” for the sources “Forest land changed to grassland (permanent pasture and meadows, PPM and marginal grasslands and lawns, MGL)”, “Cropland (annuals and perennials) changed to grassland”, “Other land changed to grassland” were estimated.

The combined uncertainty for “Living biomass” is **53** %. The trend uncertainty due to activity data and emission factors amounts to **42** %.

The combined uncertainty for „Soil“ is **24** %. The uncertainty in the estimated tendency for the gas emissions is **72**%.

Table 234 Uncertainties in the gas emissions from the IPCC category "Grassland"

IPCC sub-category	Pool	Level of estimation	Gas	Base year emissions	Current year emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total in the current year	Uncertainty in trend introduced by emission factor uncertainty	Uncertainty in trend introduced by activity data uncertainty	Uncertainty introduced into the trend
Grassland remaining Grassland	Living biomass	growth PPM biomass	CO2	-130.26	-101.99	5	79.35	79.51	43.74	4.70	0.73	22.59
		loss MGL biomass	CO2	103.69	81.18	5	50.00	50.25	11.07	2.36	0.58	5.91
		growth MGL biomass	CO2	-21.73	-65.87	5	50.00	50.25	7.29	1.97	0.47	4.08
		loss PPM biomass	CO2	27.30	82.75	5	79.35	79.51	28.79	3.92	0.59	15.71
	Soil	conversion of MGL to PPM	CO2	273.57	239.24	5	1.54	5.23	1.04	0.15	1.70	2.93
		conversion of PPM to MGL	CO2	-108.24	-187.03	5	1.54	5.23	0.64	0.08	1.33	1.78
		conversion of PPM to MGL	N2O	32.78	28.66	5	91.94	92.07	4.63	1.09	0.20	1.24
Land use changed to grassland	Living biomass	new biomass of PPM	CO2	-910.28	-30.05	10	79.35	79.98	3.84	86.62	0.43	7503.39
		conversion of forest land	CO2	0.00	0.00	10	32.41	33.92	0.00	0.00	0.00	0.00
		conversion of annual cropland	CO2	443.04	14.63	10	23.03	25.11	0.09	12.40	0.21	153.92
		conversion of perennial cropland	CO2	61.12	2.02	10	25.00	26.93	0.00	1.85	0.03	3.42
		conversion of other land	CO2	0.00	0.00	10	75.00	75.66	0.00	0.00	0.00	0.00
		new biomass of MGL	CO2	-256.66	-195.67	10	50.00	50.99	66.21	6.09	2.79	44.84
		conversion of forest land	CO2	0.00	0.00	10	32.41	33.92	0.00	0.00	0.00	0.00
		conversion of annual cropland	CO2	92.85	11.87	10	23.03	25.11	0.06	2.39	0.17	5.72
		conversion of perennial cropland	CO2	12.81	1.64	10	25.00	26.93	0.00	0.36	0.02	0.13
		conversion of other land	CO2	0.00	0.00	10	75.00	75.66	0.00	0.00	0.00	0.00
	Soil	conversion of forest land to PPM	CO2	0.00	0.00	10	24.20	26.19	0.00	0.00	0.00	0.00
		conversion of annual cropland to PPM	CO2	-132.67	-212.61	10	4.00	10.77	3.49	0.20	3.03	9.21
		conversion of perennial cropland to PPM	CO2	-15.47	-24.80	10	16.28	19.11	0.15	0.09	0.35	0.13
		conversion of other land to PPM	CO2	0.00	0.00	10	185.30	185.57	0.00	0.00	0.00	0.00
		conversion of forest land to MGL	CO2	0.00	0.00	10	10.49	14.49	0.00	0.00	0.00	0.00
		conversion of annual cropland to MGL	CO2	-106.27	-569.95	10	0.49	10.01	21.66	0.22	8.12	65.92
		conversion of perennial cropland to MGL	CO2	-11.96	-64.15	10	4.31	10.89	0.32	0.21	0.91	0.88
		conversion of other land to MGL	CO2	-346.67	-236.08	10	110.48	110.93	456.14	21.28	3.36	464.31
		Total emissions		**-993.07**	**-1226.22**	**Overall uncertainty in the year (%)**			**25**	**Trend uncertainty (%)**		**91**

6.5.5 DATA VERIFICATION CATEGORY-SPECIFIC QA/QC AND VERIFICATION, IF APPLICABLE

See 6.1.6 QA/QC VERIFICATION

6.5.6 CATEGORY-SPECIFIC RECALCULATIONS

See 6.1.7 RECALCULATIONS.

6.5.7 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

See 6.1.8 PLANNED IMPROVEMENTS

6.6 WETLANDS (4.D)

6.6.1 DESCRIPTION OF THE CATEGORY

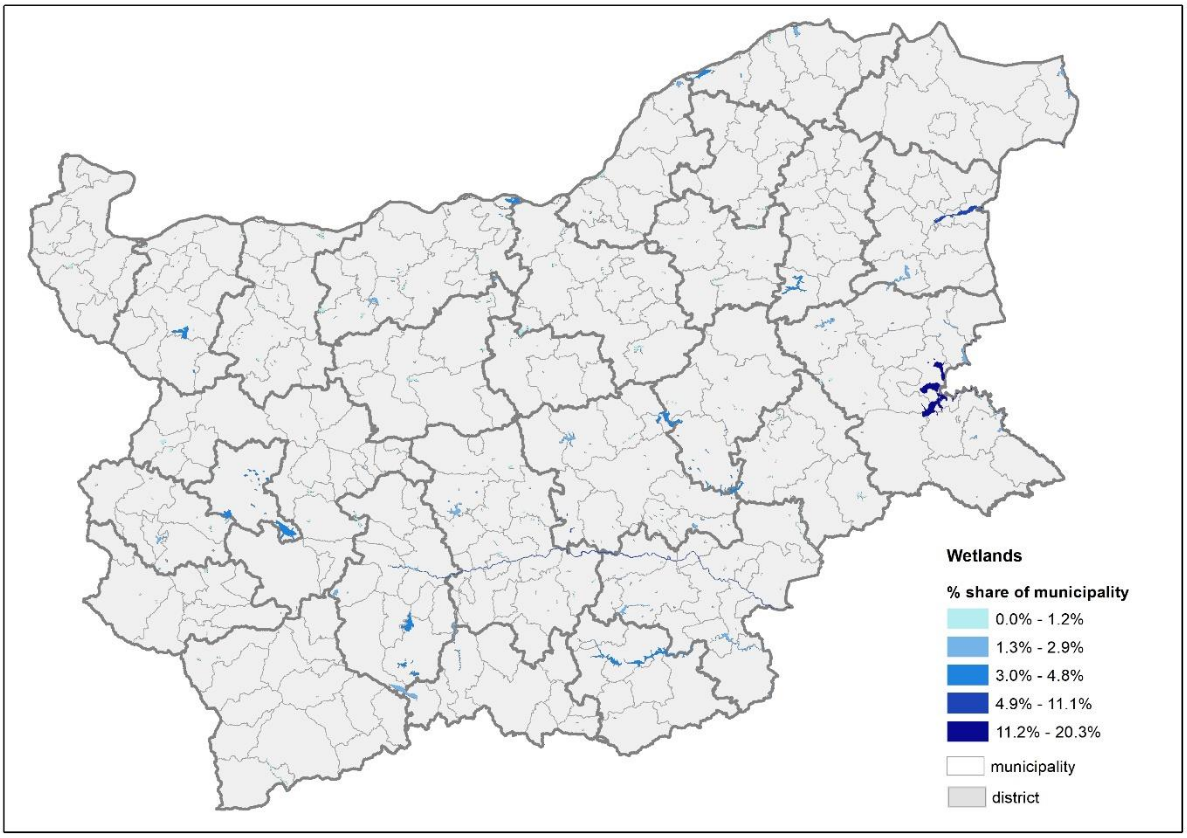


Figure 124 Share of municipality area occupied by Wetlands. The map is elaborated based on CLC, 2018.

The areas of the wetlands range between 214 to 232 kha over the reporting period. The table below presents data on the area of wetlands.
Due to the lack of information, it is assumed that the carbon stocks in the biomass, the dead organic matter and the soils of the surface waters is equal to 0.

Table 235 Land- use and land- use changes in the category Wetlands (kha) (other land use changes are not occurring)

year	4.D Wetlands - Total	4.D.1 Wetlands remaining wetlands	4.D.2 LUC in wetlands	4.D.2.3. Grassland in wetlands	4.D.2.5 Other land in wetlands
1988	213.50	206.20	7.30	5.91	1.39
1989	213.50	206.58	6.92	5.60	1.31
1990	213.50	206.97	6.53	5.29	1.24
1991	213.50	207.35	6.15	4.98	1.17
1992	213.50	207.74	5.76	4.67	1.10
1993	213.50	208.12	5.38	4.36	1.02
1994	213.50	208.51	5.00	4.05	0.95
1995	214.00	208.89	5.11	4.12	0.99
1996	214.49	209.27	5.22	4.20	1.02
1997	215.49	209.66	5.83	4.70	1.14
1998	216.49	210.04	6.45	5.21	1.25
1999	217.50	210.43	7.07	5.71	1.35
2000	218.50	210.81	7.69	6.23	1.46
2001	219.50	211.20	8.30	6.75	1.56
2002	220.50	211.58	8.92	7.28	1.64
2003	221.50	211.96	9.54	7.81	1.72
2004	222.50	212.35	10.16	8.35	1.81
2005	223.51	212.73	10.77	8.89	1.88
2006	224.51	213.12	11.39	9.43	1.96
2007	225.51	213.50	12.01	9.99	2.02
2008	226.51	213.50	13.01	10.85	2.16
2009	227.51	213.50	14.01	11.72	2.29
2010	228.52	213.50	15.01	12.59	2.42
2011	229.52	213.50	16.02	13.46	2.55
2012	230.52	213.50	17.02	14.33	2.69
2013	230.73	213.50	17.23	14.51	2.72
2014	230.94	213.50	17.44	14.69	2.75
2015	231.15	214.00	17.15	14.49	2.66
2016	231.36	214.49	16.87	14.28	2.59
2017	231.57	215.49	16.08	13.65	2.43
2018	231.78	216.49	15.29	13.01	2.27
2019	231.99	217.50	14.50	12.38	2.12

It was assumed that during the period of inventory the conversion to wetlands comes out from shrubs and grasslands and other lands. The emissions of carbon dioxide from the wetlands are presented in the table below.

Table 236 Emissions (+)/removals of CO_2 in Wetlands Remaining Wetlands and Lands Converted to Wetlands (Gg CO_2 equivalent)

year	5.D Wetlands Total	5.D.2.2 Grassland converted to Wetlands	5.D.2.5 Other land in wetlands	5.D.2.2 Grassland converted to Wetlands 2 (N_2O converted into CO_2 equivalents)	5.D.2.5 Other land in wetlands 2(N_2O converted into CO_2 equivalents)
1988	107.47	94.29	13.18	11.30	1.12
1989	101.81	89.33	12.48	10.70	1.06
1990	96.15	84.36	11.79	10.11	1.00
1991	90.50	79.40	11.10	9.51	0.94
1992	84.84	74.44	10.40	8.92	0.89
1993	79.19	69.48	9.71	8.32	0.83
1994	73.53	64.51	9.02	7.73	0.77
1995	82.41	73.04	9.37	7.87	0.80
1996	84.08	74.40	9.68	8.02	0.82
1997	101.23	90.43	10.80	8.97	0.92
1998	110.59	98.76	11.83	9.94	1.01
1999	119.72	106.86	12.86	10.92	1.09
2000	128.92	115.05	13.87	11.89	1.18
2001	138.34	123.55	14.79	12.89	1.26
2002	147.86	132.26	15.59	13.90	1.33
2003	157.22	140.85	16.37	14.93	1.39
2004	166.56	149.42	17.15	15.95	1.46
2005	175.96	158.08	17.89	16.98	1.52
2006	185.44	166.87	18.58	18.02	1.58
2007	195.03	175.83	19.19	19.08	1.63
2008	210.10	189.60	20.50	20.73	1.75
2009	225.41	203.69	21.73	22.39	1.85
2010	240.46	217.48	22.99	24.05	1.96
2011	255.57	231.32	24.25	25.71	2.06
2012	270.62	245.08	25.54	27.37	2.17
2013	260.64	234.83	25.81	27.72	2.20
2014	263.82	237.74	26.08	28.06	2.22
2015	259.82	234.52	25.30	27.68	2.15
2016	255.78	231.20	24.58	27.28	2.09
2017	244.21	221.18	23.04	26.08	1.96
2018	232.59	211.00	21.59	24.86	1.84
2019	220.98	200.85	20.13	23.64	1.71

Note: The reporting of the subcategory "wetland remaining wetland" follows Tier 1 – no changes in carbon stocks.

6.6.2 INFORMATION ON THE APPROACHES USED TO PRESENT THAT DATA FOR THE AREAS AND THE DATABASE FOR THE LAND-USE USED FOR THE INVENTORY

The data on total of Wetlands areas for single years (1994, 1996) has been obtain from the cadastral maps of the agricultural fund of Bulgaria (Balance by Type of Territories as per their Designation, Cadastre Agency) as well as data from the balance of the territory of Bulgaria based on orthophoto images for the years 2010 - 2019. In order to cover the time series – interpolation has been applied. The wetlands area for 1996 according to the cadastral map is much lower than the wetlands area according to the balance of the territory based on orthophoto images. The difference is about 30 kha.

Such a dramatic increase in wetlands area has been considered as unlikely. Probably the observed increase is due to the different data sources used in the aggregation of the area data. However, the data from orthophoto images has been considered as more reliable. Then, in order to level out the big increase in wetlands area a correction of the 1996 data on wetlands has been made. The correction coefficient of 12.38 kha is the net increase in wetlands from 1996 to 2012 according to Corine Land Cover data (1996-2006 CLC data and extrapolated to 2012) as it was reported in the previous submissions. The value of 12.38 kha has been added to the total wetlands area in 1996 and 1994 according to the cadastral map. Then the interpolation between 2012 and 1996 has been applied. The areas of wetlands for the years before 1994 have been considered to be the same as in 1994.
The LUCs to wetlands have been assumed to stem from grassland and other land. The determination of these land use categories as the possible land-use changes where the increase in wetlands may stem from is based on the last step from the hierarchical treatment of the data sources – that is data gaps. It has been considered that the shares of these individual land use categories to the observed increase in wetlands behave like the ratios of the total areas of these land use categories in Bulgaria. In its previous submission Bulgaria reported LUCs from forest land to wetlands due to probability reasons. It was assumed that the observed increase in wetlands suggests also deforestation for wetlands. This forest loss to wetlands was estimated as a share of forest land in the totals of forest land, cropland plus grassland (it was supposed that the wetlands increase comes from such lands). The reported LUC from forestland to wetlands in the previous submissions of Bulgaria represented an overestimation of deforestation activity since all the information for forest loss due to changes in designation of forest was reported under LUCs to settlements (SM). Since the last improvements in area representation made for the Submission 2014 LUCs from forestland to wetlands were not calculated. According to experts from the ExFA, the changes of designation of forest in the years 1988-2012 have been associated with conversion only to SM. There is only one new dam lake (Tsankov kamak) which was built up in recent years but the forest loss associated with its construction works has been already reported in the 70's. Therefore, Bulgaria reports all information provided by the ExFA for forest loss across the time series as LUC associated with conversion to SM.

6.6.3 METHODOLOGY

6.6.3.1 Lands converted to wetlands (4.D.2)

6.6.3.1.1 Changes in the carbon stock in living biomass of croplands converted to wetlands

The annual change in the carbon stock in the living biomass of croplands converted to wetlands is calculated using the following equation.

$$\mathbf{The\ annual\ change\ in\ the\ carbon\ stock} = \mathbf{anual\ area\ of\ lands\ converted\ to\ wetlands} \cdot (\mathbf{B_{after}} - \mathbf{B_{before}}) \cdot \mathbf{CF}$$

where,

B_{before}– living biomass stock in lands before the conversion – 5.24 tC/ha for Shrubs and grasslands and 0 tC/ha for other land.

B_{after} – living biomass immediately after the conversion, t d.m./ha (for Tier 1 = 0),

CF –carbon fraction in the dry matter (d.m.) (under Tier 1 = 0.5 t C/t d.m.).

6.6.3.1.2 Changes in the carbon stock in soils in lands converted to wetlands

Changes in the carbon stock in the soils when converting annual crops to wetland areas are calculated using the equation:

$$\Delta \boldsymbol{C_{wl}} = \boldsymbol{A} \cdot \frac{\boldsymbol{SOC_{after}} - \boldsymbol{SOC_{before}}}{\mathbf{20}}$$

where:

A – area of the converted lands for a transition period of 20 years, ha.

SOC_{before} – carbon stock in the soil immediately before the conversion, 86.96 tC/ha; for soils of shrubs and grasslands and 51.8 tC/ha for other lands

SOC_{after} – carbon stock in the soil 20 years after the conversion, t C/ha. The conversion of carbon in the soils 20 years after the conversion is assumed to be 0.

6.6.3.1.3 N_2O emissions from N mineralization associated with loss of soil organic matter resulting from change of land use

Emissions has been estimated for all situations where C losses in mineral soils occur (according 2006 IPCCC Guidelines), based on equations 11.1, 11.2, 11.8.
The ratio C/N in the mineral soils in OL is default from 2006 IPCCC Guidelines – 15, whereas for shrubs and grasslands is derived based on data from soil survey in BG.

6.6.4 UNCERTAINTY ASSESSMENT

The overall uncertainty in estimation of gas emissions and removals over a year for the category "Wetlands", which is equivalent to the sub-category "Land use changed to wetlands", is **15** %. The trend uncertainty due to activity data and emission factors is **24**% (Table 236).
The uncertainties of gas emission estimations from the pools "Living biomass" and "Soil" for the sources "Cropland changed to wetlands, "Grassland changed to wetlands" and "Other land changed to wetlands" were estimated. The combined uncertainty for "Living biomass" is **51** %. The combined uncertainty for „Soil", which is the primary gas emission and uncertainty source, is **15** %. The trend uncertainty due to activity data and emission factors amounts to **24** %.

Table 237 Uncertainties in the gas emissions from the IPCC category "Wetlands"

IPCC sub-category	Pool	Level of estimation	Gas	Base year emissions	Current year emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total in the current year	Uncertainty in trend introduced by emission factor uncertainty	Uncertainty in trend introduced by activity data uncertainty	Uncertainty introduced into the trend
Land use changed to wetlands	Living biomass	conversion of annual cropland	CO2	0.00	0.00	10	23.03	25.11	0.00	0.00	0.00	0.00
		conversion of perennial cropland	CO2	0.00	0.00	10	25.00	26.93	0.00	0.00	0.00	0.00
		conversion of PPM	CO2	0.00	0.00	10	79.35	79.98	0.00	0.00	0.00	0.00
		conversion of MGL	CO2	0.00	3.51	10	50.00	50.99	0.53	1.46	0.41	2.31
		conversion of other land	CO2	0.00	0.00	10	75.00	75.66	0.00	0.00	0.00	0.00
	Soil	conversion of annual cropland	CO2	0.00	0.00	10	0.04	10.00	0.00	0.00	0.00	0.00
		conversion of perennial cropland	CO2	0.00	0.00	10	1.24	10.08	0.00	0.00	0.00	0.00
		conversion of PPM	CO2	0.00	0.00	10	0.27	10.00	0.00	0.00	0.00	0.00
		conversion of MGL	CO2	11.30	23.64	10	108.03	108.49	108.41	0.39	2.79	7.93
		conversion of MGL	N2O	94.29	197.34	10	0.10	10.00	64.18	0.00	23.28	541.90
		conversion of other land	CO2	1.12	1.71	10	131.51	131.89	0.84	0.65	0.20	0.46
		conversion of other land	N2O	13.18	20.13	10	75.00	75.66	38.24	4.34	2.37	24.47
		Total emissions		**119.89**	**246.34**	**Overall uncertainty in the year (%)**			**15**	**Trend uncertainty (%)**		**24**

6.6.5 DATA VERIFICATION

See 6.1.6 QA/QC VERIFICATION

6.6.6 CATEGORY-SPECIFIC RECALCULATIONS

See 6.1.7 RECALCULATIONS

6.6.7 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

There are no planned improvements.

6.7 SETTLEMENTS (4.E)

6.7.1 DESCRIPTION OF THE CATEGORY

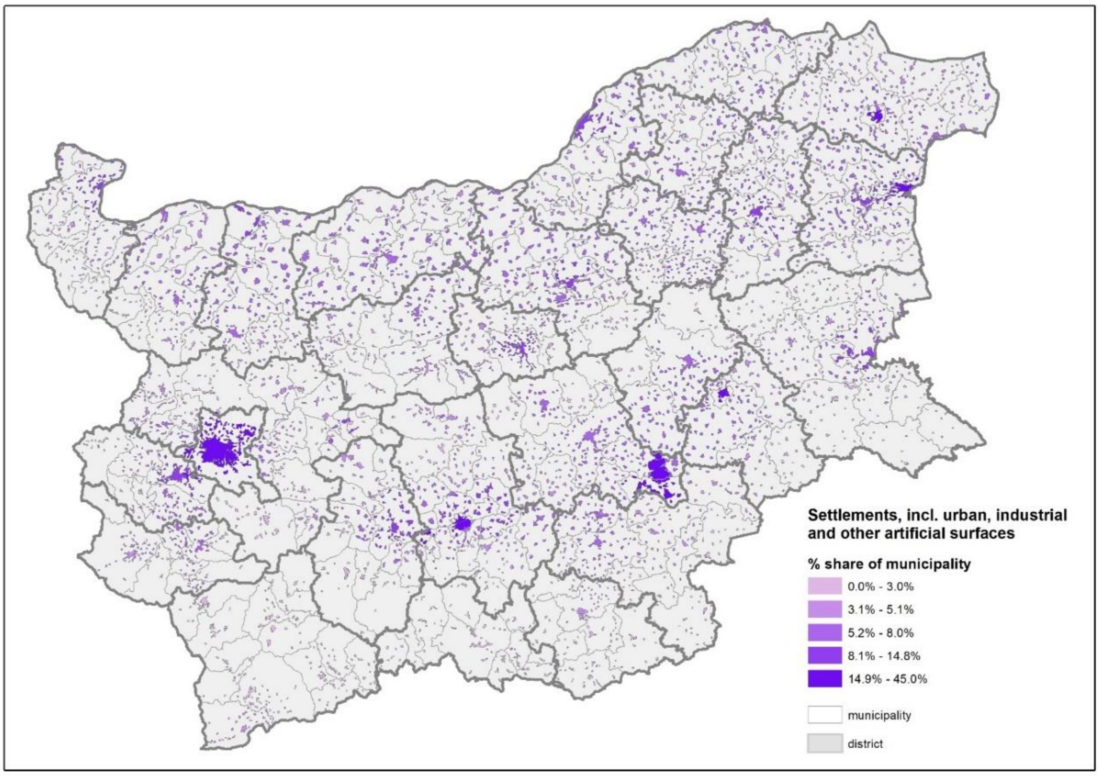


Figure 125 Share of municipality area occupied by Settlements. The map is elaborated based on CLC, 2018.

Settlements cover an area of 533.71 kha in 2019, which represent 5% of the total territory of the country.

The area of settlements has increased gradually over the period. The settlements area in 2019 is by 16% higher compared to the base year. The reporting of the subcategory "settlements remaining settlements" follows Tier 1 – no changes in carbon stocks. It is assumed that dead wood and litter do not exist in the settlements, therefore only emissions/removals from changes in living biomass and in soil have been calculated. The land-use changes to settlements origin from the categories Forests (data provided by the Executive Forest Agency), Cropland, Grassland (data provided by the Ministry of Agriculture and Food) and Other land.

Table 238 Land-use and land-use changes in the category Settlements (kha) (other land use changes are not occurring)

year	4.E SM Total	4.E.1 SM remaining SM	4.E.2 LUC in SM	4.E.2.1 Forest land in SM	4.E.2.2.a Annual Cropland in SM	4.E.2.2.b Perennial Cropland in SM	4.E.2.3a Pastures and meadows in SM	4.E.2.3b Shrubs and grasslands in SM	4.E.2.5 OL converted to SM
1988	461.71	423.08	38.63	1.43	21.66	1.40	9.93	4.15	0.07
1989	463.50	425.02	38.49	1.43	21.59	1.40	9.89	4.04	0.13
1990	465.30	426.96	38.34	1.41	21.52	1.41	9.86	3.94	0.20
1991	467.09	428.90	38.19	1.48	21.39	1.41	9.80	3.85	0.26
1992	468.88	430.84	38.04	1.66	21.19	1.40	9.71	3.76	0.32
1993	470.67	432.77	37.90	1.64	21.09	1.40	9.67	3.72	0.38
1994	472.46	434.71	37.75	1.65	20.97	1.38	9.63	3.68	0.44
1995	474.25	436.65	37.60	1.58	20.88	1.37	9.59	3.69	0.50
1996	476.04	438.59	37.45	1.50	20.78	1.35	9.56	3.70	0.56
1997	478.54	440.53	38.00	1.43	21.05	1.36	9.68	3.84	0.65
1998	481.03	442.47	38.56	1.37	21.29	1.37	9.80	4.00	0.73
1999	483.52	444.41	39.11	1.41	21.50	1.37	9.89	4.13	0.80
2000	486.01	446.35	39.66	1.43	21.71	1.39	9.98	4.27	0.88
2001	486.86	448.29	38.58	1.37	21.11	1.35	9.63	4.16	0.96
2002	488.04	450.23	37.81	1.42	20.64	1.31	9.33	4.07	1.04
2003	489.26	452.16	37.10	1.42	20.23	1.28	9.04	4.00	1.12
2004	490.37	454.10	36.27	1.43	19.75	1.24	8.73	3.92	1.20
2005	494.11	456.04	38.07	1.55	20.86	1.29	8.93	4.17	1.28
2006	498.00	457.98	40.02	1.63	22.09	1.34	9.16	4.44	1.36
2007	502.82	459.92	42.90	1.85	23.82	1.42	9.55	4.82	1.44
2008	508.91	461.71	47.20	2.60	26.08	1.51	10.13	5.41	1.45
2009	512.21	463.50	48.70	2.63	27.03	1.54	10.30	5.73	1.47
2010	518.41	465.30	53.11	2.89	29.69	1.66	11.00	6.38	1.48
2011	521.85	467.09	54.77	2.85	30.80	1.70	11.21	6.70	1.50
2012	523.83	468.88	54.95	2.84	30.96	1.69	11.13	6.79	1.55
2013	525.34	470.67	54.67	3.25	30.57	1.66	10.86	6.75	1.58
2014	526.23	472.46	53.77	3.32	30.01	1.63	10.53	6.65	1.62
2015	529.08	474.25	54.82	3.91	30.38	1.64	10.50	6.73	1.66
2016	530.68	476.04	54.64	4.38	30.06	1.63	10.24	6.64	1.70
2017	532.25	478.54	53.71	4.87	29.32	1.58	9.81	6.42	1.72
2018	533.71	481.03	52.68	4.99	28.76	1.54	9.44	6.21	1.73
2019	535.85	483.52	52.33	5.53	28.35	1.51	9.13	6.05	1.76

Table 239 Emissions (+)/removals of CO_2 in Settlements remaining settlements and Lands converted to settlements (Gg CO_2 equivalent)

Year	4.E Settlements	4.E.1 Settlements remaining Settlements	4.E.2 Land converted to Settlements	4.E.2.1 Forests converted to Settlements	4.E.2.2 Cropland converted to Settlements	4.E.2.3 Grassland converted to Settlements	4.E.2.5 OL converted to Settlements
1988	436.48	NE	436.48	27.58	236.34	172.13	0.44
1989	434.54	NE	434.54	27.58	235.60	170.49	0.88
1990	428.37	NE	428.37	22.77	235.08	169.20	1.32
1991	445.78	NE	445.78	44.35	232.89	166.82	1.73
1992	463.77	NE	463.77	67.51	229.92	164.23	2.11
1993	422.65	NE	422.65	24.74	230.23	165.14	2.53
1994	427.39	NE	427.39	31.75	228.39	164.32	2.94
1995	409.58	NE	409.58	13.52	227.81	164.89	3.35
1996	408.14	NE	408.14	12.88	226.53	164.97	3.76
1997	425.40	NE	425.40	12.47	234.23	174.39	4.32
1998	433.36	NE	433.36	14.21	236.58	177.71	4.86
1999	460.48	NE	460.48	37.69	238.07	179.34	5.38
2000	463.06	NE	463.06	34.41	240.52	182.24	5.90
2001	406.26	NE	406.26	15.20	222.76	161.86	6.43
2002	428.00	NE	428.00	41.98	219.85	159.20	6.97
2003	410.64	NE	410.64	30.86	216.36	155.91	7.51
2004	401.76	NE	401.76	32.86	210.25	150.60	8.04
2005	488.74	NE	488.74	62.40	243.32	174.44	8.58
2006	502.01	NE	502.01	53.82	257.24	181.83	9.12
2007	579.88	NE	579.88	92.11	281.44	196.68	9.65
2008	774.53	NE	774.53	238.12	310.56	216.11	9.74
2009	567.25	NE	567.25	48.50	302.11	206.80	9.83
2010	715.79	NE	715.79	110.98	352.27	242.61	9.93
2011	637.83	NE	637.83	56.49	341.08	230.21	10.06
2012	646.67	NE	646.67	88.94	328.58	218.81	10.34
2013	698.33	NE	698.33	158.78	318.57	210.38	10.59
2014	596.49	NE	596.49	72.30	310.05	203.29	10.86
2015	760.94	NE	760.94	207.75	327.01	215.07	11.11
2016	703.01	NE	703.01	174.50	314.08	203.06	11.37
2017	698.33	NE	698.33	185.82	305.96	195.06	11.49
2018	587.34	NE	587.34	82.97	302.44	190.32	11.61
2019	736.73	NE	736.73	239.28	299.57	186.11	11.76

Table 240 Total N_2O emissions from N mineralization associated with loss of soil organic matter in Gg CO_2 equivalent

Year	4.E.2 Land converted to Settlements	4.E.2.1 Forests converted to Settlements	4.E.2.2 Cropland converted to Settlements	4.E.2.3 Grassland converted to Settlements	4.E.2.5 OL converted to Settlements
1988	47.79	1.05	27.58	19.12	0.04
1989	47.53	1.05	27.51	18.90	0.08
1990	47.28	1.03	27.44	18.70	0.11
1991	46.99	1.09	27.28	18.47	0.15
1992	46.66	1.22	27.04	18.23	0.18
1993	46.44	1.20	26.91	18.10	0.22
1994	46.20	1.21	26.74	17.99	0.25

Year	4.E.2 Land converted to Settlements	4.E.2.1 Forests converted to Settlements	4.E.2.2 Cropland converted to Settlements	4.E.2.3 Grassland converted to Settlements	4.E.2.5 OL converted to Settlements
1995	46.02	1.16	26.62	17.95	0.29
1996	45.84	1.10	26.48	17.93	0.33
1997	46.54	1.05	26.80	18.31	0.37
1998	47.25	1.01	27.11	18.71	0.42
1999	47.90	1.04	27.37	19.03	0.46
2000	48.57	1.05	27.65	19.36	0.51
2001	47.18	1.01	26.87	18.75	0.56
2002	46.14	1.04	26.27	18.23	0.60
2003	45.19	1.04	25.74	17.76	0.65
2004	44.09	1.05	25.11	17.23	0.69
2005	46.25	1.14	26.50	17.87	0.74
2006	48.61	1.20	28.04	18.60	0.79
2007	52.07	1.36	30.20	19.69	0.83
2008	57.13	1.91	33.01	21.36	0.84
2009	59.04	1.93	34.19	22.06	0.85
2010	64.49	2.12	37.52	23.99	0.86
2011	66.61	2.10	38.89	24.75	0.87
2012	66.84	2.08	39.07	24.79	0.89
2013	66.26	2.39	38.57	24.39	0.91
2014	65.06	2.44	37.86	23.82	0.94
2015	66.05	2.87	38.32	23.90	0.96
2016	65.54	3.22	37.91	23.43	0.98
2017	64.08	3.57	36.98	22.53	0.99
2018	62.45	3.44	36.27	21.74	1.00
2019	61.43	3.59	35.73	21.10	1.01

6.7.2 INFORMATION FOR THE APPROACHES USED TO PRESENT THE DATA FOR THE AREAS AND THE DATABASE FOR THE LAND-USE USED FOR THE INVENTORY

Information on the total Settlements area is aggregated using the data on settlements area from the cadastral maps of the agricultural fund of Bulgaria for the years 1994,1996 (Balance by Type of Territories as per their Designation, Cadastre Agency) and data from the balance of the territory of Bulgaria based on orthophoto images for the year 2014 - 2019. In order to ensure the time series consistency interpolation and extrapolation have been applied. The total settlements area according to the balance from the orthophoto images is lower than the area from the cadastral map. Since a decrease in settlements area is considered as unlikely, it was assumed that the discrepancy in the extent of the settlements territory is because of using different methodology by the data providers. The settlements area according to cadastral map includes also lands next to villages, which usually are under cropland or grassland management. In the orthophotos these lands are in separate class but are referred to CL or GL. In order to avoid double counting of lands the SM area pattern has been recalculated. The following has been applied:

- Adjustment of the total settlements area for 1996 to match with the known increase in settlements for the period 2001-2016
- Interpolation between the adjusted settlements area for 1996 and 2015
- Extrapolation of settlements area for the period 1988-1996 considering the available data on LUC to settlements

Concerning the LUCs to settlements there is information for LUC from forest land to settlements, which is available for the period 1990-1994 and for the years 2001 to 2019. The annual forest loss to settlements for the years 1988, 1989 and 1995-2000 is estimated as an average value of forest loss in the period 1990-1994. Information for LUC from arable land (e.g. cropland and grassland) to settlements is available for the years 2001 to 2019. The share of annual cropland, perennial cropland and grassland within the available figure for the total area, which is changed to settlement between 2001 and 2019, was assumed the same as the share of the totals of these land-use categories. LUCs from arable lands to settlements for the years before 2001 are estimated using the data gaps approach. The reported land-use changes to settlement fit very well to the observed increase in settlements area.

6.7.3 METHODOLOGY

6.7.3.1 Land use change to settlements (4.E.2.)

6.7.3.1.1 Forests converted to settlements

The methodology and the data for the forests are presented in Chapter 6.3. The estimates include the losses of forest biomass as well as the annual increase of the settlement biomass over the transition period (20 years) and also the changes in the litter (humic and fumic layers) and soil C stock (including the losses in litter). The converted forest area to settlements ranges between 1-2 kha.

6.7.3.1.1.1 Changes in the carbon stock in living biomass of forests converted to settlements

For estimating biomass loss associated with deforestation, data from the forest inventory on volume stock over bark has been used. The data on volume stocks over the five years period since 1990 has been expanded and converted with the related country specific (or default) expansion/conversion factors: wood density (0.43 t/m^3 for coniferous, 0.60 t/m^3 for deciduous), stemwood plus branches expanded to the whole aboveground tree biomass (1.08 for coniferous, 1.03 for deciduous), root-to-shoot ratios (0.29 for coniferous, 0.24 for deciduous) and C-content (0.48 tC/t d.m). Then it has been estimated the share of the coniferous and deciduous stocks in the total biomass stock for the respective years. Like this the weighted means for tree biomass stock have been calculated. The means have been used for estimating biomass loss from deforestation for the years across the time series.

Table 241 Living biomass stocks which are used to calculate the emissions associated with forest loss to settlements

		1990	1995	2000	2005	2010	2015-2019
Weighted mean tree biomass stocks	tC/ha	45.47	50.89	55.19	57.10	62.71	65.86

Estimates for living biomass in settlements are based on the results of scientific study 31 carried out in Bulgaria on mapping and assessment of ecosystem services in urban areas (Project TunesinUrb, funded by EEA Grants). The information used comes from case study area of Pleven district. Biomass data from the following urban subsystems has been used – residential and public areas, urban area, industrial sites, and urban green areas. Based on the biomass data of trees (Zhiyanski et al.(2015a))[32], shrubs (Nowak et al. (2002)[33]) and ground vegetation ((Zhiyanski et al. 2013)[34]) in this

[31] Nedkov, S., M. Zhiyanski, M. Nikolova, A. Gikov, P Nikolov, L. Todorov. 2016. Mapping of carbon storage in urban ecosystems: a Case study of Pleven District, Bulgaria. Proceedings of scientific conference "Geographical aspects of land use and planning under climate change". Varshets 23-25.09.2016. pp. 223-233

[32] Zhiyanski M., A. Hursthouse, S. Doncheva. 2015. Role of different components of urban and peri-urban forests to store carbon – a case-study of the Sandanski region, Bulgaria. Journal of Chemical, Biological and Physical Sciences. JCBPS, Section D; May 2015 – July 2015, Vol. 5, No. 3; 3114-3128. IF (2013) = 0,723

[33] Nowak, D.J., Crane, D.E., 2002. Carbon storage and sequestration by urban trees in the USA. Environmental Pollution 116 (3), 381-389.

[34] Zhiyanski, M., V. Doichinova, K. Petrov. 2013. The social aspects and role of green infrastructure in mitigating climatic changes at regional level. Proceedings of

study an average biomass per ha settlement area was calculated (see table below) using the relative share of each urban subsystem. The average share of green spaces in the SM areas are estimated to be 3% (based on CLC data classes 1.4.1, 1.4.2). Thus, the change in carbon stock of biomass is estimated only for 3% of the observed LUC.

Table 242 Average biomass stock and annual growth in biomass on settlement, tC/ha

	tC/ha	data source:	rotation length	annual growth in biomass in SM
trees in parks	36.5	Zhiyanski et al. (2015a)	60	0.61
scattered trees	25.0	Nowak et al. (2002)	60	0.42
estimated weighted mean value	27.3		60	0.46
shrubs	4.5		20	0.23
trees and shrubs				**0.68**
ground veg.	2.0	Zhiyanski et al. (2013)	1	**2.00**

6.7.3.1.1.2 Changes in carbon stock in dead organic matter of forests converted to settlements

The calculation of the emissions from litter pool (humic and fumic layer) as a result of the conversion of forests to settlements was made by using national data for the carbon stocks in litter (humic and fumic) in forests (10.22 t C/ha). The estimation of changes in litter pool are done based on annual change from FL to WL, cause it is assumed that the litter is oxidised in the year of conversion. Litter does not occur in Settlements, so the carbon stock here is considered as 0 t C/ha.
For estimating changes in DW stock due to deforestation activity average carbon stock in DW has been used. It has been estimated based on the approach described in 6.3.3.1.2.

Table 243 Dead wood stocks used for estimating the changes in DW pool after deforestation

		1990	1995	2000	2005	2010	2015 - 2019
DW stock	tC/ha	3.15	3.15	3.51	3.92	4.20	4.47

6.7.3.1.1.3 Changes in the carbon stock in soils of forests converted to settlements

The calculation of the emissions from soils as a result of the conversion of forests to settlements has been made by using national data for the carbon stocks in the soils in forests (61.86 tC/ha) and the carbon stocks in the soils of the settlements (19.7 tC/ha). The carbon stock in the soils of settlements is determined on the basis of data for the carbon stock in the soils of the green areas in Sofia for 30 cm depth.

6.7.3.1.2 Cropland converted to settlements

6.7.3.1.2.1 Changes in the carbon stock in living biomass of the croplands converted to settlements

When calculating the changes in the carbon stock in the biomass during the conversion of cropland to settlements the values used are the average annual stock of carbon in the biomass of annual crops (3.56 tC/ha) and perennials (4.42 tC/ha) and the growth rates of the carbon stock in the biomass of the settlements (Section 6.4.3.1)

3rd International Conference "Ecology of urban areas 2013", Zrenjanin, October 11, 2013, Serbia, 451-459

The annual emissions of carbon dioxide are presented in Table 238

6.7.3.1.2.2 Changes in the carbon stock in soils for croplands converted to settlements

When calculating the changes in the carbon stock of soils during conversion of croplands to settlements the values used are those of the carbon stock in the soils of annual crops (67.74 tC/ha) and perennials (67.49 tC/ha), and values of the carbon stock in the soil of the settlements – 19.7 tC/ha.

6.7.3.1.3 Grassland converted to settlements

6.7.3.1.3.1 Changes in carbon stock in living biomass of the grasslands converted settlements

When calculating the changes in the carbon stock of the biomass during the conversion of grassland to settlements the values used are the average annual carbon stock in the biomass of grasslands determined for Bulgaria (6.58 tC/ha for Pastures and meadows and 5.2 tC/ha for Shrubs and grasslands) and the annual growth rates of the carbon stock in the biomass of the settlements.

6.7.3.1.3.2 Changes in the carbon stock in soils from grassland converted to settlements

When calculating the changes in the carbon stocks in the soil during conversion of other land to settlements the values used are those of the carbon stock in the soil of grassland (72.77 for pastures and meadows and 86.96 tC/ha for shrubs and grasslands).

6.7.3.1.4 Other land converted to settlements

6.7.3.1.4.1 Changes in carbon stock in living biomass of other land converted to settlements

When calculating the changes in the carbon stock of the biomass during the conversion of other land to settlements the values used are the average annual carbon stock in the biomass of other land (0 t C/ha) and the annual growth rates of the carbon stock in the biomass of the settlements.

6.7.3.1.4.2 Changes in the carbon stock in soils from other land converted to settlements

When calculating the changes in the carbon stocks in the soil during conversion of grassland to settlements the values used are those of the carbon stock in the soil of grassland (51.8 tC/ha).

6.7.3.1.5 N_2O emissions from N mineralization associated with loss of soil organic matter resulting from change of land use

Emissions has been estimated for all situations where C losses in mineral soils occur (according 2006 IPCCC Guidelines), based on equations 11.1, 11.2, 11.8.
The ratio C/N used in the estimation for the mineral soils of FL and OL is the default value from 2006 IPCCC Guidelines – 15. The C/N ratio for CL and GL is calculated based on data from soil survey in BG (since 2005).

6.7.4 UNCERTAINTY ASSESSMENT

The category "Settlements" is represented only by the sub-category "Land use changed to settlements". Its overall uncertainty in estimation of gas emissions and removals over a year is **10** %. The trend uncertainty due to activity data and emission factors is **13** % (Table 243).

The uncertainties of gas emission estimations from the pools "Living biomass", "Dead wood", "Litter" and "Soil" for the sources "Forest land changed to settlements", "Cropland changed to settlements", "Grassland changed to settlements" and "Other land changed to settlements" were estimated.

The combined uncertainty for "Living biomass" is **21** %, while trend uncertainty amounts to **137** %. The overall uncertainty over a year for „Dead wood" is **13** %. The trend uncertainty due to activity data and emission factors is 183 %.

The combined uncertainty for „Litter" is **31** %. The uncertainty in the estimated tendency for the gas emissions is **129**%.

The overall uncertainty over a year for "Soil" is **11** %. The trend uncertainty due to activity data and emission factors amounts to **10** %.

Table 244 Uncertainties in the gas emissions from the IPCC category "Settlements"

IPCC sub-category	Pool	Level of estimation	Gas	Base year emissions	Current year emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total in the current year	Uncertainty in trend introduced by emission factor uncertainty	Uncertainty in trend introduced by activity data uncertainty	Uncertainty introduced into the trend
Land use changed to settlements	Living biomass	growth biomass in settlements	CO2	-3.28	-4.39	10	35.00	36.40	0.04	0.07	0.13	0.02
		conversion of forest land	CO2	11.89	157.06	10	20.46	22.78	20.09	5.81	4.59	54.76
		conversion of annual cropland	CO2	13.42	11.50	10	23.03	25.11	0.13	-0.51	0.34	0.37
		conversion of perennial cropland	CO2	1.21	0.75	10	25.00	26.93	0.00	-0.06	0.02	0.00
		conversion of PPM	CO2	10.98	6.71	10	79.35	79.98	0.45	-1.86	0.20	3.51
		conversion of MGL	CO2	1.83	3.56	10	50.00	50.99	0.05	0.06	0.10	0.01
		conversion of other land	CO2	0.00	0.00	10	75.00	75.66	0.00	0.00	0.00	0.00
	Dead wood	conversion of forest land	CO2	0.82	10.67	10	8.99	13.45	0.03	0.17	0.31	0.13
	Litter	conversion of forest land	CO2	2.67	24.37	10	29.84	31.47	0.92	1.23	0.71	2.02
	Soil	conversion of forest land	CO2	12.31	47.74	10	17.14	19.84	1.41	0.97	1.39	2.89
		conversion of annual cropland	CO2	210.17	275.13	10	14.40	17.53	36.52	-2.11	8.03	69.01
		conversion of perennial cropland	CO2	13.51	14.63	10	14.56	17.66	0.10	-0.23	0.43	0.24
		conversion of PPM	CO2	105.58	97.05	10	13.16	16.53	4.04	-2.09	2.83	12.39
		conversion of MGL	CO2	54.91	80.02	10	10.57	14.55	2.13	-0.23	2.34	5.51
		conversion of other land	CO2	0.46	11.92	10	107.01	107.48	2.58	2.47	0.35	6.21
		conversion of forest land	N2O	1.05	3.59	10	109.38	109.83	0.24	0.42	0.10	0.19
		conversion of annual cropland	N2O	27.58	35.73	10	93.04	93.58	17.55	-1.87	1.04	4.58
		conversion of grassland	N2O	19.12	21.10	10	91.93	92.47	5.97	-1.98	0.62	4.29
		conversion of other land	N2O	0.04	1.01	10	152.05	152.38	0.04	0.30	0.03	0.09
		Total emissions		**484.27**	**798.16**	**Overall uncertainty in the year (%)**			**10**	**Trend uncertainty (%)**		**13**

6.7.5 DATA VERIFICATION CATEGORY-SPECIFIC QA/QC AND VERIFICATION, IF APPLICABLE

See 6.10. QA/QC VERIFICATION.

6.7.6 CATEGORY-SPECIFIC RECALCULATIONS

Recalculations are due to N_2O emissions from N mineralization associated with loss of soil organic matters resulting from change of land use have been included in the current submission.

6.7.7 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

There are no category-specific planned improvements.

6.8 OTHER LAND (4.F)

Data on area of other land is gathered from Executive Forest Agency. The EFA provides data on rocks and landslides from the forestry fund while the MAFF provides information on sands, small-scale non-arable lands, lands with poor vegetation. The share of Other land to the total country's territory is <2%. The total national area of 11100.19 kha remains constant over time. Thus, in accordance with IPCC 2006, the difference of the area of all land-use category and the whole area of the country is referred to "Other land" category in order to avoid double accounting or omission of an area. Like this the difference between the area of all land use categories and the total area of Bulgaria ranges between 0.01-0.02 %.

6.9 HARVESTED WOOD PRODUCTS

The contribution of the Harvested Wood Products (HWP) to the emissions and removals from LULUCF is estimated and reported. The annual changes in carbon stocks and associated CO2 emissions and removals from the HWP pool are estimated, following the production approach described in the Annex to Volume 4, Chapter 12, of the 2006 IPCC Guidelines (IPCC, 2006), in line with Decision 2/CMP.7 and the guidance provided by the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP Supplement, IPCC 2014). The estimation follows the Tier 2 method - first order decay, which is based on Eq. 2.8.5 (KP Supplement, IPCC 2014). This equation considers carbon stock in the particular HWP categories, which is reduced by an exponential decay function using the specific decay constants. The default half-life constants were used:

- 35 years for sawnwood,
- 25 years for wood-based panels
- years for paper and paperboard.

The second part of Eq. 2.8.5 (IPCC 2014) adds the material inflow in the particular year and HWP categories.

The activity data (production of sawnwood, wood based panels and paper and paperboard) are derived from FAO forest product statistics (Food and Agriculture Organization of the United Nations: forest product statistics, http://faostat3.fao.org/download/F/FO/E). Equation 2.8.1 (IPCC, 2014) has been applied to estimate the annual fraction of the feedstock coming from domestic harvest for the HWP categories sawnwood and wood-based panels and eq. 2.8.2 for category paper and paperboard. In addition, Equation 2.8.3 has been applied to allocate the domestic harvest to the relevant forest activities (AR, D and FM). For HWP coming from Deforestation tier 1 – instantaneous oxidation is applied. The initial stock has been estimated using Equation 2.8.6 of KP Supplement with t0=1990. Default conversion factors has been applied as provided in Table 2.8.1 KP Supplement. The trend of inflows and associated emissions and removals from HWP are provided in the next figures.

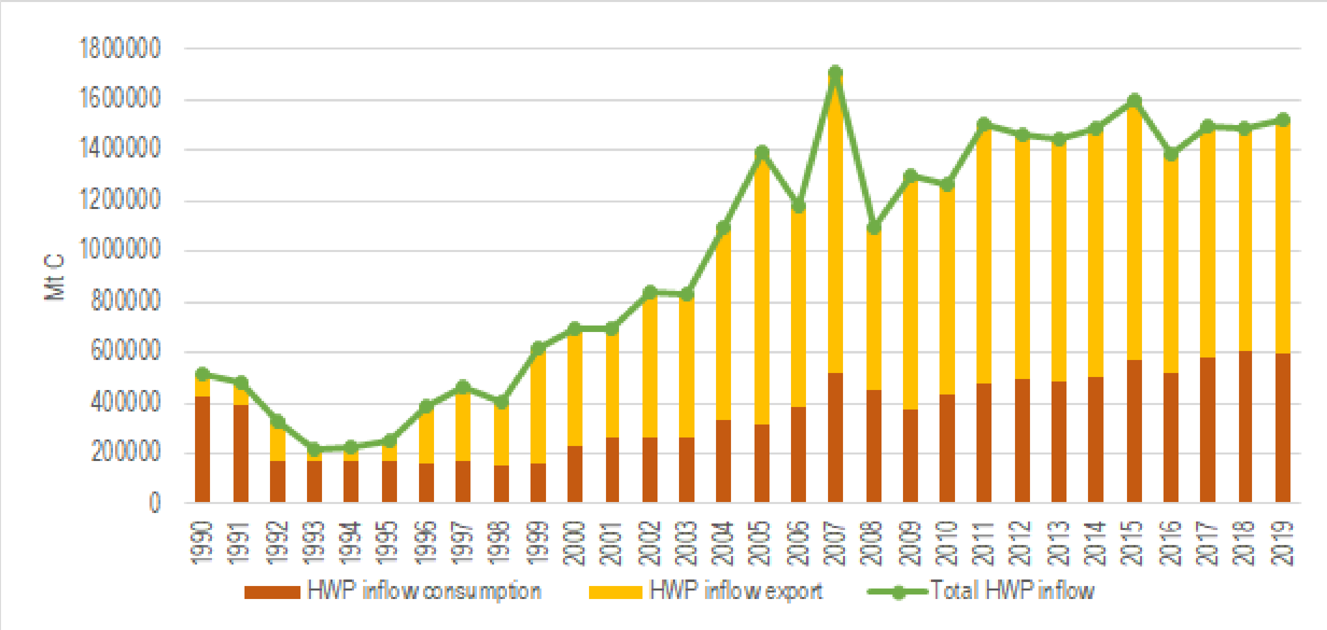


Figure 126 Annual HWP Inflow

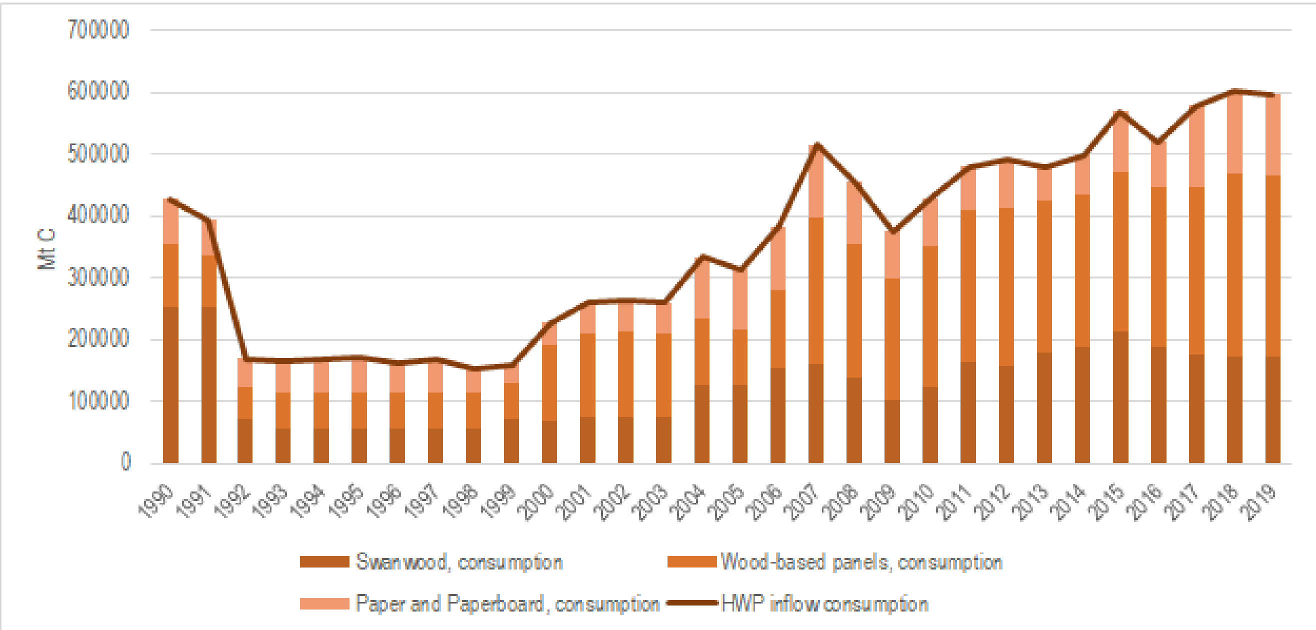


Figure 127 Annual Inflow of HWP in consumption by semi-finished products, Mt C

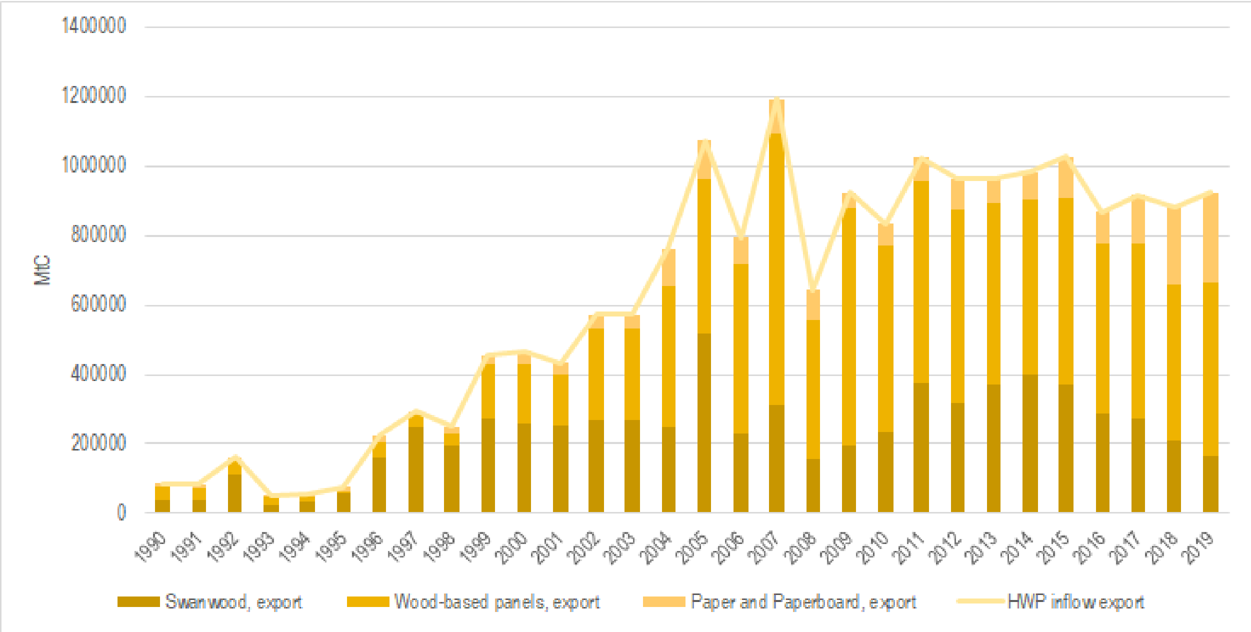


Figure 128 Annual Inflow of exported HWP by semi-finished products, Mt C

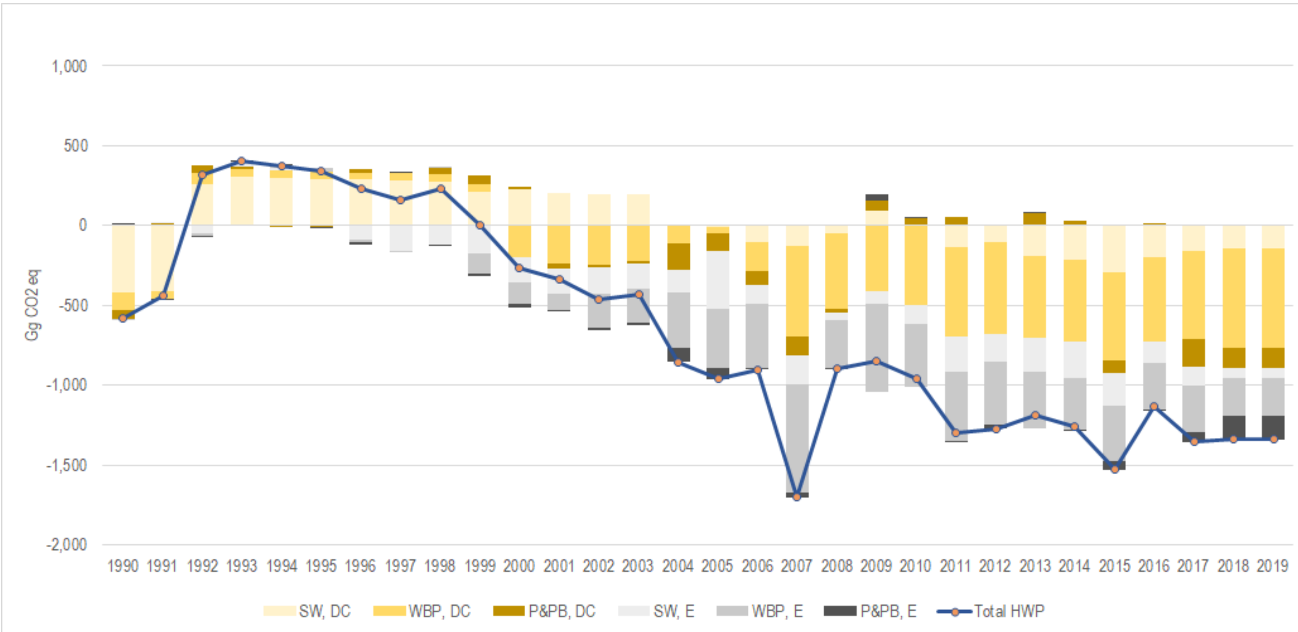


Figure 129 Emissions and removals from HWP, Gg CO_2 eq

The overall uncertainty over a year for the „Harvested wood products" is **15** %. The trend uncertainty due to activity data and emission factors amounts to **43** %.

Table 245 Uncertainties in gas emissions from HWP

IPCC sub-category	Pool	Gas	Base year emissions	Current year emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total in the current year	Uncertainty in trend introduced by emission factor uncertainty	Uncertainty in trend introduced by activity data uncertainty	Uncertainty introduced into the trend
HWP	Sawnwood	CO2	-406.14	-204.19	0	30.59	30.59	21.78	37.91	0.00	1437.53
	Wood-based panel	CO2	-123.69	-860.49	0	18.24	18.24	137.45	17.99	0.00	323.72
	Paper and paperboard	CO2	-53.44	-273.93	0	35.51	35.51	52.80	9.20	0.00	84.67
	Total emissions		**-583.27**	**-1338.61**	**Overall uncertainty in the year (%)**			**15**	**Trend uncertainty (%)**		**43**

7 WASTE (CRF SECTOR 5)

7.1 OVERVIEW OF SECTOR

This Chapter includes information on the GHG emissions from the Waste sector. The categories and activities for estimation of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions are described in detail.

According to the IPCC nomenclature, the following categories are included in this sector:

- Solid Waste Disposal on Land (5 A)
- Biological treatment of waste (5 B)
- Waste incineration (5 C)
- Wastewater handling (5 D)

The report includes information on methods for estimating greenhouse emissions as well as references of activity data and emissions factors concerning waste management and treatment activities reported under CRF Category 5 Waste.

The most important gas produced in this category is methane.

7.1.1 EMISSION TREND

The major greenhouse gas emissions from Waste sector are CH_4, CO_2 and N_2O. The GHG emissions trends in this sector are presented in Table 246 and following figures.

Table 246 Trend in GHG emissions from Waste by sub-sectors for 1988-2019

GHG gases	CH_4				N_2O			CO_2
Category	5 A	5 B	5 C	5 D	5 B	5 C	5 D	5 C
1988	136.73	NO	7.01E-05	108.96	NO	0.004864	0.802	18.514
1990	137.35	NO	7.49E-05	105.75	NO	0.005224	0.666	19.835
1995	137.02	NO	7.9E-05	63.98	NO	0.005498	0.586	20.596
2000	132.40	NO	2.31 E-05	43.86	NO	0.016854	0.561	62.580
2005	125.95	NO	2.06 E-05	29.41	NO	0.014506	0.482	54.826
2010	122.90	NO	5.25E-05	22.42	NO	0.003425	0.490	13.454
2011	122.36	0.33	3.88E-05	21.46	0.0201	0.002411	0.492	9.707
2012	120.38	0.37	7.68E-05	20.08	0.0221	0.005221	0.476	20.089
2013	117.45	0.43	1.44 E-05	25.52	0.0256	0.010440	0.485	38.902
2014	114.76	0.23	4.3E-05	26.14	0.0141	0.002931	0.482	11.264
2015	112.02	1.24	3.88E-05	26.29	0.0746	0.002612	0.479	10.102
2016	108.66	1.05	4.66E-05	23.28	0.0631	0,003211	0,476	12.272
2017	104.39	0.95	5.57E-05	18.70	0.0571	0.003863	0.472	14.716
2018	102.26	0.38	2.64E-05	17.92	0.0229	0.003252	0.469	6.767
2019*	102.26	0.38	2.67E-05	15.99	0.0229	0.003255	0.461	6.878

* The data for the 5A and 5B, are set equal to the previous year because Bulgaria still has no actual data for 2019 from national statistics. The waste accounts were not updated in time for the emission inventory calculations and submission.

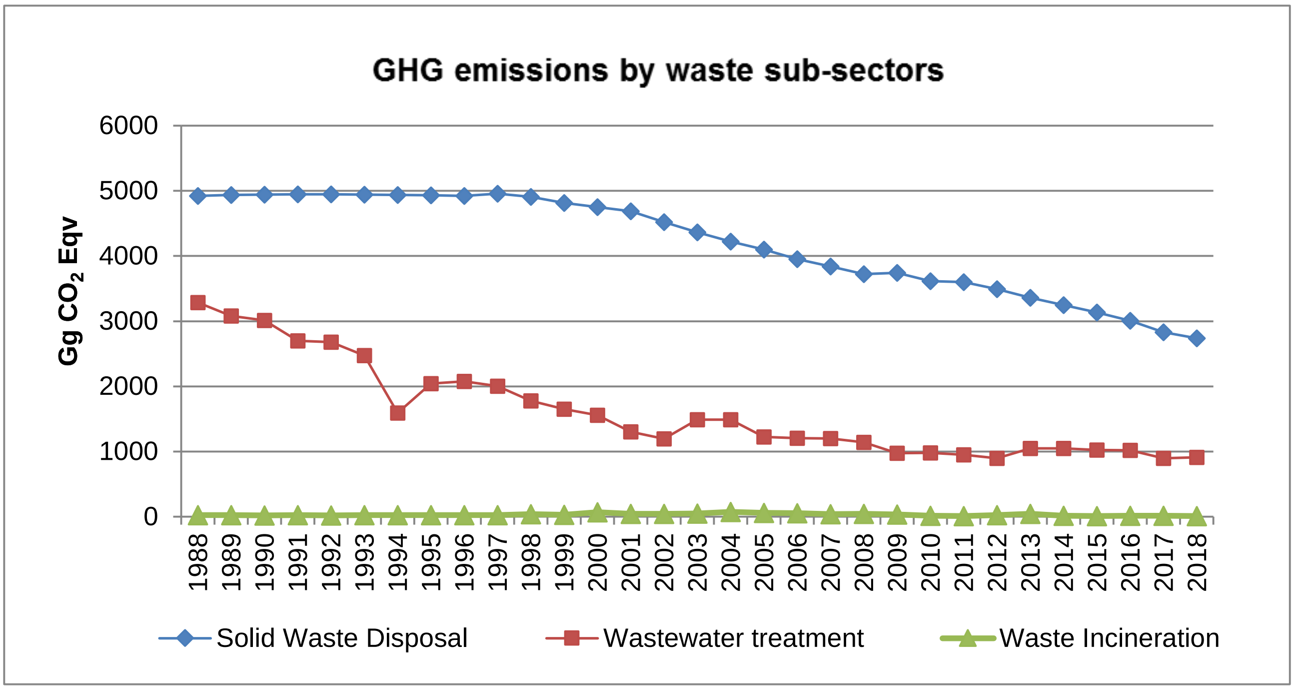


Figure 130 Emissions by waste sub-sectors

Emissions from the waste sector in 2019 decreased by 51.29% (3118,09Gg CO_2-eq in 2019 compared to 6401,33 Gg CO_2-eq in 1988) compared to the base year.
Figure below presents the total CO_2 eqv from the whole waste sector.

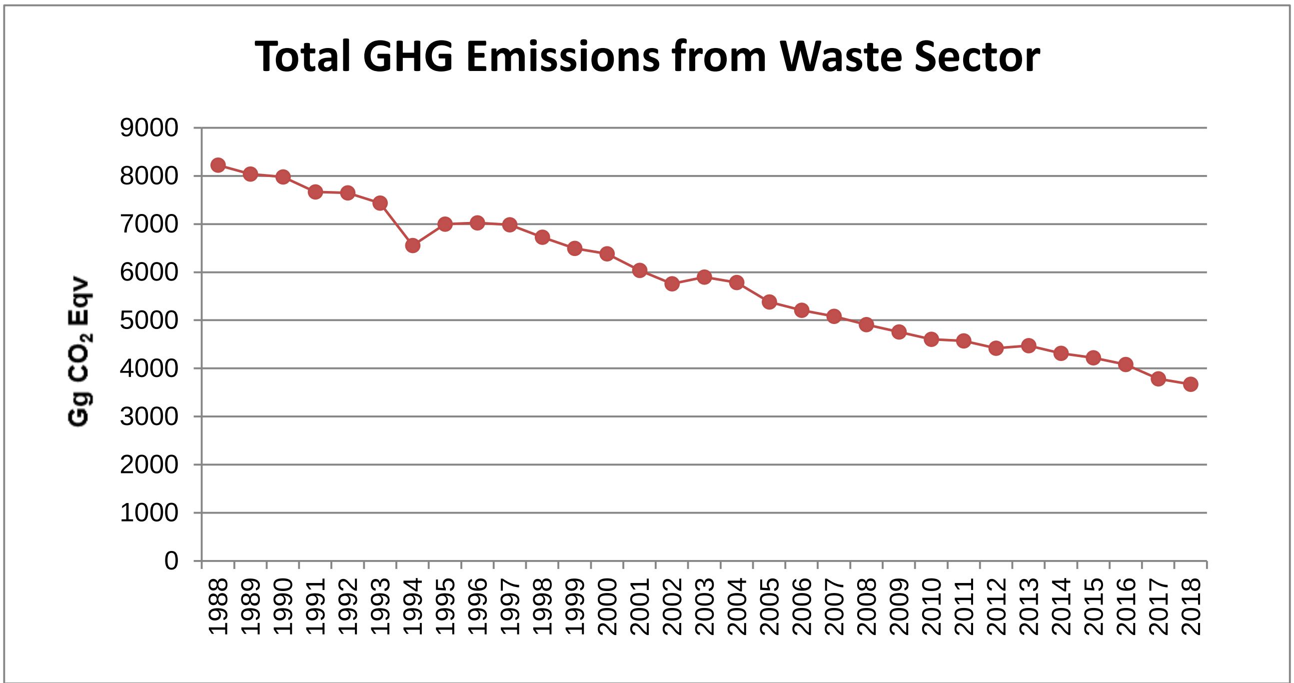


Figure 131 GHG emissions from Waste sector

7.1.2 KEY CATEGORIES

Table 247 describes the key categories of the waste sector and type of emitted greenhouse emissions.

Table 247 Key categories, Waste sector (Tier 1)

CRF categories	Category	Key category Y/N	GHG	Assessment of Key Source excluding LULUCF	Assessment of Key Source including LULUCF
5A	Solid Waste Disposal on Land	Yes	CH_4	L,T	L,T
5D	Wastewater handling	Yes	CH_4	L,T	L,T

7.1.3 METHODOLOGY

A more detailed description on the methodology for calculating emissions can be found, described in each subcategory of waste sector.

7.1.4 QUALITY ASSURANCE AND QUALITY CONTROL

Generally described checks and improvements have been taken and are described in sub chapters.

7.1.5 UNCERTAINTY ASSESSMENT

Uncertainty assessments are provided in respective subchapter.

7.1.6 COMPLETENESS

Table 248 Description of the completeness

Waste IPCC Category	Waste IPCC Category	CO_2	CH_4	N_2O
5A Solid waste Disposal on land	5A1 Managed waste disposal	NA	✓	NA
5A Solid waste Disposal on land	5A2 Unmanaged waste disposal	NA	✓	NA
5B Biological treatment of solid waste	5B1Composting Municipal Solid Waste	NA	✓	✓
5C Waste Incineration	5C1 Incineration of municipal waste	NA	NA	NA
5C Waste Incineration	5C1 Incineration of hospital waste	✓	✓	✓
5C Waste Incineration	5C1 Incineration of sewage sludge	NO	NO	NO
5C Waste Incineration	5C1 Incineration of different type of hazardous waste	✓	✓	✓
5D Wastewater handling	5 D1 Domestic wastewater	NA	✓	✓
5D Wastewater handling	5 D2 Industrial wastewater	NA	✓	NA

✓ *- indicates that emissions from this sub-sector have been estimated*

7.2 SOLID WASTE DISPOSAL ON LAND (CRF SECTOR 5A)

7.2.1 SOURCE CATEGORY DESCRIPTION

Treatment like disposal of municipal, industrial and other solid waste produces significant amounts of methane (CH_4). CH_4 produced at SWDS contributes approximately 3 to 4 percent to the annual global anthropogenic greenhouse gas emissions (IPCC 2001). In this report CH_4 is addressed.
The methodology used to estimate emissions from waste management activities requires country-specific knowledge on waste generation, composition and management practice. The main parameters that influence the estimation of the emissions from landfills, apart from the amount of the disposed waste, are: the waste composition, fraction of methane in landfill gas and amount of landfill

gas that is collected and treated. These parameters are strictly dependent on the waste management policies throughout the waste streams which start from waste generation through collection and transportation, separation for resource recovery, recycling and energy recovery and terminate at landfill sites. The improvements of quality and quantity of data are visible in last couple of years. Efforts were done in order to evaluate and compile data coming from different sources and adjust them to recommended IPCC methodology which is used for GHGs emissions estimation. At present in our country are used country specific data, where they are available. Default values are used when such data are not available.

Legislation and development planning processes in the field of waste management in Bulgaria:

The end of global economic, political and regime change of government in our country started to lay the groundwork for approval of plans and strategies outlining guidelines on sustainable management.
At the beginning of the 1990s the country began to develop practices for separate collection of household waste and their subsequent recycling.
During the last couple of years the measures in national legislation aimed at decreasing CH_4 emissions from landfills - limiting the disposal of municipal waste, measures for closure and rehabilitation of municipal landfills with terminated operation; coverage of all household waste in a managed system of waste treatment, including all waste to be disposed of in managed landfills and capturing, utilizing or flaring of landfill gas.
New waste management law 2012 - separate bio-waste collection (yards, park and garden wastes, green wastes must be treated via composting or anaerobic digestion); reducing the amount of biodegradable waste, sent to landfills).
National strategic plan for diversion of biodegradable waste going to landfills (2010-2020)
National strategic plan on sewage sludge management (2012-2020)
Ordinance for the treatment of bio-waste and separate bio-waste collection (2016)
Third National Action Plan on Climate Change (2013-2020)
National Waste Management Plan (2014-2020)
Bulgarian legislation introduced the specific quantitative targets for separate collection, recycling and recovery of municipal bio waste as well as targets for diverting biodegradable municipal waste from landfills. The provisions of the Waste Management Act require that by 31 December 2020 the amount of biodegradable municipal waste should have decreased to 35 percent, compared to the total waste in the Republic of Bulgaria from 1995. This is compliant with the requirements of the European directive on the landfill of waste.
The effect of the legislative measures will be visible in the future. Currently, some positive tendencies are being observed, concerning SWD on the managed and unmanaged disposal sites.
Since 2000 the share of population, land filling on unmanaged sites has decreased and the share of population, which disposes of wastes on managed sites is increasing.
The landfills are classified as managed and unmanaged (see below: Activity data).
The main criteria governing whether landfills are managed or unmanaged are justified by the fact if the landfills meet the requirements laid down in EU Directive 1999/31/EC on the landfill of waste.

7.2.2 EMISSION TREND

Methane emissions are shown in the Table 246, Table 254 and Figure 132 CH4 Emissions from SWDS from managed and unmanaged sites.
The data for the SWDS (5A) are set equal to the previous year because Bulgaria still has no actual data for 2019 from national institutions. The waste accounts were not updated in time for the emission inventory calculations and submission. Only the recalculation, proposed by TERT in 2020 Review was implemented.
Total CO_2 eq. from Solid waste disposal for 2018 are 2741.32 Gg CO_2 eqv. In 2018 emissions decrease with 3.12% in comparison with previous year.
Landfilling as a method of waste disposal still holds the biggest share in the management of municipal waste, but there is a steady decline in this indicator in recent years (the percentage of waste disposed in landfills drop from 95% in 1990 to 60% in 2018). Recyclable waste collection, which was a scarce practice at the beginning of the 1990s, has been increased. In 2013, legislation on bio-waste

management was promulgated, which combined with the existing economic instruments as well as the introduced in 2011 landfill tax per ton led to the present positive trends.
The total amount of municipal waste generated in Bulgaria in 2018 is 2967 kt which is in average 1.16 kg/capita/day. The total amount of municipal waste generated in the country is following a positive trend towards permanent decrease.
The amounts of separately collected fractions from municipal waste are gradually increasing. Since 2009, collection schemes have been improved for management of six special waste categories - packaging waste, waste oils, end-of-life vehicles, waste electrical and electronic equipment, waste tires, batteries and accumulators. This resulted in increased quantities of collection and recovery of those waste streams and decrease in per capita waste generation. Bulgaria is among the member-states with close to the average level of recycling in recent years.
In the country exist regional systems for waste management where before land filling the waste is subjected to pre-treatment (separation) as recyclable fractions such as paper and cardboard, metals, glass, plastics and wood are sent to recycling facilities. This practice reduces the amount of waste which going to landfills, additionally development of composting activities concerning the decreased land filled degradable fraction of MSW.
The emissions from SWDS are emitted from MSW (including AMSW-assimilated municipal solid waste and sludge from wastewater treatment plant) which are landfilled. MSW are disposed of on managed and unmanaged disposal sites as from 2000 the share of population, landfilling waste on unmanaged is decreasing and the share of population, landfilling on managed MSW sites is increasing.

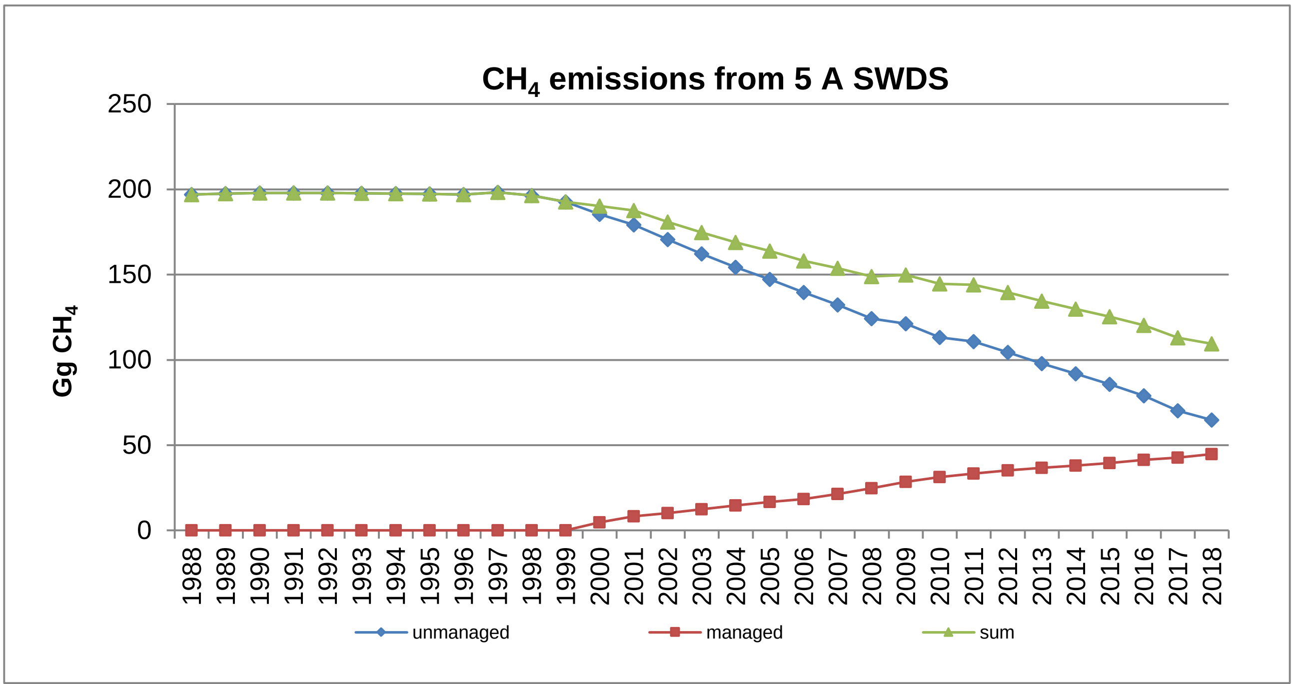


Figure 132 CH_4 Emissions from SWDS

7.2.3 METHODOLOGICAL ISSUES

7.2.3.1 Methodology

A. Choice of method:

Emissions from solid waste disposal on land have been calculated using the First Order Decay (FOD) method, the IPCC Tier 2 method given in the 2006 IPCC Guidelines.
The choice of a good practice method will depend on national circumstances.

B. Basics:

- IPCC FOD Tier 2;

- Multi –phase model (based on waste composition);
- Starting year 1950;
- Managed and unmanaged type of site;
- Source AD: NSI, MOEW, ExEA.

C. Influencing factors/ data required:

- Waste amounts deposited / waste generated (starting year 1950)
- Waste treatment (deposition, composting, incineration, recycling)
- Management practices at landfill sites (MCF)
- Conditions at landfill sites + Composition of waste deposited
- Organic carbon in landfill sites (DOC)
- Methane generation rate constant (k)
- Landfill gas recovery, Oxidation
- National waste management policy

7.2.3.2 Activity data and emission factors

The main source of activity data is NSI. Data on Municipal Solid Waste generation rate and on the quantity of MSW disposed to SWDSs and etc. are country specific data. On the basis of generated waste from 1999-2010 and total population of the country are calculated generated waste for the period 1950-1998.
Waste generation rate is based on the evaluation of the collected MSW in the country including recycled waste with origin from population.
Concerning disposed MSW, questionnaires, verified by Eurostat are sending to the municipalities in which they fill the data about the quantities of land filled municipal solid waste.

Sludge from wastewater treatment plants

The data for Sludge from wastewater treatment plants are set equal to the previous year because Bulgaria still has no actual data for 2019 from national institutions. The waste accounts were not updated in time for the emission inventory calculations and submission.

Sludge from wastewater treatment plants has also been considred, because it can be disposed of at the same landfills as municipal solid waste, once it meets a specific requirements. The fraction of sludge, disposed at ladfill sites has been estimated to be 17.9 Gg in 2004 (extrapolated value) decreasing to 3.74 Gg in 2018 (decrased by 79.1%).
In submission (2020) the amount of sludge have been extrapolated for 2002 and 2003. The fraction of sludge, disposed at ladfill sites has been estimated to be 19.67Gg for 2002 and 19,55 for 2003.

On the basis of its characteristics, sludge from wastewater treatment plants is also used in agriculture, in compost production with red Californian worms, landfilled or temporarily stored on special platforms.
Source of information about sludge from wastewater treatment plants is National Statistical Institute. Information about sludge is available from 2005 (Regulation EC No 2150/2002 on waste statistics). For 2004 values are extrapolated.
Information from NSI is ensured by conducting the following annual statistical surveys included in National statistical programme:

- Water supply, sewage and treatment – exhaustive survey. Data are collected from public water supply companies, dealing with water collection, treatment, water supply and wastewater collection, discharge and treatment (water supply companies/urban wastewater treatment plants operators and irrigation systems).

Another source of information is Executive Environment Agency through National legislation (Ordinance on the way of recovery of sludge from wastewater treatment through its use in agriculture; Ordinance No 1 on the procedures and forms for providing information about waste management activities and the procedure for keeping public records).

Table 249 Time series of sewage sludge production and landfilling is reported

Year	2004	2005	2006	2007	2008	2009	2010	2011
Sewage sludge production Gg	40.38	41.70	38.00	39.90	42.90	39.40	49.80	51.40
Sewage sludge landfilled Gg	17.90	23.40	16.40	20.80	17.80	11.10	13.97	7.05

Year	2012	2013	2014	2015	2016	2017	2018	2019*
Sewage sludge production Gg	59.30	60.30	54.94	57.36	65.76	68.88	53.12	53.12
Sewage sludge landfilled Gg	6.64	10.49	8.47	8.54	6.15	6.95	3.74	3.74

* The data for Sludge from wastewater treatment plants are set equal to the previous year because Bulgaria still has no actual data for 2019 from national institutions.

Industrial waste

Industrial waste assimilated to municipal solid waste (AMSW) could be disposed of to the same landfills as MSW. It originates from commercial establishments and related handicraft activities, recreation and entertainment; from professional services, hotels, restaurants, schools and etc.

The description of methodology for collecting information about industrial (AMSW) waste in the country is provided by National Statistical Institute (NSI).

- ✓ Methodology for collecting information about industrial (AMSW) waste:

A source of waste data from the economy is NSI statistical surveys. Since 2004, information on non-hazardous waste from the production activity has been collected through a sample representative of economically active economic entities in the country. After weighing, the data from the sample is transferred to the national level and supplemented with data from the National Environmental Monitoring System of the Executive Environment Agency. Dangerous waste data is entirely from NEMS.The methodology has been developed in accordance with the requirements of EU Regulation No 2150 of 25.11.2002 on waste statistics. A "European Waste Catalogue" nomenclature is used, which corresponds to the "Waste List".

Table 250 Represents the trend in AMSW, disposed of to landfills.

Year	2013	2014	2015	2016	2017	2018	2019
Assimilated municipal solid waste dsposed in landfills (Gg)	408.98	443.41	398.80	370.20	353.06	355.10	355.10

The table below presents the summarized sources of initial activity data.

Table 251 Source of Activity data by year

Year	Parameters										
	generated waste	Source of information	waste generation rate	Source of information	landfilling waste	Source of information	waste composition	Source of information	type of landfill		Source of information
									managed	unmanaged	
1950-1998	CS	NSI (proportional to the population)	CS	NSI	CS	NSI	D	IPCC 2006	not defined as such	all unmanaged	IPCC 2006
1998-2000	CS	NSI	CS	NSI	CS	NSI	D	IPCC 2006	not defined as such	all unmanaged	IPCC 2006

Year	Parameters										
	generated waste	Source of information	waste generation rate	Source of information	landfilling waste	Source of information	waste composition	Source of information	type of landfill		Source of information
									managed	unmanaged	
2000-2002	CS	NSI	CS	NSI	CS	NSI	D	IPCC 2006	CS	CS	MOEW
2002-2018	CS	NSI	CS	NSI	CS	NSI	CS	MOEW	CS	CS	MOEW

The emissions of methane on basis of the activity data are calculated for the entire period 1950-2018, and the plan for calculation depending on the time of reallocated activity data. The quantity of CH_4 emitted during decomposition process is directly proportional to the fraction of degradable organic carbon (DOC), which is defined as the carbon content of different types of organic biodegradable wastes such as paper and textiles, garden and park waste, food waste, wood and straw waste. The main reason for the choice of the period for composition of waste calculation is the fact that in 2002 is done a study at the national level for determine the morphology of the waste. This waste composition is set later in the Implementation Program for Directive 1999/31/EC. A major feature of the study is to determine the rate of accumulation of different types of waste based on distribution and population in different settlements. (Program for the implementation of Directive 1999/31/EC on the landfill of waste, p.21) Table 252 shows the morphological composition of the waste allocated according to distribution of population.

Table 252 Waste composition

Population	until 3 000	from 3 000 to 25 000	from 25 000 to 50 000	over 50 000
A	Organic waste, %			
Food	4.86	12.56	20.85	28.80
Paper	3.87	6.55	10.45	11.10
Paperboard	1.30	0.70	1.63	9.70
Plastics	5.21	8.98	9.43	12.00
Textiles	3.48	4.70	3.40	3.20
Rubber	1.15	0.45	1.10	0.60
Leather	1.36	1.35	2.10	0.70
Garden waste	14.12	14.00	5.53	6.80
Wood waste	2.14	2.28	1.58	1.30
B	Non-organic waste, %			
Glass	8.85	3.40	8.75	9.90
Metals	2.88	1.30	2.83	1.70
C	Other waste, %			
Inert waste	50.78	43.73	32.35	14.20

For country specific biodegradable organic fraction of waste calculations is implemented a model, based on human settlements and distribution of population in them, with the percentage composition of different types of waste and total waste generated for a specific year. Using this model, respectively, the composition of waste is calculated, mainly in following groups:
A – paper, paperboard;

B - garden and park waste;
C - food (kitchen) waste;
D - wood waste.
E – textile;
F – rubber and leather
S – sludge (from wastewater treatment plants)
DOC is calculated according Equation 3.7 (2006 IPCC, Vol.5: Waste p. 3.13):

$$\boldsymbol{DOC} = \sum_i (\boldsymbol{DOC_i} \bullet \boldsymbol{W_i})$$

Where:
DOC – fraction of degradable organic carbon in bulk waste, Gg C/Gg waste
DOC_i – fraction of degradable organic carbon in waste type i
W_i – fraction of waste type i by waste category
Default values for DOC in different MSW component are used in calculations (2006 IPCC, Vol.5: Waste, Table 2.4, p.2.14). For paper and paperboard – DOC content 40%; for food waste – DOC content 15%; for wood waste – DOC content 43% and for garden and park waste – DOC content 20%; for rubber and leather – DOC content 39 %; for textile – DOC content 24% and for sludge – DOC content 50%.
With the above equation is calculated the value of the decomposed organic structure of the waste for the country for 2018 as a whole:

DOC = 12.61 %

DOC was estimated by using country-specific data on waste composition and quantities based on compiled data from 2002 to 2018 for managed disposal sites. From 1950 to 2001 for unmanaged disposal sites for DOC calculations country used a default morphology (table 2.3, p.2.13, 2006 IPCC) and default DOC values for each waste component to derive DOC of bulk waste using the approach in the 2006 IPCC Guidelines. **DOC** for unmanaged disposal sites is **18.13 %.**
The default waste composition is used for 1950-2001: Paper/paperboard-**21.80%**; Food waste-**30.10%**; Wood waste-**7.50%**; Textile-**4.70%**; Rubber/leather-**1.40%.** The default value for DOC-**0.18134,** is used for 1950-2001 for all waste composition

Table 253 Components of waste composition 2002-2018

Year	Waste composition	%	Degradable waste, %	DOC
2002	paper/paperboard	12.94%	49.06%	0.1259
	garden and park waste	10.22%		
	food waste	18.05%		
	wood waste	1.76%		
	textile	3.58%		
	rubber and leather	1.90%		
	Sludge	0.62%		
2003	paper/paperboard	12.95%	49.08%	0.1259
	garden and park waste	10.22%		
	food waste	18.05%		
	wood waste	1.75%		
	textile	3.58%		
	rubber and leather	1.90%		
	Sludge	0.62%		
2004	paper/paperboard	12.96%	49.08%	0.1259
	garden and park waste	10.23%		
	food waste	18.07%		
	wood waste	1.76%		
	textile	3.58%		
	rubber and leather	1.89%		
	sludge	0.58%		

Year	Waste composition	%	Degradable waste, %	DOC
2005	paper/paperboard	13.00%	49.29%	0.1268
	garden and park waste	10.21%		
	food waste	18.11%		
	wood waste	1.75%		
	textile	3.58%		
	rubber and leather	1.89%		
	sludge	0.75%		
2006	paper/paperboard	13.04%	49.23%	0.1263
	garden and park waste	10.19%		
	food waste	18.18%		
	wood waste	1.75%		
	textile	3.58%		
	rubber and leather	1.89%		
	sludge	0.60%		
2007	paper/paperboard	13.04%	49.35%	0.1268
	garden and park waste	10.21%		
	food waste	18.17%		
	wood waste	1.75%		
	textile	3.58%		
	rubber and leather	1.88%		
	sludge	0.70%		
2008	paper/paperboard	13.05%	49.19%	0.1260
	garden and park waste	10.17%		
	food waste	18.21%		
	wood waste	1.75%		
	textile	3.58%		
	rubber and leather	1.89%		
	sludge	0.53%		
2009	paper/paperboard	13.03%	48.97%	0.1249
	garden and park waste	10.15%		
	food waste	18.23%		
	wood waste	1.75%		
	textile	3.58%		
	rubber and leather	1.90%		
	sludge	0.33%		
2010	paper/paperboard	13.08%	49.17%	0.1258
	garden and park waste	10.13%		
	food waste	18.28%		
	wood waste	1.75%		
	textile	3.58%		
	rubber and leather	1.90%		
	sludge	0.46%		
2011	paper/paperboard	13.26%	49.32%	0.1257
	garden and park waste	10.04%		
	food waste	18.55%		
	wood waste	1.74%		
	textile	3.57%		
	rubber and leather	1.88%		
	sludge	0.28%		
2012	paper/paperboard	13.30%	49.37%	0.1258
	garden and park waste	10.02%		
	food waste	18.60%		

Year	Waste composition	%	Degradable waste, %	DOC
	wood waste	1.73%		
	textile	3.57%		
	rubber and leather	1.88%		
	sludge	0.26%		
2013	paper/paperboard	13.34%	49.64%	0.1270
	garden and park waste	10.01%		
	food waste	18.64%		
	wood waste	1.73%		
	textile	3.57%		
	rubber and leather	1.88%		
	sludge	0.48%		
2014	paper/paperboard	13.30%	49.47%	0.1264
	garden and park waste	9.99%		
	food waste	18.61%		
	wood waste	1.73%		
	textile	3.56%		
	rubber and leather	1.89%		
	sludge	0.38%		
2015	paper/paperboard	13.31%	49.52%	0.1267
	garden and park waste	9.99%		
	food waste	18.60%		
	wood waste	1.73%		
	textile	3.56%		
	rubber and leather	1.89%		
	sludge	0.44%		
2016	paper/paperboard	13.35%	49.47%	0.1263
	garden and park waste	9.97%		
	food waste	18.66%		
	wood waste	1.73%		
	textile	3.56%		
	rubber and leather	1.89%		
	sludge	0.39%		
2017	paper/paperboard	13.38%	49.22%	0.1268
	garden and park waste	9.98%		
	food waste	18.69%		
	wood waste	1.73%		
	textile	3.56%		
	rubber and leather	1.88%		
	sludge	0.40%		
2018	paper/paperboard	13.42%	49.5%	0.1261
	garden and park waste	9.96%		
	food waste	18.15%		
	wood waste	1.73%		
	textile	3.56%		
	rubber and leather	1.88%		
	sludge	0.21%		

The Methane Correction Factor (MCF) reflects the way in which MSW is managed and the effect of management practices on CH_4 generation.
MCF accounts for the fact that unmanaged SWDS produce less CH_4 from a given amount of waste than anaerobic managed SWDS.

The methodology requires countries to provide data or estimates of the quantity of waste that is disposed of to each of categories of solid waste disposal sites. 2006 IPCC Guidelines gives a default values for MCF (2006 IPCC, Vol.5: Waste Table 3.1, p.3.14).
To determine the quantity of managed and unmanaged landfills at the national level is applied the method of expert judgment, assessment by leading experts in the field of waste from the structure of MOEW (2006 IPCC Guidelines, Vol.1 General Guidance and Reporting). As the main criteria for whether landfills are managed and unmanaged, is considered the fact if the landfills meet the requirements laid down in the EU Directive 1999/31/EC on the landfill of waste. For managed SWDS country uses MCF=1 and for unmanaged (deep) - MCF=0.8.
The CH_4 generation potential (Lo), (Gg CH_4 generated) depends upon the composition of waste, on waste disposal practices and on the physical characteristics of the SWDS. For calculation of CH_4 generation potential Equations 3.2 and 3.3 (2006 IPCC Vol.5: Waste p. 3.9) are used.
For 2018 inventory year the values are:

$$\mathbf{Lo}_{\text{managed landfills}} = 0.042019 \text{Gg } CH_4$$

$$\mathbf{Lo}_{\text{unmanaged landfills}} = 0.033615 \text{ Gg } CH_4$$

Methane generation rate constant (k)

k=0.09 (1/yr)

The methane generation rate constant (k) in the FOD method is related to the time necessary for DOC in waste to decay to half of its initial mass (the "half life or t½) and depends on large number of factors associated with the composition of waste and conditions at the site.
For calculation of methane generation rate (k), Bulgaria used default k value=0.09 for bulk waste for estimation of CH_4 emissions from Solid waste disposal after ERT recommendation in country review in November 2016. Due to consistency, recalculations have been made for the period 2002-2015 for managed solid waste disposal sites and for unmanaged - from 1950 to 2001.
Besides the following parameters are chosen:
Fraction of DOC dissimilated (DOC_f) is an estimate of the fraction of carbon that is ultimately degraded and released from SWDS, and reflects the fact that some organic carbon does not degrade, or degrades very slowly, when deposited in SWDS. It is also good practice to use a value of 0.5 (including lignin C) as the default (2006 IPCC). For calculations of DOC_f Bulgaria uses a default value of 0.5.
Fraction of CH_4 in landfill gas (F): Landfill gas consists mainly of CH_4 and carbon dioxide (CO_2). The CH_4 fraction F is usually taken to be 0.5 by default according to the 2006 IPCC Guidelines.
Methane recovery (R): The country reports methane recovery since 2010 when the installation was brought to exploitation. Before that is zero (2006 IPCC Guidelines).
The calculation of CH_4 from landfills is based on regulatory basis of obtaining information about waste - Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014).The operators of installations are obliged to report on annual basis. In the reporting formats under the Ordinance there is information about methane, stored in reservoirs, burned in a flare and utilized methane. The amount of gas collected and utilized, measured at SWDS is reported to RIEW (Regional Inspectorate of Environment and Water). Reporting is based on the metering of gas recovered for energy utilization and flaring. These data are country specific.
For 2018 the recovered methane is 0.09726 Gg. The resulting emissions (CO_2, CH_4 and N_2O) are estimated in Energy sector and are included in Sector 1.A – Fuel combustion, Subcategory 1.A.4 – Gaseous fuels,gaseous biomass.The quantities of recovered methane are given in Table 254.

Sofia landfill is equipped with gas collection system, system for CH_4 utilization and flaring system. The system for methane utilization is co-generation system (CHP-combined heat and power) for heat and electricity production. The system is operating since 2010. Landfill near Silistra does not collect the landfill gas. It has a flaring system (SIMENS installation).

Oxidation factor (OX). Country uses OX=0.1 for managed and OX=0 for unmanaged landfills.

Table 254 Parameters in Tier 2 for Solid waste Disposal Sites

Year	Total population	Waste generation rate	Fraction of MSW disposed	Fraction DOC in MSW	CH_4 oxidation factor	CH_4 fraction in landfill gas	CH_4 generation rate constant	Time lag	CH_4 emissions	CH_4 recovery
	1000s	kg/person/day						yr	Gg/yr	Gg/yr
1988	8986.636	1.38	0.950	0.1813	0; 0.1	0.5	0.090	38	196.897	NO
1989	8767.308	1.38	0.950	0.1813	0; 0.1	0.5	0.090	39	197.466	NO
1990	8669.269	1.38	0.950	0.1813	0; 0.1	0.5	0.090	40	197.792	NO
1991	8595.465	1.38	0.950	0.1813	0; 0.1	0.5	0.090	41	197.944	NO
1992	8484.863	1.38	0.950	0.1813	0; 0.1	0.5	0.090	42	197.865	NO
1993	8459.763	1.38	0.950	0.1813	0; 0.1	0.5	0.090	43	197.742	NO
1994	8427.418	1.38	0.950	0.1813	0; 0.1	0.5	0.090	44	197.566	NO
1995	8384.715	1.38	0.950	0.1813	0; 0.1	0.5	0.090	45	197.320	NO
1996	8340.936	1.38	0.950	0.1813	0; 0.1	0.5	0.090	46	197.008	NO
1997	8283.200	1.38	0.950	0.1813	0; 0.1	0.5	0.090	47	198.253	NO
1998	8230.371	1.38	0.950	0.1813	0; 0.1	0.5	0.090	48	196.340	NO
1999	8190.876	1.64	0.651	0.1813	0; 0.1	0.5	0.090	49	192.564	NO
2000	8149.468	1.68	0.654	0.1813	0; 0.1	0.5	0.090	50	190.136	NO
2001	7891.095	1.66	0.670	0.1813	0; 0.1	0.5	0.090	51	187.519	NO
2002	7845.841	1.65	0.676	0.1228	0; 0.1	0.5	0.090	52	181.079	NO
2003	7801.273	1.65	0.681	0.1229	0; 0.1	0.5	0.090	53	175.077	NO
2004	7761.049	1.63	0.669	0.1259	0; 0.1	0.5	0.090	54	169.312	NO
2005	7718.750	1.60	0.698	0.1268	0; 0.1	0.5	0.090	55	164.312	NO
2006	7679.290	1.57	0.627	0.1263	0; 0.1	0.5	0.090	56	158.456	NO
2007	7640.238	1.50	0.714	0.1268	0; 0.1	0.5	0.090	57	153.984	NO
2008	7606.551	1.62	0.749	0.1260	0; 0.1	0.5	0.090	58	149.248	NO
2009	7563.710	1.61	0.770	0.1249	0; 0.1	0.5	0.090	59	150.065	NO
2010	7504.868	1.48	0.748	0.1258	0; 0.1	0.5	0.090	60	144.783	0.251
2011	7327.224	1.34	0.719	0.1257	0; 0.1	0.5	0.090	61	144.211	0.246
2012	7284.552	1.22	0.797	0.1258	0; 0.1	0.5	0.090	62	139.811	0.223
2013	7245.677	1.19	0.705	0.1270	0; 0.1	0.5	0.090	63	134.701	0.223
2014	7202.198	1.21	0.694	0.1264	0; 0.1	0.5	0.090	64	130.098	0.127
2015	7153.784	1.15	0.662	0.1267	0; 0.1	0.5	0.090	65	125.511	0.096
2016	7101.859	1.11	0.642	0.1263	0; 0.1	0.5	0.090	66	120.415	0.092
2017	7050.034	1.14	0.599	0.1268	0;0.1	0.5	0.090	67	113.179	0.098
2018	7000.039	1.16	0.5989	0.1261	0;0.1	0.5	0.090	66	109.653	0.097
2019	6951,482	1.16	0.5989	0.1261	0;0.1	0.5	0.090	66	109.653	0.097

7.2.4 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

To ensure consistency over time, it is good practice (2006 IPCC Guidelines) a time series should be developed using the same methods. For entire time series we apply the same FOD methods for emission calculation.

Table 255 Activity data and emission factors Uncertainty Range

Total Municipal Solid Waste (MSWT)		30%
Fraction of MSWT sent to SWDS (MSWF)		±30%
Emission factor uncertainty		80%
Total uncertainty of Waste composition		±30%
Degradable Organic Carbon (DOC) (default)		20%
Degradable Organic Carbon (DOC) (country-specific values)		±10%
Fraction of Degradable Organic Carbon Decomposed (DOCf) (IPCC default value (0.5))		± 20%
Methane Correction Factor (MCF) (IPCC default value)	= 1.0	–10%, +0%
	= 0.8	±20%
Fraction of CH_4 in generated Landfill Gas (F) = 0.5 (default)		±5%

Methane Recovery (R)		±110%
Oxidation Factor (OX)		-
half-life (t1/2) (default)	7	17% /-22%
Combined uncertainty		85%

7.2.5 SOURCE-SPECIFIC QA/QC AND VERIFICATION

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation according to QA/QC (Improvement) plan.
Regarding to Tier 2 activities, emission factors and activity data were checked for key source categories. Solid waste disposal on land represent key source category in Waste sector. CH_4 emissions from solid waste disposal on land were estimated using Tier 2 method which is a good practice.
The next basic QA/QC activities were implemented and national circumstances was taken into account:

- Check activity data, emission factors and other parameters (value, record and archive);
- Check for errors in data input and references;
- Check that emissions and parameters are calculated correctly;
- Check completeness;
- Trends checks and etc.

7.2.6 SOURCE-SPECIFIC RECALCULATION

The recalculation in this subsector was made due to recommandation from 2018 UNFCCC review. The amount for Sludge was extrapolated for 2002 and 2003. For years before 2002 (1950-2001) the country used a default morphology (table 2.3, p.2.13, 2006 IPCC) and default DOC values for each waste component to derive DOC of bulk waste using the approach in the 2006 IPCC Guidelines(please see above). The recalcutation is including the years 2002-2018.
In 2020 UNFCCC review TERT recommended a technical correction. The inventory team provided a revised estimation, which was accepted by TERT and implemented in Submission 2021.

7.2.7 SOURCE-SPECIFIC IMPROVEMENT PLAN

There is no plan improvement.

7.3 BIOLOGICAL TREATMENT OF WASTE (CRF CATEGORY 5B)

7.3.1 SOURCE CATEGORY DESCRIPTION

The category includes calculation of CH_4 and N_2O emissions in the atmosphere from biological treatment of solid waste (composting). Calculation of the emissions depends on the quality of collected data, amount and type of solid waste, treated biologically and the choice of emission factors respectively.
Composting is a waste management practice for reducing the volume of land filled organic waste and reducing CH_4 emissions respectively. This activity was not well developed in the country until 2011. With adoption of new Waste management law in 2012 composting is regulated as a practice for reducing the share of biodegradable waste sent to SWDS. In this period three composting facilities have been built.
CH_4 and N_2O emissions from composting are decreasing in 2014 due to decreasing amount of waste composted. The reason for the small amount of composted waste is the quality of incoming raw materials for compost production. After biological treatment of waste, organic fraction gets a very low quality and it has been used in landfills as a soil covering material.

7.3.1.1 Methodological issues

Methodology for calculation of CH_4 and N_2O emissions from composting.
The estimation and calculations of the emissions from biological treatment of waste are based on the methodology, proposed in the 2006 IPCC Guidelines.
For the emissions estimation from biological treatment of solid waste country uses TIER 1 with default emission factors.

Default emission factors for CH_4 and N_2O emissions from biological treatment of waste

Type of biological treatment	CH_4 Emission Factors (g CH_4/kg waste treated)		N_2O Emission Factors (g N_2O/kg waste treated)	
	on a dry weight basis	on a wet weight basis	on a dry weight basis	on a wet weight basis
Composting	10 (0.08-20)	4 (0.03-8)	0.6 (0.2-1.6)	0.24 (0.06-0.6)

7.3.1.2 Activity data

The source of activity data is National Statistical Institute.
The emissions from composting are given in the table below.
The data for the BTW (5B) are set equal to the previous year because Bulgaria still has no actual data for 2019 from national institutions. The waste accounts were not updated in time for the emission inventory calculations and submission.

Table 256 CH_4 and N_2O emissions from composting

Year	Total annual amount treated by biological treatment facilities (Gg)	CH4 emissions (kt)	N2O emissions (kt)
2011	83.686	0.335	0.0201
2012	92.000	0.368	0.0221
2013	106.492	0.426	0.0256
2014	58.628	0.235	0.0141
2015	311.000	1.244	0.0746
2016	263.000	1.052	0.0631
2017	238.000	0.952	0.0571
2018	95.538	0.382	0.0229
2019	95.538	0.382	0.0229

During the review in February 2020 TERT notes that there is an important reduction of the amount of waste composted between 2017 and 2018.
The AD used to estimation the emissions in this sector are provided official by National Statistical institute (NSI).

7.3.1.3 Emission factors

Default emission factors (on wet weight basis) are used for emission estimation of CH_4 and N_2O from composting. Country specific emission factors or plant specific emission factors are not available at the moment.

7.3.2 UNCERTAINTY AND TIME – SERIES CONSISTENCY

The uncertainty in CH_4 emissions from compost production is estimated to be about 30% concerning activity data, 30% for N_2O emission factor used and 400% for CH_4 EF used.

7.3.3 SOURCE-SPECIFIC QA/QC AND VERIFICATION

The category is covered by the general QA/QC procedures.

7.3.4 SOURCE-SPECIFIC RECALCULATIONS

The are no recalculations for this category.

7.3.5 SOURCE-SPECIFIC IMPROVEMENT PLAN

Investigation of anaerobic digestion of organic waste in the country and subsequent calculation of CH_4 emissions from this type of biological treatment.

7.4 WASTE INCINERATION (CRF CATEGORY 5C)

7.4.1 OVERVIEW OF THE SECTOR

Emissions from waste incineration without energy recovery have to be reported in the Waste sector, while emissions from incineration with energy recovery should be reported in the Energy sector. According to the 2006 IPCC Guidelines incineration of waste produces emissions of CO_2, CH_4 and N_2O. Normally, emissions of CO_2 from waste incineration are significantly greater than CH_4 and N_2O emissions. Except this type of emissions in the atmosphere are released non-greenhouse gasses like NOx, NH_3, NMVOCs and etc. Emissions of CH_4 are not likely to be significant and these emissions are much dependent on the continuity of the incineration process, the incineration technology and management practices.

For the purpose of this inventory are calculated emissions of CO_2 from waste incineration (significantly greater than N_2O emissions) N_2O and CH_4 emissions.

Incineration of waste is not a key category in the country. For estimation of CO_2, N_2O and CH_4 emissions TIER 1 method is applied. This report includes emissions from incineration of clinical and hazardous waste that are incinerated in the country.

7.4.1.1 Emission trend

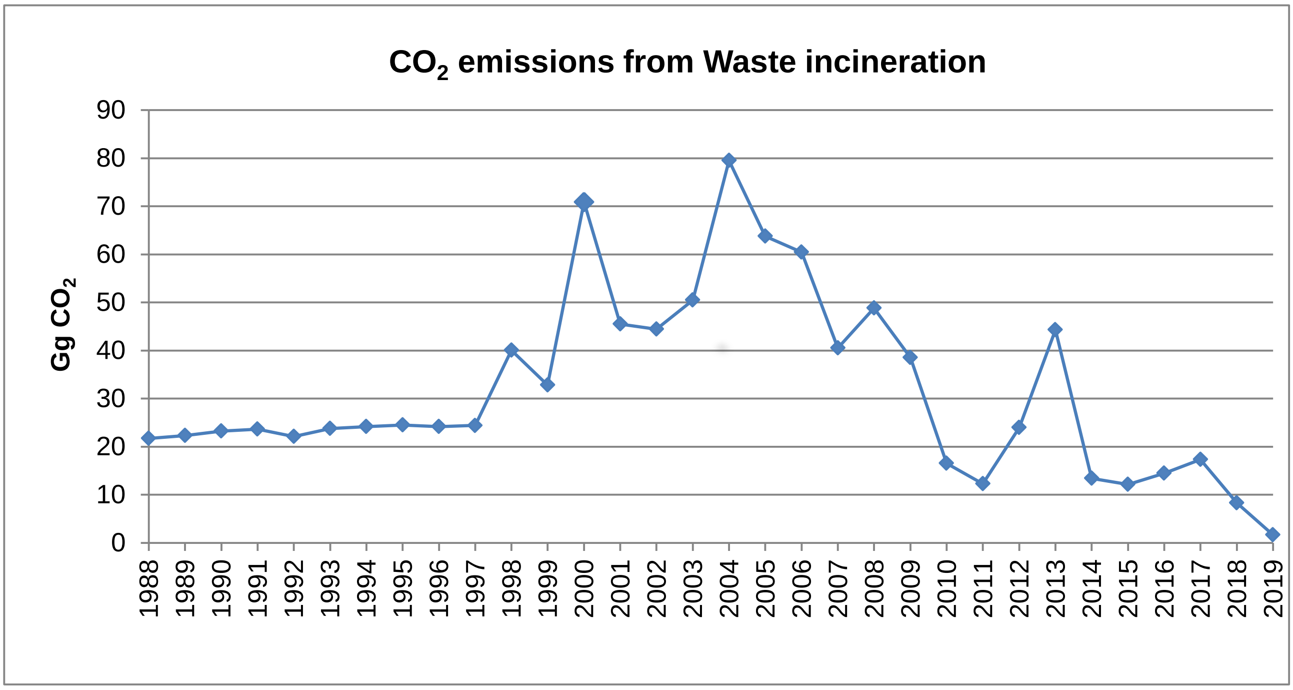


Figure 133 CO2 emissions from waste incineration

Table 257 Quantity of incinerated type of waste and CO_2, CH_4 and N_2O emissions from waste incinerations shows in systematic way the quantity of incinerated type of waste and respectively emissions of CO_2, N_2O and CH_4, according to activity data and type of waste for different years

Year	Clinical waste				Hazardous waste			
	Clinical waste Gg/yr	CO_2 emissions	CH_4 emissions	N_2O emissions	Hazardous waste Gg/yr	CO_2 emissions	CH_4 emissions	N_2O emissions
1988	0.976	2.146	5.854E-06	4.878E-05	10.70	19.62	0.0000642	0.005
1990	0.977	2.149	5.86E-06	4.884E-05	11.50	21.08	0.0000690	0.005
1995	1.070	2.354	6.419E-06	5.349E-05	12.10	22.18	0.0000726	0.005
2000	1.124	2.472	6.742E-06	5.618E-05	37.33	68.43	0.000224	0.017
2005	2.353	5.177	1.412E-05	0.0001177	31.97	58.62	0.0001918	0.014
2006	2.579	5.673	1.547E-05	0.0001289	29.88	54.78	0.0001793	0.013
2007	2.035	4.478	1.221E-05	0.0001018	19.66	36.03	0.0001179	0.009
2008	1.440	3.168	8.64E-06	7.2E-05	24.93	45.70	0.0001496	0.011
2009	1.301	2.862	7.805E-06	6.504E-05	19.48	35.70	0.0001169	0.009
2010	1.285	2.827	7.71E-06	6.425E-05	7.47	13.69	4.481E-05	0.003
2011	1.244	2.738	7.466E-06	6.222E-05	5.22	9.57	3.132E-05	0.002
2012	1.355	2.982	8.133E-06	6.777E-05	11.45	21.00	6.871E-05	0.005
2013	0.892	1.963	5.353E-06	4.461E-05	23.10	42.35	0.0001386	0.010
2014	0.744	1.638	4.466E-06	3.722E-05	6.430	11.788	3.858E-05	0.003
2015	0.751	1.651	4.504E-06	3.753E-05	5.722	10.490	3.433E-05	0.003
2016	0.715	1.573	4.290E-06	3.575E-05	7.056	12.94	4.23E-06	0.003
2017	0.788	1.734	4.728E-06	3.940E-05	8.499	15.58	5.10E-05	0.004
2018	0.626	1.378	3.757E-06	3.131E-05	3.768	6.91	3.26E-05	0.002
2019	0.753	1.656	4.515E-06	3.76E-05	3.768	6.91	3.26E-05	0.002

**No AD for hazardous waste for 2019 were available for the time of calculation and 2021 Submission*

Reduced incineration of hazardous waste in the installation of Luk Oil Neftochim for 2010 is due to the reduced quantity of processed sludge which is connected with decrease in the quantity of wastewaters in wastewater treatment plant. For 2011 except reduced quantity of processed sludge, a repair of the three-phase centrifuge for oil middling slime processing took place for a long time. For 2012 the quantity of incinerated hazardous waste in the installation increase in comparison with preceding years (doubled quantity of the incinerated waste in comparison with 2011) and that lead to emissions increase respectively.

Reduced incineration of hazardous waste in the installation of Luk Oil Neftochim for 2014 is due to the frequent shutdowns of the furnaces for repair. In 2014 the construction of installations for purifying flue gases from kiln incinerators is completed. Furnaces have a system for continuous measurements of pollutants in flue gases.

Concerning clinical waste, before 2006 in country were working considerable number of furnaces for clinical waste incineration, located on the territory of the hospitals throughout the country. Following the adoptions of more stringent requirements of Directive 2000/76/EC transposed into Regulation No 6/28.04.2004 that has led to the closure of the operation of all this type of furnaces and emissions reduction respectively.

7.4.2 INCINERATION OF CLINICAL WASTE (CRF CATEGORY 5C)

7.4.2.1 Category description

Currently waste incineration is a practice to manage clinical waste. There are two incinerators for incineration of clinical waste at the EMEPA and Medicom, located in Sofia. Concerning activity data, we have regulatory basis for obtaining information about waste - Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014). The operators of installations are obliged to report on annual basis. In the reporting formats under the ordinance the quantities of treated waste are included. They contain information about:

- Type of incineration plant

- Capacity of installation
- Year of commissioning the installation
- Reconstruction of the installation (change, year and etc.)
- Quantity of incinerated waste
- Characteristics of incinerated waste

7.4.3 METHODOLOGICAL ISSUES

The choice of a good method for emission calculations depend on national circumstances, including whether incineration of waste is a key category and to what extent country and plant-specific information is available. Concerning waste incineration, most adequate and correct results are going to be completed if the information about type of waste and incineration technology are available. The methods for estimating CO_2, N_2O and CH_4 emissions from incineration differ because of the different factors that influence emission levels. For this reason they are described separately.

7.4.3.1 Choice of method for estimating CO_2 emissions from clinical waste incineration

TIER 1 method is used for estimation of CO_2 emissions from incineration of clinical waste, because it is not a key category. CO_2 emissions have been calculated using the methodology, proposed by the 2006 IPCC Guidelines, by multiplying the incinerated waste with default values for dry matter content in the waste, fraction of carbon in dry matter, fraction of fossil carbon and oxidation factor.
Equation 5.1 (2006 IPCC, Vol.5: Waste p.5.7) is used for estimating CO_2 emissions.

7.4.3.2 Choice of method for estimating N_2O emissions from clinical waste incineration

For N_2O emission calculations equation 5.5 is used (2006 IPCC, Vol.5: Waste p.5.14, TIER 1, non key category)

7.4.3.3 Choice of method for estimating CH_4 emissions from clinical waste incineration

For CH_4 emission calculations equation 5.4 is used (2006 IPCC, Vol.5: Waste p.5.12, TIER 1, non key category)

7.4.4 CHOICE OF EMISSION FACTORS

In the annual reports from operators of incinerators lacks sufficient information for specifying characteristics of waste as carbon content in the waste, fraction of fossil carbon, dry matter content, etc.
For estimation of CO_2 emissions from clinical waste incineration, country used 60 % total carbon content in % of dry weight; 40 % fossil carbon fraction in % of total carbon content and 100 % oxidation factor (2006 IPCC,Vol.5:Waste, p.5.18, Table 5.2)

7.4.4.1 Choice of emission factors for N_2O estimations

If site-specific emissions factors are not available, default factors can be used.
In country incineration plants are type heart or grate. There is no a default EF N_2O for such type of installation. For estimation of N_2O emissions from incineration of clinical waste we choose EF N_2O 50g N_2O/t waste for continuous and semi-continuous incinerators (2006 IPCC, Vol.5: Waste, p.5.22, Table 5.6)

7.4.4.2 Choice of emission factors for CH_4 estimations

For calculation of CH_4 emissions from clinical waste incineration, default EF is used - 6 kg/Gg incinerated waste for semi-continuous incineration (2006 IPCC, Vol.5: Waste, p.5.20, Table 5.3)

7.4.5 INCINERATION OF HAZARDOUS WASTE (CRF CATEGORY 5C)

7.4.5.1 Category description

In the installation of Luk Oil Neftochim are incinerated hazardous waste, mainly sludge and other waste contaminated with oil.
Concerning activity data, we have regulatory basis for obtaining information about waste-Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014). The operators of installations are obliged to report on annual basis. In the reporting formats under the ordinance the quantities of treated waste are included.

7.4.5.2 Choice of method for estimating CO_2 emissions from hazardous waste incineration

TIER 1 method is used for estimation of CO_2 emissions from hazardous waste incineration, because it is not a key category.
Equation 5.1 (2006 IPCC, Vol.5: Waste p.5.7) is used for estimating CO_2 emissions

7.4.5.3 Choice of method for estimating N_2O emissions from hazardous waste incineration

TIER 1 method is used for estimation of N_2O emissions from hazardous waste incineration. The calculation of N_2O emissions is based on the waste input to the incinerators and default emission factor.
For N_2O emission calculations equation 5.5 is used (2006 IPCC, Vol.5: Waste p.5.14)

7.4.5.4 Choice of method for estimating CH4 emissions from hazardous waste incineration

The calculation of CH_4 emissions is based on the amount of waste incinerated and on the related emission factor for TIER 1 - Equation 5.4 (2006 IPCC, Vol.5: Waste p.5.12).

7.4.6 CHOICE OF EMISSION FACTORS

For calculation of CO_2 emissions from incineration of hazardous waste default parameters have been used (2006 IPCC, Vol.5: Waste, p.5.18, Table 5.2)
For estimation of CO_2 emissions from hazardous waste incineration, country used 50% total carbon content in % of dry weight; 90% fossil carbon fraction in % of total carbon content and 100 % oxidation factor.

7.4.6.1 Choice of emission factors for N_2O estimations

For calculation of N_2O emissions from hazardous waste incineration we used EF N_2O of 450 g N_2O/t waste (2006 IPCC, Vol.5: Waste, p.5.21, Table 5.5)

7.4.6.2 Choice of emission factors for CH_4 estimations

For calculation of CH_4 emissions from hazardous waste incineration we used EF CH_4 of 6 kg/Gg waste incinerated on a wet weight basis for semi-continuous incineration (2006 IPCC, Vol.5: Waste, p.5.20,Table 5.3).

7.4.7 UNCERTAINTY AND TIME – SERIES CONSISTENCY

Emission factor uncertainty from waste incineration is estimated to be about 100 % - default factors are used, concerning AD uncertainty - 10 % due to higher uncertainty of clinical waste.
Emissions from waste incineration are calculated using the same method and data set consistently for every year in the time series.

7.4.8 SOURCE-SPECIFIC QA/QC AND VERIFICATION

The category is covered by the general QA/QC procedures.

7.4.9 SOURCE-SPECIFIC RECALCULATIONS

Source specific recalculations are not planned.

7.4.10 SOURCE-SPECIFIC IMPROVEMENT PLAN

Improvements are not planned.

7.5 WASTEWATER HANDLING (CRF SECTOR 5 D)

7.5.1 OVERVIEW OF THE SECTOR

This sector includes CH_4 emissions from wastewater when treated or disposed anaerobically and indirect N_2O emissions for the period 1988-2019. CO_2 emissions from wastewater are not considered in the 2006 IPCC Guidelines.
The calculation of the emissions is separated in two sub categories:
5D1 – Domestic/commercial wastewater treatment;
5D2 – Industrial wastewater treatment

7.5.2 EMISSION TREND

Total CO_2 equivalents from wastewater handling for 2019 are 537.35 Gg CO_2 eq. In 2019 emissions decrease with 8.6% in comparison with 2018.
TIER 2 is applied in the calculation of the CH_4 emissions from Domestic and Industrial wastewater handling.
Methane emissions from wastewater treatment are shown on the figure below. We divide the emission by domestic and industrial origin.

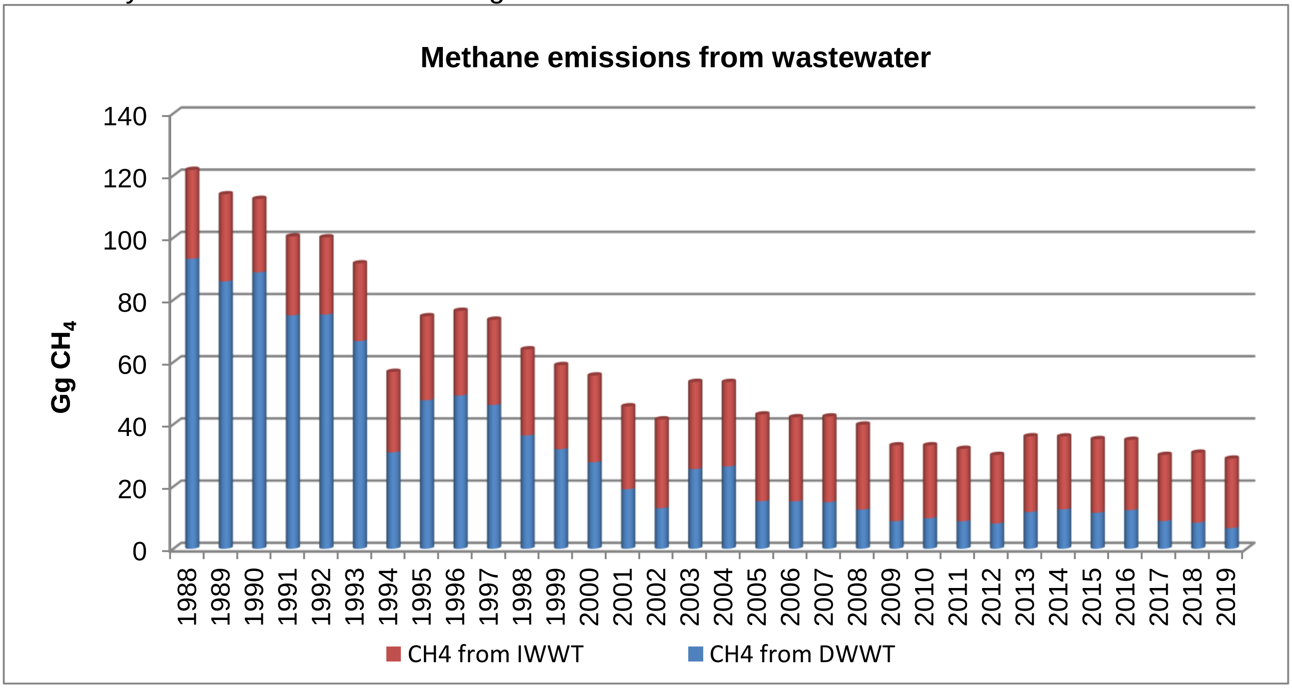


Figure 134 CH4 emissions from wastewater handling

7.5.3 DOMESTIC WASTEWATER HANDLING (CRF CATEGORY 5D1)

7.5.3.1 Category description

This category is a key category.

The National Statistical Institute is the source of information about treatment and discharge pathways or systems in the country, as well as quantities of wastewater, generated and handled in each treatment system of domestic/industrial wastewater.
According to NSI data, domestic wastewater has been treated in centralized aerobic treatment plants, septic systems, latrines and discharged into water bodies (sea, river, lakes).
In Bulgaria, 73,73% of the population is classified as urban income group and 26.27 % - as rural income group (NSI data). Degree of utilization (T) of treatment and discharge pathways for each income group are shown in Table 260.
Total methane emissions from domestic wastewater treatment for 2019 are 9.37Gg. Significant contribution to these emissions have septic systems – 4.39 Gg.

7.5.3.2 Methodological Issues

7.5.3.2.1 Methodology for calculation of the methane emissions from domestic/commercial wastewater handling (5D1)

The 2006 IPCC Guidelines describe methodology for the calculation of the methane emissions in the atmosphere during the processes of domestic wastewater treatment. The decision tree, which describes the steps and the algorithm for calculating methane emissions, is shown on Figure 6.2, page.6.10 / 2006 IPCC.
The methodology for the calculation of the methane emissions from domestic wastewater handling consists of three components: 1) definition of the total organically degradable material in domestic wastewater (TOW); 2) definition of emission factor for each domestic wastewater treatment/discharge pathway or system and 3) emission estimation.
The first step in the calculations is to define the total organically degradable material in domestic wastewater (TOW), which is the AD for this source category. TOW is expressed in the term of biochemical oxygen demand (kg BOD/year). Based on the demographic data acquired by the National Statistical Institute for the respective inventory years, we calculate TOW with the following equation:

$$TOW = P \bullet BOD \bullet 0.001 \bullet I \bullet 365$$

Where:
TOW – total organics in the wastewater in inventory year, kg BOD/yr
P – country population in inventory year
BOD – country specific per capita BOD in inventory year, g/person/day
Default value = 60 g/person/day
0.001 - conversion from grams BOD to kg BOD
I - correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, used in calculations)

Table 258 Total organically degradable material (TOW) in domestic wastewater

Year	Total organic product	Year	Total organic product	Year	Total organic product	Year	Total organic product
	kg BOD/year		kg BOD/year		kg BOD/year		kg BOD/year
1988	246009161	**1998**	225306406	**2008**	208229334	**2018**	191626068
1989	240005057	**1999**	224225231	**2009**	207056561	**2019**	190296820
1990	237321239	**2000**	223091687	**2010**	205445762		
1991	235300854	**2001**	216018726	**2011**	200582757		
1992	232273125	**2002**	214779897	**2012**	199414611		
1993	231586012	**2003**	213559848	**2013**	198350408		
1994	230700568	**2004**	212458716	**2014**	197160170		
1995	229531573	**2005**	211300781	**2015**	195834837		
1996	228333123	**2006**	210220564	**2016**	194413390		
1997	226752600	**2007**	209151515	**2017**	192994681		

The next step of the calculation is to define the Emission factor.

The emission factor for wastewater treatment and discharge pathway and system is a function of the maximum CH_4 producing potential (Bo) and methane correction factor (MCF) for wastewater treatment and discharge system.
The Equation for calculation of EF is:

$$EF_j = B_0 \bullet MCF_j$$

Where:
EF_j – emission factor, kg CH_4/kg BOD
j – each treatment/discharge pathway or system
Bo – maximum CH_4 producing capacity, kg CH_4/kg BOD
MCF_j– methane correction factor (fraction)
2006 IPCC Guidelines provides the default value for domestic wastewater:
Bo = 0,60 kg CH_4 /kg BOD
The first step for the definition of MCF is to characterize the systems for wastewater treatment in the country.
Following the 2006 IPCC Guidelines, table 6.3, page.6.13, the type of wastewater treatment system and the discharge pathways are defined for the whole country. Based on the data by the National Statistical Institute, we point out four categories of methane emissions sources.
Category 1 - waters without treatment discharged in the water sources (sea, rivers and lakes).
Category 2 - waters discharged trough sewer systems into centralized aerobic wastewater treatment plant. In the general case they are amortized.
Category 3 – waters treated in septic systems.
Category 4 – waters treated in latrines
We use the *methane correction factor* as follows:
Category 1 - waters without treatment discharged in the water sources (sea, rivers and lakes) MCF = 0.1
Category 2 - waters discharged trough sewer system into centralized aerobic wastewater treatment plant – MCF = 0.3
Category 3 – waters treated in septic systems – MCF = 0.5
Category 4 – waters treated in latrines – MCF = 0.1
The same data from National Statistical Institute are used for wastewater distribution among different treatment systems. The data are country specific.

Table 259 Domestic wastewater distribution among different treatment systems

	Discharged into sea, river, lake	Centralized, aerobic not well managed treatment plant	Septic systems	Latrines
MCF	**0.1**	**0.3**	**0.5**	**0.1**
1988	43.07%	32.30%	13.35%	11.28%
1989	43.07%	32.30%	13.61%	11.02%
1990	56.14%	17.54%	14.82%	11.51%
1991	49.36%	18.95%	18.16%	13.53%
1992	51.23%	21.28%	16.04%	11.45%
1993	51.02%	22.79%	15.53%	10.65%
1994	48.08%	25.07%	16.18%	10.66%
1995	44.25%	28.99%	16.39%	10.37%
1996	43.30%	28.51%	17.54%	10.65%
1997	42.54%	29.82%	17.46%	10.18%
1998	41.54%	32.69%	16.53%	9.24%
1999	43.72%	32.19%	15.69%	8.40%
2000	40.61%	32.75%	17.61%	9.04%
2001	42.28%	33.14%	16.48%	8.10%
2002	35.52%	37.27%	18.58%	8.63%
2003	37.23%	37.10%	17.85%	7.82%
2004	40.16%	37.66%	15.70%	6.48%
2005	37.38%	40.18%	16.16%	6.28%
2006	40.27%	38.60%	15.48%	5.65%
2007	38.36%	40.52%	15.74%	5.38%
2008	38.96%	41.33%	14.93%	4.78%

	Discharged into sea, river, lake	Centralized, aerobic not well managed treatment plant	Septic systems	Latrines
2009	41.41%	40.28%	14.10%	4.21%
2010	41.20%	41.55%	13.50%	3.75%
2011	39.26%	42.55%	14.47%	3.73%
2012	38.08%	45.35%	13.38%	3.19%
2013	34.82%	43.41%	17.85%	3.92%
2014	33.50%	45.25%	17.68%	3.56%
2015	30.93%	44.16%	21.04%	3.87%
2016	30.24%	54.97%	12.68%	2.11%
2017	32.11%	56.13%	10.22%	1.53%
2018	32.00%	56.89%	9.79%	1.31%
2019	31.90%	57.36%	9.61%	1.13%

After determination of TOW, wastewater treatment systems and discharge pathways and respective MCF, we can calculate the CH_4 emissions from domestic wastewater as follows:

$$CH_4\ Emissions = \left[\sum_{i,j}\left(U_i \bullet T_{i,j} \bullet EF_j\right)\right](TOW - S) - R$$

Where:
CH_4 emissions – CH_4 emissions in inventory year, kg CH_4/yr
TOW – total organics in wastewater in inventory year, kg BOD/yr
S – organic component removed as sludge in inventory year, kg BOD/yr
R – amount of CH4 recovered in inventory year, kg CH_4/yr
U_i – fraction of population in income group i in inventory year
$T_{i,j}$ – degree of utilization of treatment/discharge pathway or system, j, for each income group fraction i in inventory year
i – income group: rural, urban high income and urban low income
j – each treatment/discharge pathway or system
EF – emission factor, kg CH_4/yr
CH_4 emissions from domestic wastewater treatment and discharge for the period 1988-2018 are shown in figure below

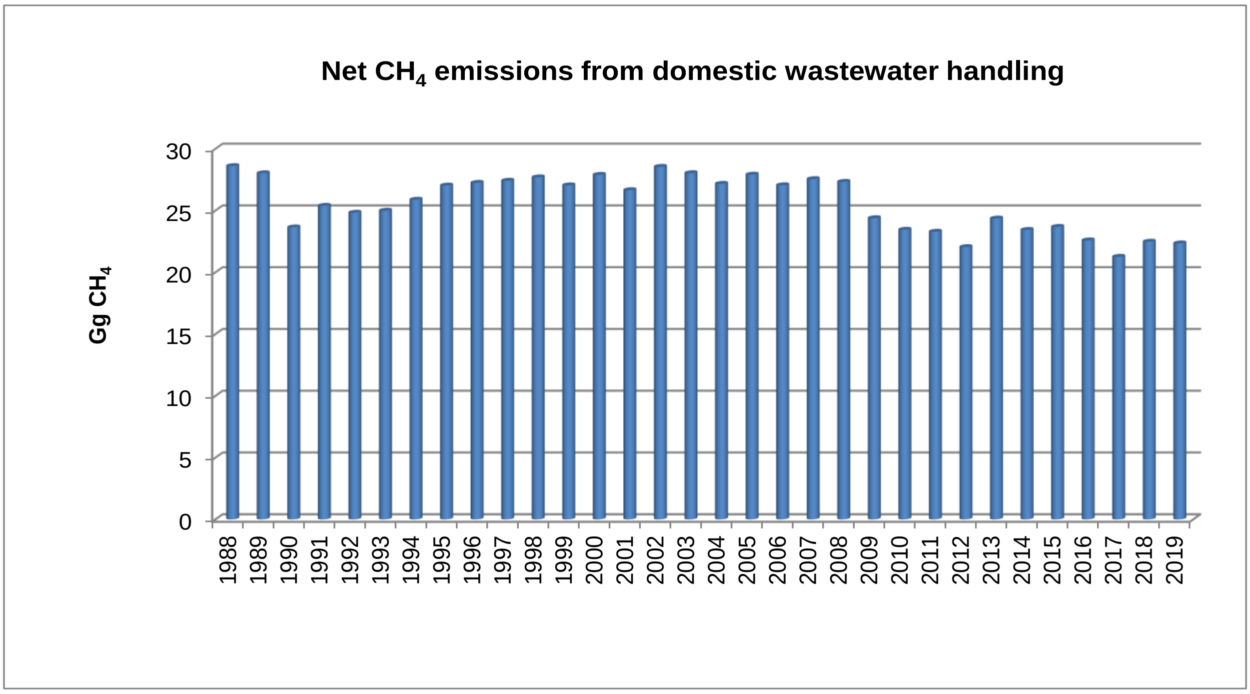


Figure 135 CH4 emissions from domestic wastewater handling

Emission increase in 2013 is due to a technical problems with methane tanks in one of the biggest wastewater treatment plant in the country.
The source of information about degree of urbanization in the country is National Statistical Institute. The population is separated into two main fractions: urban and rural as the dominating is the urban population.
The degree of utilization of each treatment system is calculated for urban and rural population.
The following table summarizes the results

Table 260 Degree of utilization of treatment systems (T) for each income group (U)

Income group	Type of treatment and discharge pathways	Treatment utilization (%)
Urban population	Discharge into the sea,river, lake	24
	Centralized aerobic treatment plant	42
	Septic systems	7
Rural population	Discharge into the sea,river, lake	8
	Centralized aerobic treatment plant	15
	Septic systems	3
	Latrines	1

7.5.3.3 Choice of emission factors and parameters

For CH_4 emission estimation, default 2006 IPCC Guidelines were used.
Wastewater treatment and discharge pathways
The National Statistical Institute is the source of information about treatment and discharge pathways or systems in the country, as well as quantities of wastewater, generated and handled in each treatment system of domestic/industrial wastewater.
Degradable organic component indicator (BOD)
For domestic wastewater, biochemical oxygen demand (BOD) is the recommended parameter used to measure the degradable organic component in wastewater. The BOD concentration indicates the amount of carbon that is aerobically biodegradable. The IPCC default value of 60 g BOD/person/day or 21900 kg BOD/1000 person/yr was used for emission calculations (2006 IPCC,Vol.5: Waste, p. 6.14).
Correction factor for additional industrial BOD discharged into sewers (I)
The factor expresses the BOD from industries and establishments that is co-discharged with domestic wastewater. The IPCC default value of 1.25 was used for emission calculations (2006 IPCC, Vol.5: Waste, p. 6.14, Table 6.4). The factor I is applied only for the wastewater, treated by WWTP.
Maximum methane producing capacity (B_0)
The IPCC default of 0.6 kg CH_4/kg BOD was used for emission calculations (2006 IPCC, Vol.5: Waste, p. 6.12, Table 6.2).
Methane correction factor (MCF)
Determination of methane correction factor depends on the available systems for wastewater treatment in the country. The defaults MCF, used in calculations are as follows:

a) waters without treatment discharged in the water sources (sea, rivers and lakes) MCF = 0.1
b) waters discharged trough sewer system into centralized aerobic wastewater treatment plant – MCF = 0.3
c) waters treated in septic systems – MCF = 0.5
d) waters treated in latrines – MCF =0.1

The MCF = 0.1 for waters treated in latrines was chosen as delault value for dry climate, small family (3-5 persons) and for BOD default value of 60 g/person/day in accordance with 2006 IPCC Guidelines, volume 5, chapter 6, table 6.3.
Methane recovery (R)
The calculation of CH_4 recovery from wastewater handling is based on regulatory basis of obtaining information about waste - Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014).The operators of installations are obliged to report on annual basis. In the reporting formats under the Ordinance there is information about the type of plant treatment

system for CH_4 utilization (e.g. gas holder system, methane tanks and gas burning system); quantity of total captured CH_4, CH_4 stored in reservoirs, utilized and flared methane) and year of commissioning of the installation for CH_4 utilization. Reporting is based on the metering of gas recovered for energy utilization and flaring. These data are country specific.
For 2018 the quantity of recovered methane is 4,71Gg. The resulting emissions (CO_2, CH_4 and N_2O) are estimated in Energy sector and are included in Sector 1.A – Fuel combustion, Subcategory 1.A.4 – Gaseous fuels,gaseous biomass.
Organic component removed as sludge (S). For sludge removal from the wastewater default IPCC value of zero was used for emission calculations (2006 IPCC, Vol.5: Waste, p.6.9).
For the last couple of years there is an improvement in the sludge management practices – as sludge is stabilized in methane tanks. Information about the quantities of treated sludge and type of treatment is obtained through Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014). For 2018 nearly 73% of the sludge in the country is treated anaerobically. All wastewater treatment plants with anaerobic sludge stabilization utilise biogas for generation of heat and/or electricity. Sludge, which will be used in agriculture, need to be treated in a proper way to ensure safety in terms of microbiological and parasitological parameters. According Ordinance on the way of recovery of sludge from wastewater treatment through its use in agriculture for 2018 the quantity of sludge, used in agriculture is 29,8kt; 2,87кt sludge are composted with red Californian warms; 5,91kt are used for reclamation of disturbed areas;3.74kt of sludge are land filled and respective emissions are reported in sector 5 A - Solid waste disposal and 10,80kt of sludge are temporarily stored.

7.5.3.4 Methodology for calculation of the methane emissions of industrial wastewater handling (CRF 5D2)

Industrial wastewater can be treated on site or discharged into centralized sewer. Emissions from industrial wastewater discharged into centralized sewer, are included in emissions from domestic wastewater.
The source of activity data about treatment and discharge pathways or systems in the country, quantities of wastewater, treated in each treatment system and generated and treated domestic/industrial wastewater is National Statistical Institute.
In this sub-category we calculate the methane emissions from industrial wastewater treated on site.
Based on the data acquired by the National Statistical Institute we determine the percentage on industrial wastewater treated on site.

Table 261 Industrial wastewater treated on site

Year	Total industrial wastewater	Treated on site		Non treated on site	
	thou.m^3	thou.m^3	%	thou.m^3	%
1988	1 075 286	610 746	56.80%	464 540	43.20%
1989	1 008 789	572 976	56.80%	435 812	43.20%
1990	1 127 165	610 252	54.14%	516 913	45.86%
1991	900 404	460 803	51.18%	439 601	48.82%
1992	766 131	368 586	48.11%	397 545	51.89%
1993	608 420	304 300	50.01%	304 120	49.99%
1994	526 760	291 347	55.31%	235 413	44.69%
1995	587 085	361 591	61.59%	225 494	38.41%
1996	577 742	352 879	61.08%	224 863	38.92%
1997	489 706	298 698	61.00%	191 008	39.00%
1998	418 679	250 707	59.88%	167 972	40.12%
1999	377 265	206 549	54.75%	170 716	45.25%
2000	328 497	158 273	48.18%	170 224	51.82%
2001	274 475	121 677	44.33%	152 797	55.67%
2002	225 023	136 029	60.45%	88 994	39.55%
2003	666 142	558 201	83.80%	107 941	16.20%
2004	657 812	555 546	84.45%	102 267	15.55%
2005	180 648	102 945	56.99%	77 703	43.01%

Year	Total industrial wastewater	Treated on site		Non treated on site	
	thou.m^3	thou.m^3	%	thou.m^3	%
2006	227 422	121 008	53.21%	106 414	46.79%
2007	219 057	119 621	54.61%	99 436	45.39%
2008	204 462	109 484	53.55%	94 978	46.45%
2009	172 156	80 950	47.02%	91 206	52.98%
2010	171 890	84 462	49.14%	87 428	50.86%
2011	153 581	69 733	45.40%	83 848	54.60%
2012	146 536	69 526	47.45 %	77 011	52.55%
2013	154 477	74 043	47.93 %	80 433	52.07 %
2014	146 283	74 743	51.09%	71 540	48.91%
2015	110 519	66 812	60.45%	44 543	40.30%
2016	117 862	76 683	65.06%	41 178	34.94%
2017	113 822	75 257	66.12%	38 565	33.88%
2018	110 469	67 380	60.99%	43 090	39.01%
2019	98 812	58 302	59.00%	40 510	41.00%

2006 IPCC Guidelines describe a method for calculating methane emissions from industrial wastewater in the atmosphere, similar to methodology for calculation of the emissions from domestic/commercial wastewater.
As the first step, it is necessary to determine the total amount of organically degradable material in the wastewater (TOW). It is expressed in terms of chemical oxygen demand (kg/COD/yr). The equation for calculation of TOW for particular industrial sector is:

$$TOW_i = P_i \bullet W_i \bullet COD_i$$

Where:
TOW – total organically degradable material in wastewater for industry i, kg COD/yr
Pi – total industrial product for industrial sector i, t/yr
Wi – wastewater generated, m^3/t product
COD – degradable organic component in wastewater, kg COD/yr
i – industrial sector
Secondly, the emission factors for each industrial wastewater treatment and discharge pathways have to be estimated (2006 IPCC, Vol.5: Waste, p.6.21, eq.6.5). The emission factor is function of the maximum CH_4 producing potential (Bo) and methane correction factor (MCF).

$$EF_j = B_0 \bullet MCF_j$$

Where:
EF_j – emission factor for each treatment/discharge pathway or system, kg CH_4/kg COD
Bo – maximum CH_4 producing capacity, kg CH_4/kg COD
MCF – methane correction factor
j – each treatment/discharge pathway or system
To determine the methane correction factor, the type of wastewater treatment systems and discharge pathways are defined for the whole country by National Statistical Institute:
a) waters, discharged into sea, river, lake - MCF= 0.05
b) waters, discharged trough sewer system into centralized aerobic treatment plant – MCF= 0.3;
c) waters, treated in stagnant sewer – MCF= 0.5
These methane correction factors are used in estimation of CH_4 emissions from industrial wastewater treatment.
In the end, the total emission of methane from industrial wastewater is estimated. The equation for calculation of annual CH_4 emissions is as follows:

$$CH_4\ emission = \sum_i [(TOW_i - S_i)EF_i - R_i]$$

Where:
CH_4 emissions – CH_4 emissions in inventory year, kg CH_4/kg COD
TOW – total organically degradable material in wastewater in industry I in inventory year, kgCOD/yr
i – industrial sector
EF – emission factor for industry i, kg CH_4/kg COD for treatment/discharge pathway or system
Ri – amount of CH_4 recovered in inventory year.
CH_4 emissions from industrial wastewater treatment for the period 1988-2019 are shown in figure below.

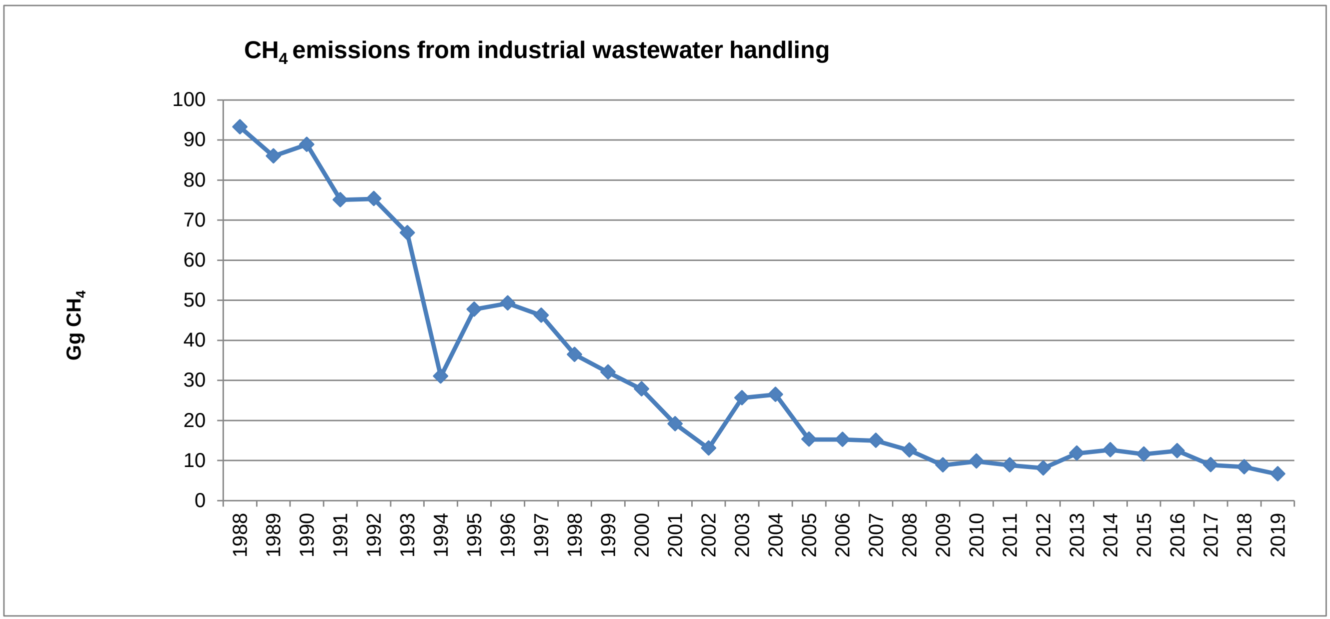


Figure 136 CH4 emissions from industrial wastewater handling

After the crisis in 1989 in the country and changes in economy in that period a decline in total generated wastewater from industry is observed (1990-1994). This trend is characteristic for paper and pulp production, production of food and beverage, organic chemicals, textile and textile products and affect the emissions in that period.
In 2002 again a decline in total generated wastewater could be observed from industry: food and beverage, paper and pulp production, organic chemicals and textile. This is connected with the next stage of the economy restructuring in the country – privatization of enterprises (part of them are sold, closed or changed their functions).
During 2003-2004 a significant growth of generated industrial wastewater is observed, formed by discharged wastewater from preceiding years (discharge of several big tailing ponds of mining companies in the country) with permission of the Ministry of Environment and waters which gives rise of the emissions from industrial wastewater treatment.
In 2019 the quantity of generated industrial wastewater is less than 2018 with 10.5%.

Table 262 The total organically degradable material in industrial wastewater (total organic product-TOW)

Year	Total organic product	Aggregate Emission Factor	Net methane emissions
	kg COD/year	kg CH_4/kg COD	Gg CH_4
1988	1770357161	0.05	93.23
1989	1660875637	0.05	85.96
1990	1768925993	0.05	88.86
1991	1335720988	0.06	75.03
1992	1068413305	0.07	75.31
1993	882068686	0.08	66.78
1994	844522069	0.04	30.99
1995	1048137030	0.05	47.73
1996	1022883720	0.05	49.25
1997	865830274	0.05	46.23
1998	675249732	0.05	36.42

Year	Total organic product	Aggregate Emission Factor	Net methane emissions
	kg COD/year	kg CH_4/kg COD	Gg CH_4
1999	560226105	0.06	32.01
2000	453700479	0.06	27.81
2001	335359951	0.06	19.14
2002	366472888	0.04	13.03
2003	1393752184	0.02	25.61
2004	1384385079	0.02	26.46
2005	366112919	0.04	15.25
2006	396185055	0.04	15.23
2007	405429790	0.04	14.97
2008	342864487	0.04	12.58
2009	214454606	0.04	8.85
2010	250936231	0.04	9.80
2011	223019186	0.04	8.82
2012	218531125	0.04	8.10
2013	246893557	0.05	11.79
2014	260715532	0.05	12.66
2015	239732348	0.05	11.57
2016	286189398	0.04	12.42
2017	241114483	0.04	8.90
2018	211831635	0.04	8.39
2019	175876911	0.04	6.62

The quantity of methane from industrial wastewater streams depends on the concentration of the biodegradable organic component in wastewater, the wastewater volume and type of treatment (aerobic or anaerobic).
Using these criteria, we determine the industries with the greatest potential for release of methane emissions, namely:

- Production of food and beverage
- Production of Paper and pulp
- Production of Organic chemicals
- Production of textiles and textile products

These four sectors are generating a large amount of wastewater with high content of degradable organic component.
<u>Quantity of wastewater</u>
Annual amount of the wastewater output for different industrial sectors comes from the National Statistical Institute. Data are collected through statistical questionnaires in electronic and paper format (with instruction for filling, definition and some formulas). Respondents send completed questionnaires to the Regional Statistical Offices for data validation and then to the Central NSI office. Data on the wastewater volume are calculated by combination the survey data and estimations. Statistical questionnaires require detail data on wastewater, generated and discharged by origin of water flows, by place of discharge and by technology of treatment.
Table below shows the wastewater distribution among different treatment systems (Source-NSI).

Table 263 Industrial wastewater distribution among different treatment systems

Year	Discharged into sea, river, lake	Centralized, aerobic, not well managed treatment plant	Stagnant sewer
1988	42.29%	49.53%	8.18%
1989	43.40%	48.85%	7.76%
1990	45.98%	46.08%	7.94%
1991	38.80%	50.34%	10.85%
1992	8.62%	89.63%	1.75%
1993	6.05%	84.98%	8.97%
1994	66.33%	27.37%	6.30%
1995	49.64%	47.24%	3.13%
1996	46.00%	50.20%	3.80%

Year	Discharged into sea, river, lake	Centralized, aerobic, not well managed treatment plant	Stagnant sewer
1997	36.92%	60.16%	2.92%
1998	36.37%	60.29%	3.34%
1999	31.27%	65.38%	3.35%
2000	24.07%	73.28%	2.66%
2001	31.71%	64.52%	3.77%
2002	65.22%	32.14%	2.65%
2003	90.84%	8.85%	0.30%
2004	89.93%	9.42%	0.64%
2005	54.87%	43.21%	1.92%
2006	60.82%	36.28%	2.90%
2007	62.49%	35.55%	1.96%
2008	64.55%	31.40%	4.05%
2009	57.15%	38.86%	3.98%
2010	59.94%	37.04%	3.02%
2011	58.31%	39.67%	2.02%
2012	62.28%	35.73%	1.99%
2013	44.82%	53.67%	1.51%
2014	43.98%	53.90%	2.12%
2015	44.39%	53.62%	1.99%
2016	51.41%	47.54%	1.05%
2017	62.22%	36.18%	1.59%
2018	57.16%	42.17%	1.60%
2019	60.36%	38.92%	0.72%

7.5.3.5 Choice of emission factors and parameters

For CH_4 emission estimation, default IPCC 2006 values were used.
Industrial degradable organic component indicator (COD)
The principal factor in determining the CH_4 generation potential of wastewater is the amount of degradable organic material in the wastewater. Common parameter used to measure the organic component of the industrial wastewater is Chemical Oxygen Demand (COD). The COD measures the total material available for chemical oxidation.
In the 2006 IPCC Guidelines are set default values for the degradable organic component of COD (kg/m^3) for the different types of industries (2006 IPCC, Vol.5: Waste, p. 6.22,Table. 6.9).
Based on these data and data provided by the National Statistical Institute about the quantity of wastewater, we define degradable organic components for the different types of industry.
For food and beverage industry, the used value for COD (kg/m^3) is 2.8, which is a default value. For other industries: paper and pulp COD (kg/m^3)=9.0; organic chemicals COD (kg/m^3)=3.0; textile COD (kg/m^3)=0.9
Maximum methane producing capacity (B_0)
It is good practice for the maximum CH_4 producing capacity B_0 to use country specific data from measurements made of various wastewaters. If there is no such specific data, IPCC provides for B_0 to take a default value for industrial wastewater B_0 = 0,25 kg CH_4 / kg COD, used in calculations (2006 IPCC,Vol.5: Waste, p. 6.12,Table 6.2).
Methane correction factor (MCF)
Determination of methane correction factor depends on the available systems for wastewater treatment in the country. The present calculations of CH_4 emissions from industrial wastewater treatment are based on the project, which defines wastewater treatment systems and discharge pathways in the country and respective MCF for each treatment/discharge pathway or system. The MCF, used in calculations is as follows:
a) for waters, discharged into sea, river, lake - MCF= 0.05 ;
b) for waters, discharged trough sewer system into centralized aerobic treatment plant – MCF= 0.3;
c) for waters, treated in stagnant sewer - MCF= 0.5
Organic component removed as sludge (S)
For sludge removal from the waste water default IPCC value of zero was used for emission calculations (2006 IPCC, p.5.20, pg.6.9).
Methane recovery (R)

For amount of methane recovered default IPCC value of zero was used for emission calculations (2006 IPCC, Vol.5: Waste, p.6.9).

7.5.4 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Table 264 Uncertainty of sub-sector Wastewater handling

CRF categories	Key Category	GHG	AD uncertainty	EF uncertainty	Combined uncertainty
5 D1	Domestic Wastewater Handling	CH_4	39	42	67.42
5 D1	Domestic Wastewater Handling	N_2O	20	50	53.9
5 D2	Industrial Wastewater Handling	CH_4	55	30	51.61

7.5.5 SOURCE-SPECIFIC QA/QC AND VERIFICATION

It is recommended to carry out the following basic procedures for checking the quality of data and calculations:
Review and detailed analysis of natural indicators;
Analysis of trends in emissions of greenhouse gases emitted in the treatment of wastewater
Evaluation of the emission factors;
Overview of all archived documents and data necessary for the inventory

7.5.6 SOURCE-SPECIFIC RECALCULATIONS

In 2020 UNFCCC review TERT recommended a technical correction. The inventory team provided a revised estimation, which was accepted by TERT and implemented in Submission 2021.

7.5.7 SOURCE-SPECIFIC IMPROVEMENT PLAN

There is no plan improvement.

7.5.8 NITROUS OXIDE EMISSIONS FROM WASTEWATER

7.5.8.1 Methodological Issues

For estimation of N_2O from domestic wastewater effluent, 2006 IPCC Guidelines suggest a single methodology for calculations with no higher TIERS and decision tree provided.

7.5.8.2 Choice of method

Nitrous oxide emissions can occur as direct emissions from treatment plants or from indirect emissions from wastewater after disposal of effluent into waterways, lakes or the sea. This section addresses indirect N_2O emissions from wastewater treatment effluent that is discharged into aquatic environments. 2006 IPCC Guidelines suggests a methodology for calculation of N_2O emissions.
The calculations of the emissions follow the general equation 6.7 (p.6.25):

Equation 6.7:

$$N_2O \text{ Emissions} = N_{Effuent} \bullet EF_{Effluent} \bullet 44/28,$$

Where:
N_2O emissions - N_2O emissions in inventory year, kg N_2O/yr
$N_{Effluent}$ - nitrogen in the effluent discharged to aquatic environments, kg N/yr
$EF_{Effluent}$ - emission factor for N_2O emissions from discharged to wastewater, kg N_2O-N/kg N

The factor 44/28 is the conversion of kg N_2O-N into kg N_2O.

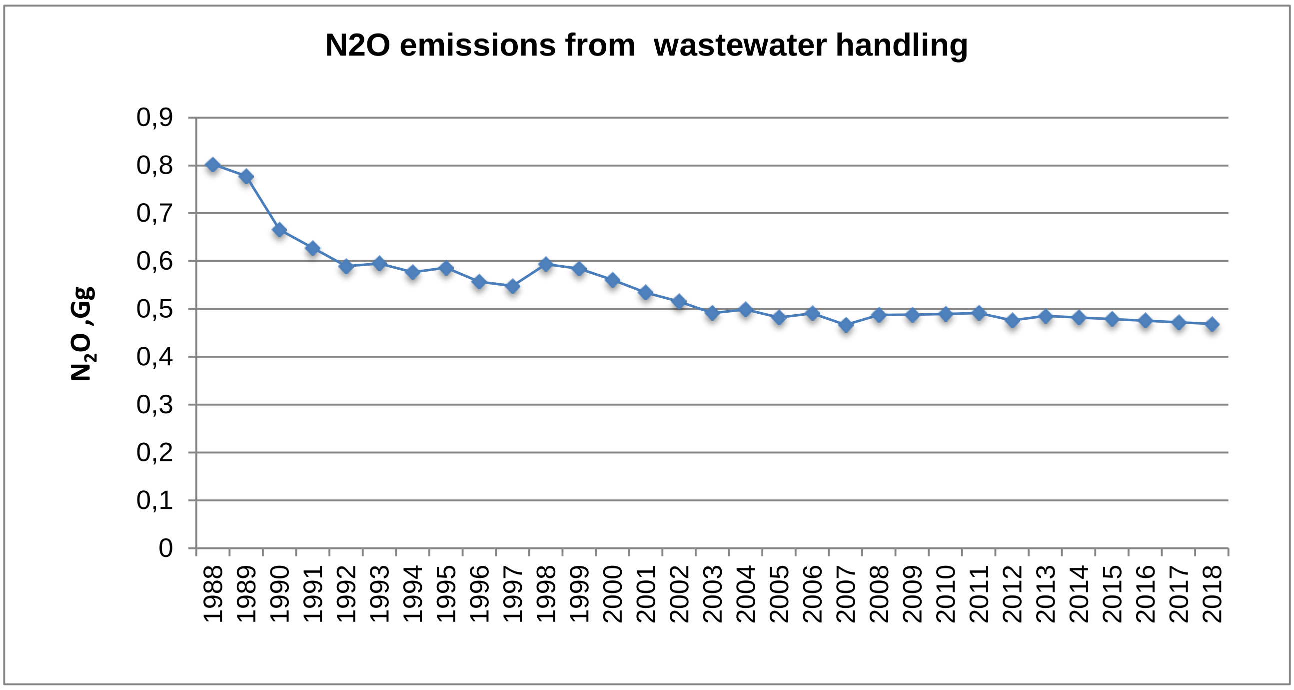


Figure 137 N_2O emissions from wastewater handling

7.5.8.3 Choice of emission factors

The default IPCC emission factor for N_2O emissions from domestic wastewater nitrogen effluent is 0.005 (0.0005-0.25) kg N_2O-N/kg N.

7.5.8.4 Choice of Activity data

The activity data that are needed for estimating N_2O emissions are nitrogen content in the wastewater effluent, country population and average annual per capita protein generation (kg/person/yr). Per capita protein generation consists of intake (consumption) of protein, available at FAO statistics, multiplied by factors to account for additional "non-consumed" protein and for industrial protein discharged into the sewer system. The total nitrogen in the effluent is estimated, using equation 6.8 (p. 6.25) :

Equation 6.8:

$$N_{Effluent} = (P \bullet Protein \bullet F_{NPR} \bullet F_{NON\text{-}CON} \bullet F_{IND\text{-}COM}) - N\ sludge,$$

Where:
$N_{Efflent}$ - total annual amount of nitrogen of the wastewater effluent, kg N/yr
P- human population (country specific)
Protein - annual per capita protein consumption, kg/person/yr
F_{NPR} – fraction of nitrogen in protein, default = 0.16 kg N/kg protein
$F_{NON\text{-}CON}$ – factor for none-consumed protein added to the wastewater (1.4)
$F_{IND\text{-}COM}$ – factor for industrial and commercial co-discharged protein into the sewer system (1.25)
N_{Sludge} – nitrogen removed with sludge (default = zero), kg N/yr
Table 6.11 (IPCC 2006, p.6.27) summarizes N_2O methodology default data

7.5.9 UNCERTAINTIES AND TIME SERIES CONSISTENCY

Large uncertainties are associated with IPCC default emission factors for N_2O from effluent.
Calculations of the N_2O emissions with new emission factors are made for whole time series.

7.5.10 SOURCE-SPECIFIC RECALCULATIONS

There are no recalculations.

7.5.11 SOURCE-SPECIFIC IMPROVEMENT PLAN

Improvements are not planned.

8 OTHER (CRF SECTOR 7)

This sector from the IPCC classification is designated to submit all GHGs emission sources, which for one or another reason have not been categorized at one of the six preceding sectors.
The Bulgarian inventory has no such specific sources to be reported in this sector.

9 INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS

Indirect CO_2 and nitrous oxide emissions have been reported at the relevant chapters of the report.

9.1 DESCRIPTION OF SOURCES OF INDIRECT EMISSIONS IN GHG INVENTORY

Please see the relevant chapters of the report.

9.2 METHODOLOGICAL ISSUES

Please see the relevant chapters of the report.

9.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Please see the relevant chapters of the report.

9.4 CATEGORY-SPECIFIC QA/QC AND VERIFICATION,

Please see the relevant chapters of the report.

9.5 CATEGORY-SPECIFIC RECALCULATIONS

Please see the relevant chapters of the report.

9.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS

Please see the relevant chapters of the report.

10 RECALCULATIONS AND IMPROVEMENTS

10.1 EXPLANATIONS AND JUSTIFICATIONS FOR RECALCULATIONS, INCLUDING IN RESPONSE TO THE REVIEW PROCESS

Recalculations of previously submitted inventory data are performed following the 2006 IPCC Guidelines, chapter 7 with the purpose to improve the GHG inventory. Specific sectoral information on recalculations made are given in Chapters 3-7 dedicated to source/sink categories.

10.1.1 GHG INVENTORY

The GHG emission recalculations for the period 1988-2019 (emission data 1988-2019) were made because of update and revision of activity data, EF and other parameters used for all sectors.
The main reason for recalculations is implementation of recommendations of the Expert Review Team as set out in the annual review report.

Table 265 Summary of GHG emission recalculations in submission 2021

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
1. Energy			
A. Fuel combustion (sectoral approach)	Revised AD in the National energy balances	Reallocated Coal mines consumption to 1A1ciii (previously was in 1A1ci)	Revised AD in the National energy balances
2. Manufacturing industries and construction			
3. Transport	Updated COPERT 5.4 model	Revised vehicle fleet matrix – added new vehicle categories.	Updated COPERT 5.4 model
4. Other sectors			
5. Other		Reallocated military aviation emissions to 1A5b	
B. Fugitive emissions from fuels	Revised AD, EFs and methodologies	Complete recalculation of the sector applying updated methodologies and EFs from 2019 refinement of 2006 IPCC GL	See Chapter 3.4.6
1. Solid fuels			
2. Oil and natural gas		Corrected technical error for fugitive emissions from natural gas production and gathering	See Chapter 3.4.6
C. CO2 transport and storage			
2. Industrial processes and product use			
A. Mineral industry			
B. Chemical industry			
C. Metal industry			
D. Non-energy products from fuels and solvent use	Updated COPERT 5.3 model.	There has been recalculation through the whole time series due to the: (1) revision of the fuel consumption data; (2) implementation of new COPERT 5.3 model.	For more information please see relevant chapter – 2.D.3.D Urea use in SCR catalysts of diesel engines.
	AD revision	Recalculation in the whole timeseries of AD for 2D3 Asphalt blowing.	Chapter 2D3
	Revised EF	Due to revision of Guidebook in EMEP GUIDELINES 2019	See SNAP code 060202
E. Electronic Industry			
F. Product uses as ODS substitutes	Revised lifetime factor	For the subcategory Stationary air conditioning (2.F.1.f) a recalculation was made after the emission inventory review in 2020. The equipment lifetime factor was changed to 15 years.	More information is provided in Chapter 2F1
G. Other product manufacture and use			
H. Other	Revised calculation.	Sector 2H3 is included elsewhere.	Chapter Vegetable oil production 2H3.
3. Agriculture			
A. Enteric fermentation			
B. Manure management	Revised activity data	The recalculation have been made for 2017 due to technical mistake in activity	For more information please see Chapter Agriculture/Manure

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
		data for cattle and swine.	management
C. Rice cultivation			
D. Agricultural soils	Revised activity data	The recalculation have been made for 2017 due to technical mistake in activity data for manure management (Cattle and Swine) and revised data for sludge applied to soils	For more information please see Chapter Agriculture/Agricultural soils
F. Field burning of agricultural residues	Revised activity data	The recalculation have been made for 2017 due to revised activity data for Peanuts.	For more information please see Chapter Agriculture/Field burning of agricultural residues
G. Liming			
H. Urea application			
I. Other carbon-containing fertilizers			
J. Other			
4. Land use, land-use change and forestry			
A. Forest land	Revised AD and EF	Revised stratification level at which estimations of emissions and removals are calculated. This affect the callculations of CSC in living biomass of both subcategories – FlrFL and LUCs to FL. For category FlrFl changes in biomass are estimated at level of tree species and then grouped for the reporting into forest types - coniferous and deciduous. More detailed data is used, and more specific emission factors are applied accordingly. For category LUC to FL, the annual average biomass growth has been recalculated as the expansion and conversion factors have been recalculated. Moved from higher tier back to tier 1 in calculating the changes in carbon stock in DOM and Soil for subcategory FLrFL	More information about these changes is presented in Chapter 6.3.2 More information is provided in 6.3.1
B. Cropland			
C. Grassland			
D. Wetlands			
E. Settlements			
F. Other land			
G. Harvested wood products	Revised AD and EF	A complete new calculation in HWP, t0=1987	More information is provided in Chapter LULUCF, HWP
H. Other			
5. Waste			
A. Solid waste disposal	Revised estimates	The recalculation have been made due to recommendation.	Please see Chapter Waste.
B. Biological treatment of solid waste			
C. Incineration and open burning of waste			
D. Waste water treatment and discharge	Revised estimates	The recalculation have been made due to recommendation.	Please see Chapter Waste.
E. Other			
6. Other (as specified in summary 1.A)			

10.2 IMPLICATIONS FOR EMISSION LEVELS

10.2.1 GHG INVENTORY

As a result of the continuous improvement of Bulgaria's GHG inventory, emissions of some sources have been recalculated on the basis of updated data or revised methodologies, thus emission data for 1988 to 2019 which are submitted this year differ slightly from data reported previously.

Table 266 Recalculation Difference of National Total GHG Emissions.

Year	National Total GHG emissions without LULUCF		
	Submission 2020 [Gg CO_2e]	Submission 2021 [Gg CO_2e]	Recalculation Difference [%]
1988*	116754.5	114801.0	-1.67

1990	101794.3	99978.1	-1.78
1991	83349.9	81795.8	-1.86
1992	77727.1	76218.4	-1.94
1993	76742.3	75610.6	-1.47
1994	73107.4	71519.5	-2.17
1995	74614.5	72908.9	-2.29
1996	74782.9	73249.3	-2.05
1997	71967.8	70028.8	-2.69
1998	67955.9	65922.2	-2.99
1999	60709.3	58817.0	-3.12
2000	59580.0	57864.3	-2.88
2001	62640.7	60776.9	-2.98
2002	59963.8	58130.2	-3.06
2003	64510.0	62940.3	-2.43
2004	63592.4	62109.5	-2.33
2005	64117.7	62714.9	-2.19
2006	64678.4	63377.1	-2.01
2007	68555.80	67307.9	-1.82
2008	67142.6	65996.6	-1.71
2009	58154.1	57164.0	-1.70
2010	60726.7	59796.4	-1.53
2011	65995.8	65071.4	-1.40
2012	60940.9	60087.1	-1.40
2013	55666.9	54893.9	-1.39
2014	58679.3	57987.9	-1.18
2015	61920.7	61338.4	-0.94
2016	59345.0	58800.9	-0.92
2017	61682.8	61148.5	-0.87
2018	57815.5	57281.8	-0.92

**Base year is 1988 for all gases*

10.3 IMPLICATIONS FOR EMISSION TRENDS, INCLUDING TIME SERIES' CONSISTENCY

10.3.1 GHG I INVENTORY AS CAN BE SEEN IN TABLE 266 AND FIGURE 138 BULGARIA'S GREENHOUSE GAS EMISSIONS AS REPORTED IN THE UNFCCC SUBMISSION 2019 ARE DIFFERENT COMPARED TO THE VALUES REPORTED LAST YEAR DUE TO RECALCULATIONS.

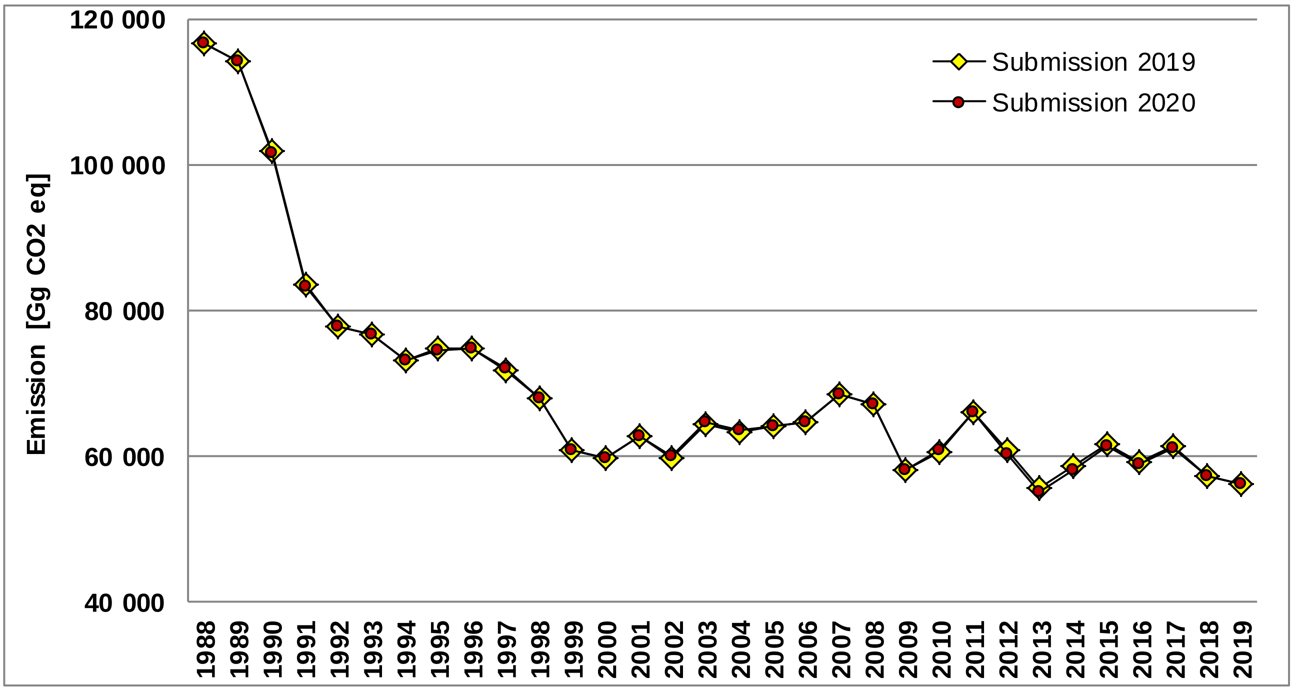


Figure 138 Emission estimates of the submission 2020 and recalculated value

10.4 PLANNED IMPROVEMENTS, INCLUDING RESPONSE TO THE REVIEW PROCESS

Many recalculations have been carried out in response to recommendations proposed in review reports.

The following general improvements are planned for the next submissions

Revision of activity data, update of emission factors and related parameters;

Conduct further studies for verification of emission factos and assumptions;

Improvement of uncertainty assessment;

Improvement of the relation with Branch Business Associations;

Executive Environment Agency (ExEA) Communication & Information Centre (Data management);

Further collaboration with external organizations;

QA/QC activities and audit;

Documentation and archiving.

All improvements will be conducted to increase TACCC.

For planned improvements please refer to respective chapters "planned improvements" for each source category.

11 KP-LULUCF

11.1 GENERAL INFORMATION

Bulgaria reports emissions/removals from afforestation, reforestation and deforestation under Article 3.3. of Kyoto Protocol and from Forest Management under Article 3.4 of Kyoto Protocol. The estimates of the emissions/removals related to art. 3.3. and 3.4. follow the guidance of the 2013 Revised Supplementary Methods and Guidance Arising from the Kyoto Protocol (2013 KP Supplement) and are consistent with the UNFCCC Decisions (15/CMP.1, 16/CMP.1, 2/CMP.6, 2/CMP.7).

11.1.1 DEFINITION OF FOREST AND ANY OTHER CRITERIA

For defining forest, Bulgaria uses the definition in the Bulgarian Forest Act (last amendment 2019):
"Area over 0.1 ha, covered with forest tree species higher than 5 meters and tree crown cover over 10% or with trees which can reach these parameters in natural environment".
Areas of natural forest regeneration outside urban areas with a size of more than 0.1 ha also represent "forest". City parks with trees, forest shelter belts, and single row trees do not fall under the category "forests".
According to their functions, forests are divided in: forests for timber production, protective and recreation forests and forests in protected areas.
All forests in Bulgaria are managed.
Forests are also:

- areas which are in a process of recovering and are still under the parameters noted, but it is expected to reach forest crown cover over 10% and tree height 5 meters;
- areas, which as a result of anthropogenic factors or natural reasons are temporarily deforested, but will be reforested;
- protective forest belts, as well as tree lines with an area over 0.1 ha and width over 10 meters;
- cork oak stands.

For reaching the targets of KP the minimal figures of the defined range of parameters for tree height, tree crown coverage and minimum area have been chosen by Bulgaria:
Minimum forest area – 0.1 ha;
Tree crown cover – 10%;
Tree height – 5 meters.
In accordance with Article 7 of the Kyoto Protocol the country will report in the National Inventories the following activities, according to the definitions of the forest related activities, as given in **Decision 16/CMP.1 Land use, land-use change and forestry:**
"Afforestation" as a direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources
"Reforestation" as a direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.
"Deforestation" as a direct human-induced conversion of forested land to non-forested land.
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

11.1.2 ELECTED ACTIVITIES UNDER ARTICLE 3, PARAGRAPH 4, OF THE KYOTO PROTOCOL

Bulgaria has decided not to elect any of the activities under Article 3, paragraph 4, in the first commitment period. For the second commitment period the accounting of emissions/removals from Forest Management is mandatory. Bulgaria decided to account for this activity in the end of the commitment period.

11.1.3 DESCRIPTION OF HOW THE DEFINITIONS OF EACH ACTIVITY UNDER ARTICLE 3.3 AND EACH ELECTED ACTIVITY UNDER ARTICLE 3.4 HAVE BEEN IMPLEMENTED AND APPLIED CONSISTENTLY OVER TIME

Bulgaria has chosen to account for each activity under Article 3, paragraph 3 at the end of the commitment period.

The base year for reporting ARD activities is 1990. The area units reported as Afforestation/Reforestation (AR) and Deforestation (D) have the same basis as the area of land-use change to and from forest under the UNFCCC GHG inventory reporting taking into account the different time frame. All LUC from and to forests are considered to be direct human induced. Afforestation/Reforestation (AR) activities are reported together.

All forests in Bulgaria are managed, therefore all activities which are carried out in the forests are considered as human-induced. Therefore, all emissions and removals of all lands which were forests in 1.1.1990 are accounted as Forest Management emissions and removals, except the emissions and removals of the ARD lands since 1.1.1990 which are accounted under the Art. 3.3 activity ARD.

The Forest Inventory (FI) and the information from the Forest Management Plans (FMP) are the main sources of information for the ARD units of land (see chapter 11.2.1).

11.2 LAND-RELATED INFORMATION

11.2.1 SPATIAL ASSESSMENT UNIT USED FOR DETERMINING THE AREA OF THE UNITS OF LAND UNDER ARTICLES 3.3 AND 3.4

The Forest Inventory (FI) and the information from the Forest Management Plans (FMP) are the main sources of information for the ARD units of land. The FI in Bulgaria covers assessments for the entire country territory in 10 years' cycles. In other words, all forest stands are surveyed once in every 10 years. Forest inventory presents collection of qualitative and quantitative data about the investigated area. The management planning provides recommendations about the silvicultural operations and activities for the next 10 years period. The process of forest inventory and planning is stable and consistent over time. The measurements of the forest inventory are carried out for all sub-compartments in each and every State Forest Enterprises (SFE). The area of one sub-compartment or forest management unit is from 1-25 ha, when forested. The area of the non-forested unit is 0,1 ha. The territory of one SFE may include the territory of one or several municipalities. The spatial assessment unit used to determine the areas of AR, D and FM is the area of sub compartments (1-25 ha,) within the area of each State Forest Enterprises. The information on AR units including their geographical location is provided in Table 254. The information there is provided for each State Forest Enterprises in the respective administrative district, but in fact the figures come as a result of LU changes traced at the level of sub compartment (0,1-25 ha).

11.2.2 METHODOLOGY USED TO DEVELOP THE LAND TRANSITION MATRIX

Reporting of AR units of land:

The reporting of the AR units of land since reported 2012 represents extrapolation of the results of the completed project (in 2014) for assessment of the AR units of land. The project has been launched following the plan for improvement of the estimation of AR units of land as accepted by the ERT team as answer to the related Saturday paper issue of the 2011 review. The plan has been implemented in stages starting in Submission 2012 and completed for the Submission 2014.

Due to financial and technical (incomplete data from FI) constraints and taking into account that Bulgaria accounts at the end of the CP, It decided that it is not necessary to carry out such an assessment for each year. It is planned to have an assessments of the AR units of lands just before the end of CP2. In the meanwhile, Bulgaria would report preliminary estimates based on extrapolation of the available data.

For transparency issue below it is describing the steps of the AR assessment.

According to this plan the following steps toward improvement have been implemented in order to fulfil the reporting requirement set out in paragraph 8 (a) of the annex to decision 15/CMP.1.

Bulgaria examined the Forest Management Plans (FMPs – see below) for all State Forest Enterprises (SFE), which were inventoried for the period 1991-2012. Therefore all changes since 1992 in forest area for each and every SFE has been traced and identified. For those SFE, where there is an increase in the forest area since 1990, the increase is derived into:

a. New forest areas which are included in the forest total area, but which were forested before 1990, so new forests with stands of older age classes.
b. And the new forested areas with stands of the youngest age class, which are due to afforestation and reforestation activities (planting and seeding) on barren areas or afforestation and reforestation activities (planting, manual and natural seeding) on grassland or on croplands.

These improvement steps have been performed by the experts from Executive Forest Agency, by using the following sources of information:

- Forest Inventory and FMPs[35];
- Forestry Fund Reporting Form 1FF[36] (forest area) for the 1990;
- Forest maps

The results (up to 2012) from the revision of the FMPs are given in the table below. The observed increase in forest area due to AR activities for every single SFEs is given for two periods - 1992-2000 and since 2000. The amount of the "new" forest areas since 1.1.1990 which were forested before 1990 (point a) was added to the total forest area in 1991 and the years after according to Forestry Fund Reporting Form 1FF (forest area). The new forest areas between 2012 and 1992 according to point b represent the **net increase** in forest due to planting or seeding (manually or naturally) activities. Changes in forest area for the years 1990, 1991 are based on extrapolation using the same forest change as in the year 1992.

[35] Forest Inventory and FMPs are carried out for each State Forest Enterprise. The inventory aims measurement and processing of the following main data:

1) Forest area and its changes
2) Tree composition, origin, age, management purpose
3) Tree height and diameter,
4) Annual increment, bonitat, density of the stands
5) Tree growing stock
6) Data about underlying geology, soil type and soil bonitat and other important habitat characteristics.

The measurements of the Forest Inventory are carried out for each and every SFE once in every 10 years.

[36] The reporting forms 1FF to 7 FF represent the forest fund reporting forms. The data gathered during the forest inventories is used as data base for preparation of the reporting forms of the forest fund.

Table 267 Results from the revision of the FMPs for all SFEs for the period 2001-2012, representing the net AR activities since 1992 till 2012

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
I. DISTRICT VIDIN							
1. Vidin	27 483	32 070	-	21	1 438	3 884	-
2. Belogradjik	27 730	27 826	620	6	-	2 128	906
3. Midjur	16 510	23 943	-	-	70	2 548	495
Total	**71 723**	**83 839**	**620**	**27**	**1 508**	**8 560**	**1 401**
II. DISTRICT MONTANA							
1. Montana	28 136	14 950	-	27	242	20	184
2. Chiprovtsi	-	16 506	1	2	19	316	818
3. Berkovitsa	24 346	26 344	59	-	196	1 392	20
4. Lom	4 868	6 237	-	50	110	573	608
5. Govejda	15 862	16 456	-	2 264	-	-	22
6. Burziya	6 919	6 644	-	-	-	-	83
Total	**80 131**	**87 137**	**60**	**2 343**	**567**	**2 301**	**1 735**
III. DISTRICT OF VRATSA							
1. Vratsa	20 591	24 588	-	-	288	627	1 068
2. Mezdra	26 816	30 140	757	670	2 109	1 260	300
3. Oryahovi	4 628	4 433	-	-	-	47	-
Total	**52 035**	**59 161**	**757**	**670**	**2 397**	**1 934**	**1 368**
IV. DISTRICT OF PLEVEN							
1. Pleven	23 002	31 441	973	-	4 767	3 001	1 320
2. Nikopol	9 645	13 559	-	40	-	198	2 054
Total	**32 647**	**45 000**	**973**	**40**	**4 767**	**3 199**	**3 374**
V. DISTRICT OF LOVECH							
1. Lovech	21 902	26 393	35	3 658	-	4 061	408
2. Teteven	19 589	19 728	119	54	11	589	992
3. Ribaritsa	15 491	20 096	-	18	-	76	2
4. Cherni Vit	9 113	13 735	-	4	314	352	863
5. Troyan	31 280	25 262	35	8	-	1 407	368
6. Rusalka, Apriltsi	11 501	12 863	-	-	334	356	84
7. Cherni Osam	12 900	13 437	-	2	1	312	68
8. Borima	-	7 779	-	3	-	-	-
9. Lesidren	19 729	32 583	159	118	-	1 186	-
10. Lukovit	14 374	-	-	-	-	-	-
Total	**155 879**	**171 876**	**348**	**3 865**	**660**	**8 339**	**2 785**
VI. DISTRICT OF GABROVO							
1. Gabrovo	25 447	28 568	35	11	-	3 228	10
2. Sevlievo	20 059	22 538	-	-	1 525	297	11
3. Rositsa	14 341	14 757	-	7	-	350	90
4.Plachkovtsi	20 969	27 291	-	-	1 327	5 370	77

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
Total	**80 816**	**93 154**	**35**	**18**	**2 852**	**9 245**	**188**
VII. DISTRICT OF VELIKO TARNOVO							
1. Bolyarka, V.Tarnovo	36 091	42 925	504	841	-	9 440	-
2. Svishtov	3 646	4 874	-	746	13	-	404
3. Gorna Oryahovitsa	17 123	20 587	211	12	4	738	94
4. Elena	30 461	33 418	-	7	-	2 736	284
5. Buinovtsi	14 366	16 507	-	33	-	123	434
Total	**101 687**	**118 311**	**715**	**1 639**	17	**13 037**	**1 216**
VIII. DISTRICT OF ROUSSE							
1. Dunav, Rousse	16 257	20 774	-	192	-	1 784	2 019
2. Byala	15 874	20 176	-	3 381	-	859	584
Total	**32 131**	**40 950**	**-**	**3 573**	**-**	**2 643**	**2 603**
IX. DISTRICT OF TARGOVISHTE							
1.Tyrgovishte	15 437	17 272	-	-	16	127	1 005
2. Omurtag	26 170	30 857	3	320	-	1 117	1 998
3. Cherni Lom, Popovo	24 753	28 561	900	484	1 848	654	1 858
Total	**66 360**	**76 690**	**903**	**804**	**1 864**	**1 898**	**4 861**
X. DISTRICT OF SHUMEN							
1. Shumen	16 299	17 395	479	1	760	156	866
2. Preslav	17 391	16 696	184	-	-	737	384
3. Varbitsa	15 489	18 856	221	-	-	515	212
4. Smyadovo	17 467	19 217	-	-	91	537	404
5. Palamara, Venets	30 773	34 025	588	40	-	1 779	816
Total	**97 419**	**106 189**	**1 472**	**41**	**851**	**3 724**	**2 682**
XI. DISTRICT OF RAZGRAD							
1. Razgrad	20 767	22 244	775	1 235	-	446	252
2. Seslav	28 411	30 484	-	-	-	219	623
3. Iri-Hisar	13 553	13 553	-	-	-	-	-
Total	**62 731**	**66 281**	**775**	**1 235**	**-**	**665**	**875**
XII. DISTRICT OF SILISTRA							
1. Silistra	25 550	24 433	-	665	-	914	4 066
2. Karakuz	17 221	25 395	311	59	-	615	452
3. Tutrakan	8 785	10 584	30	922	158	85	579
Total	**51 556**	**60 412**	**341**	**1 646**	**158**	**1 614**	**5 097**
XIII. DISTRICT OF DOBRICH							
1. Dobrich	24 691	16 981	1 199	286	123	246	2 466
2. Balchik	12 239	15 655	778	176	-	224	1 045
3. Tervel	11 096	14 264	586	51	-	519	2 321
4. General	-	14 120	2 268	108	26	143	429

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
Toshevo							
Total	**48 026**	**61 020**	**4 831**	**621**	**149**	**1 132**	**6 261**
XIV. DISTRICT OF VARNA							
1. Varna	30 611	31 075	-	-	456	-	768
2. Suvorovo	11 626	12 104	30	25	-	179	294
3. Provadiya	20 067	12 406	394	13	-	270	173
4. Tsonevo	12 168	22 653	644	650	417	70	120
5. Sherba	12 391	14 160	-	30	-	461	864
6. Staro Oryahovo	23 501	23 822	-	-	-	-	-
Total	**110 364**	**116 220**	**1 066**	**718**	**873**	**980**	**2 219**
XV. DISTRICT OF BOURGAS							
1. Bourgas	21 967	18 084	428	278	162	406	1 427
2. Nesebar	30 131	35 362	25	104	189	503	2 168
3. Aytos	40 749	42 187	252	128	251	932	1 242
4. Karnobat	6 965	26 047	70	-	-	144	795
5. Sungurlare	36 297	20 413	136	50	775	80	
6. Sredets	34 613	39 885	17	39	294	1 890	3 389
7. Ropotamo	9 696	15 419	88	12	88	77	522
8. Novo Panicharevo	19 542	20 593	133	8	-	226	39
9. Tsarevo	27 844	28 228	-	1	-	609	-
10. Gramatikovo	19 445	20 654	-	-	34	128	1 234
11. Kosti	12 650	12 994	57	-	79	248	-
12. Malko Tarnovo	30 845	20 776	3	2	162	134	3 985
13. Zvezdets	-	19 752	-	18	-	1 394	3 834
Total	**290 744**	**320 394**	**1 208**	**640**	**2 034**	**6 996**	**18 772**
XVI. DISTRICT OF YAMBOL							
1. Tundja, Yambol	19 384	20 376	-	33	18	110	907
2. Elhovo	26 857	31 289	194	703	214	721	2 524
Total	**46 241**	**51 665**	**194**	**736**	**232**	**831**	**3 431**
XVII. DISTRICT OF SLIVEN							
1. Sliven	43 370	44 827	513	38	-	300	294
2. Kotel	37 776	40 771	40	2	-	565	1 079
3. Tvarditsa	27 279	27 140	-	3	-	236	60
4. Nova Zagora	9 921	10 352	83	-	-	99	436
5. Ticha	12 505	12 983	-	12	568	73	638
6. Stara reka	7 536	8 155	-	21	-	67	713
Total	**138 387**	**144 228**	**636**	**76**	**568**	**1 341**	**3 220**
XVIII. DISTRICT OF STARA ZAGORA							

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
1. Stara Zagora	34 935	36 986	1 008	75	120	143	89
2. Chirpan	21 877	24 646	46	20	572	375	1 174
3. Mazalat	27 878	35 082	171	99	-	147	1 207
4. Gurkovo	21 668	22 493	-	-	-	356	-
5. Maglij	25 675	24 317	19	122	54	539	131
6. Kazanlak	28 956	24 410	14	37	-	-	427
Total	**160 989**	**167 934**	**1 258**	**353**	**746**	**1 560**	**3 028**
XIX. DISTRICT OF HASKOVO							
1. Haskovo	77 076	81 839	-	1 896	567	1 644	121
2.Topolovgrad	20 955	21 574	146	172	240	369	275
3. Svilengrad	25 647	28 067	607	276	354	1 807	178
4. Ivaylovgrad	44 385	48 956	104	65	244	1 685	1 623
Total	**168 063**	**180 436**	**857**	**2 409**	**1 405**	**5 505**	**2 197**
XX. DISTRICT OF KARDJALI							
1. Kardjali	35 637	22 310	4	5	-	-	29
2. Jenda	3 517	16 964	-	7	-	3	36
3.Momichilgrad	54 424	24 698	21	8	-	-	16
4. Kirkovo	-	29 155	-	2	-	-	-
5. Krumovgrad	42 794	43 205	18	2	-	24	34
6. Ardino	18 339	18 623	9	1	9	16	-
Total	**154 711**	**154 955**	**52**	**25**	**9**	**43**	**115**
XXI. DISTRICT OF SMOLYAN							
1. Smolyan	22 570	29 438	27	46	148	2 143	493
2. Zlatograd	33 180	32 409	-	-	80	27	-
3. Smilyan	30 858	32 028	-	-	11	1 028	-
4. Slaveyno	27 126	29 005	-	-	39	459	-
5. Pamporovo	8 796	-	-	-	-	-	-
6. Chepelare	11 075	-	-	-	-	-	-
7. Hvoyna	11 588	27 280	37	273	895	125	63
8. Shiroka Laka	8 206	9 124	-	-	1	569	347
9. Mihalkovo	13 802	15 430	-	7	356	633	981
10. Izvora	2 255	17 699	12	3	43	569	826
11. Devin	12 879	-	-	-	-	-	-
12. Trigrad	7 731	10 044	256	36	628	595	784
13. Borino	10 476	12 597	-	4	837	160	1 031
14. Dospat	19 421	20 577	5	35	138	461	457
Total	**219 963**	**235 631**	**337**	**404**	**3 176**	**6 769**	**4 982**
XXII. DISTRICT OF PLOVDIV							
1. Plovdiv	25 618	23 715	543	144	-	945	5 255
2. Hisar	23 815	26 157	1 078	50	283	456	651
3. Klisura	7 216	20 731	52	61	-	-	516
4. Rozino	12 472		-	-	-	-	-

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
5. Karlovo	28 649	30 590	49	55	148	1 130	668
6. Chekeritsa	12 849	31 691	28	26	609	455	901
7. Parvomai	9 796	9 706	112	23	-	177	-
8. Asenovgrad	24 633	28 076	86	285	125	1 670	988
9. Kormisosh, Laki	19 347	21 365	200	34	1 099	612	144
10. Krichim	7 978	-	-	-	-	-	-
Total	**172 373**	**192 031**	**2 148**	**678**	**2 264**	**5 445**	**9 123**
XXIII. DISTRICT OF PAZARDJIK							
1. Pazardjik	24 922	26 158	-	27	-	149	483
2.Panagurishte	38 617	39 095	371	50	-	-	207
3. Belovo	22 307	23 375	44	52	357	199	663
4. Yundola	4 977	4 933	-	1	-	-	-
5. Alabak	26 606	26 001	107	121	-	238	457
6. Chepino	2 573	19 504	-	-	18	136	135
7. Chehlyovo	15 078	-	-	-	-	-	-
8. Selishte	15 677	16 126	80	14	-	122	211
9. Shiroka Polyana	15 539	10 942	-	-	-	86	148
10. Rodopi	2 651	19 966	-	1	-	121	181
11. Beglika	12 601	-	-	-	-	-	-
12. Borovo	14 747	15 348	-	-	-	104	478
13. Batak	9 627	10 026	-	-	-	99	238
14. Rakitovo	18 771	19 614	92	109	70	15	379
15. Peshtera	18 873	19 676	476	118	21	17	203
Total	**243 566**	**250 764**	**1 170**	**493**	**466**	**1 286**	**3 783**
XXIV. DISTRICT OF BLAGOEVGRAD							
1. Blagoevgrad	24 418	29 001	16	131	345	2 490	2 559
2. Simitli	31 387	34 172	422	235	301	1 080	388
3. Kresna	21 625	23 062	-	-	92	235	431
4. Strumyani	18 780	21 015	-	3	-	148	970
5. Parvomay	18 629	17 970	252	43	-	442	-
6. Petrich	10 899	11 451	-	-	-	260	79
7. Sandanski	22 412	22 543	242	-	57	290	107
8. Katuntsi	26 629	28 193	-	-	62	48	910
9. Gotse Delchev	28 955	29 327	46	42	129	176	-
10. Dikchan, Satovcha	18 115	18 640	60	91	-	-	-
11. Garmen	24 907	27 039	40	8	-	62	-
12. Mesta	16 925	11 567	49	82	1	6	-
13. Dobrinishte	12 116	18 984	29	80	359	639	429
14. Eleshnitsa	16 607	16 814	179	132	-	546	1 065
15. Yakoruda	20 161	21 635	1 162	688	-	-	-

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
16. Belitsa	10 591	11 265	100	269	-	218	907
17. Razlog	18 269	19 596	112	54	461	-	-
Total	**341 425**	**362 284**	**2 709**	**1 858**	**1 807**	**6 640**	**7 845**
XXVI. DISTRICT OF KUSTENDIL							
1. Osogovo	46 737	58 598	-	-	868	5 990	3 175
2. Nevestino	21 703	23 166	407	525	510	497	516
3. Dupnitsa	46 798	48 973	-	-	-	450	2 561
Total	**115 238**	**130 737**	**407**	**525**	**1 378**	**6 937**	**6 252**
XXVII. DISTRICT OF PERNIK							
1. Radomir	25 248	20 589	3 834	216	-	124	135
2. Zemen	15 506	18 484	28	53	740	764	1 743
3. Breznik	8 939	10 415	153	110	-	980	176
4. Tran	30 547	33 947	956	2	797	713	421
5. Vitoshko-Studena	-	8 878	-	-	-	-	128
Total	**80 240**	**92 313**	**4 971**	**381**	**1 537**	**2 581**	**2 603**
XXVIII. DISTRICT OF SOFIA							
1. Sofia	45 229	55 423	-	2 383	-	3 223	3 175
2. Svoge	46 447	45 198	-	405	240	266	221
3. Vitinya	9 179	17 295	-	-	-	-	-
4. Botevgrad	40 797	33 957	-	111	-	1 425	307
5. Godech	10 182	11 107	-	5	14	243	626
6. Etropole	20 994	22 779	144	11	-	1 335	264
7. Pirdop	43 526	45 228	-	46	-	824	883
8. Elin Pelin	25 157	22 129	25	74	150	629	22
9. Aramliets		7 534	-	27	-	3	-
10. Ihtiman	26 682	25 622	-	56	214	625	1 275
11. Kostenets	19 409	21 228	14	208	316	409	265
12. Samokov	65 481	68 994	-	-	192	2 607	14
13. Iskar	3 297	3 470	-	-	-	-	128
Total	**356 380**	**379 964**	**183**	**3 326**	**1 126**	**11 589**	**7 360**
Total for the Country	3 531 825	3 849 576	29 026	29 144	33 411	116 794	109 376

Therefore, the net increase in forest areas plus the annual deforestation areas must represent the annual AR areas:

$$AR_x = FL_x - FL_{x-1} + D_{SMx}$$

Where,

AR – AR area

X - year

FL – forest area

D_{SM} – D area for settlements

The assessment of the former land use of the identified AR units of land was made by using an expert judgment. Land use (cropland, grassland, other land) typically follows ecological site condition. The forestry experts know the dominating land uses in the SFE region or at the region of identified AR lands, so they made an expert judgment of former land use on basis of likelihoods. For example, there are regions where grassland (GL) dominates, because growth/site conditions are not good enough for cropland (CL) plants or CL management or, site conditions are so good that CL dominates. Similarly, other land (OL) can be found in extreme site conditions where CL, GL cannot grow.

Reporting of D units of land:

All changes of designation of forests are registered in Executive Forest Agency (ExFA) for every single year since 2001. The registry contains administrative information in relation with the orders issued for excluding of forests. For the years before 2001 data on forest loss is available for the period 1990-1994. The information is provided by the experts from ExFA and is gathered from specific books, where all changes of designation of forest for these years were written up. There is no activity data on forest loss for the period of years 1995-2000, so the forest loss for these years is estimated as an average from the forest loss for the period 1990-1994. Since Bulgaria uses the national boundary as a geographical boundary for reporting of activities under Article 3.3 of KP the total amount of changes in designation of forests and lands from forest fund was used as data source for D reporting. All changes of designation of forests are associated with conversion from forest land to settlement (SM) and are reported as such. In its previous submission Bulgaria reported forest loss also for Wetlands (WL) due to probability reasons. It was assumed that the observed increase in WL suggested also a deforestation for WL. The assumed D for WL was estimated as a share of forest land in the totals of forest land, cropland plus grassland (it was supposed that the wetlands increase comes from such lands). Actually, the reported D area to WL in the previous submissions of Bulgaria represented an overestimation of D activities since all the information for forest loss due to changes in designation of forest was reported under D to SM. Since the improvements in area representation made for the Submission 2014 LUCs from FL to WL were not calculated. According to experts from the ExFA, the changes of designation of forest in the years 1990-2012 are associated with conversion only to SM. There is only one new dam lake (Tsankov kamak) which was built up in recent years but the forest loss associated with its construction works has been already reported in the 70's. Therefore, Bulgaria reports all information provided by the ExFa for forest loss across the time series (3.76 kha) as D activity associated with conversion to SM.

Reporting of FM area

All forests are managed, so to get FM area we used data for total forest area in 1990 and then for the years after we subtracted the cumulative areas of ARD.

11.2.3 MAPS AND/OR DATABASE TO IDENTIFY THE GEOGRAPHICAL LOCATIONS, AND THE SYSTEM OF IDENTIFICATION CODES FOR THE GEOGRAPHICAL LOCATIONS

The database used to identify the geographical locations of the ARD activities is the NFI in Bulgaria. All measurements gathered in accordance with the forest inventory and FMP are mapped. Forest Inventory and FMP are carried out for each State Forest Enterprise. The SFE is divided into compartments and sub-compartments. The forest maps in Bulgaria are carried out for each State Forest Enterprise (SFE) as a result of the Forest Inventory (therefore, the maps are updated every 10th year for each SFE). The country territory is divided into almost 180 State Forest Enterprises. The territory of one SFE may include the territory of one or several municipalities. The area of one sub-compartment or forest management unit is between 1-25 ha, when forested. The area of the non-

forested unit is 0,1 ha. The sub-compartments are defined based on uniformity of stands by species, age class structure, etc. The forest maps have unified consecutive numbering in the adopted geodesic coordinating system (BG, 2000), and contain information on areas or parts of them with permanent use as forests according to the Forest act. Forest maps are maintained separately by Forestry enterprises according to their FMP.
The forest maps give detailed data on:

- state boundary and all administrative boundaries in the scope of the particular map
- the boundaries of the urbanized areas
- the boundaries of the transportation areas
- the boundaries of the agricultural lands
- the boundaries of the State forestry enterprises and State game management areas and their subdivisions (forestry compartments and subcompartments)
- main and secondary watersheds
- roads, track and underground line facilities, within the boundaries of the forestry departments

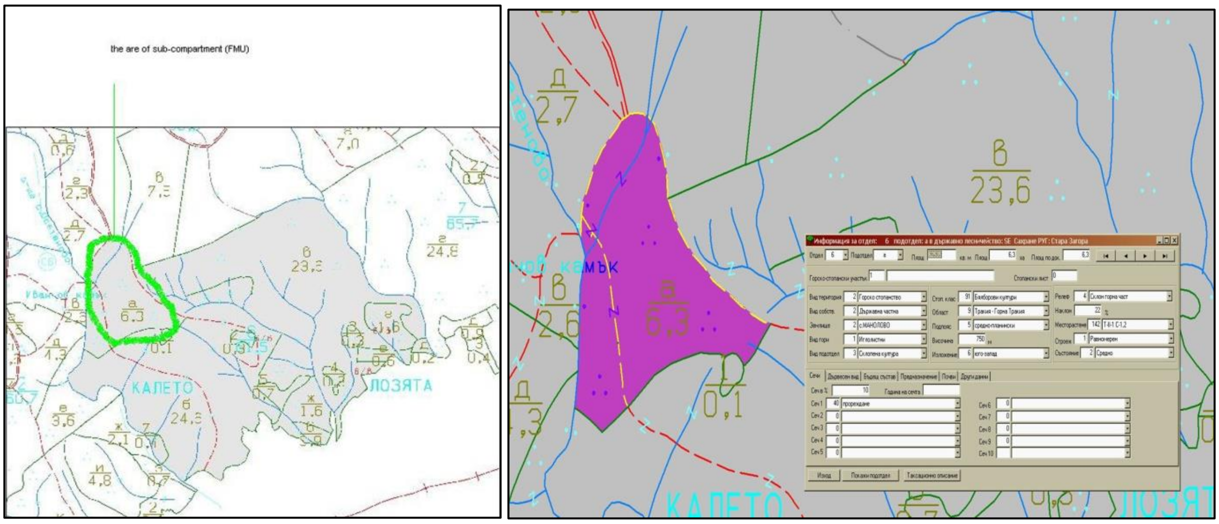


Figure 139 A map of one SFE (on left side), showing a forest land compartment (in grey colour and) and a sub-compartment (green line). On the right side - the area of sub-compartment and its details in the table.

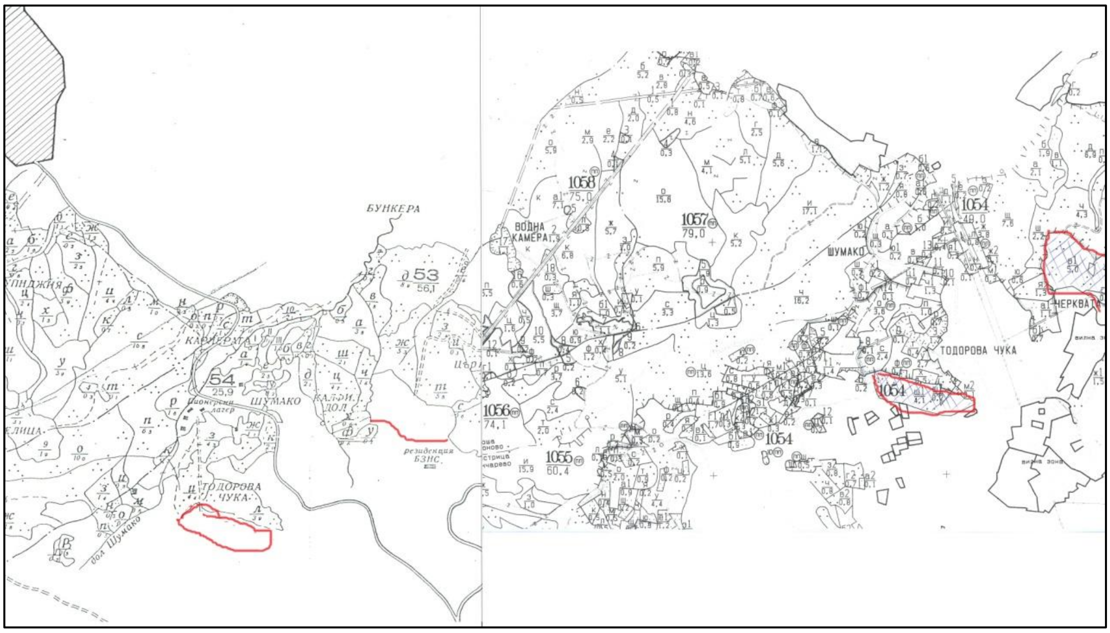


Figure 140. A map of the area of one SFE before (left) and now (right), which trace the changes in the forest land (in red).

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

The methodologies and assumptions used for the reporting under the Kyoto Protocol Art. 3.3. and Art. 3.4 follow completely these for the areas of LUCs from and to forests (see Chapter 6.3.2).

The emission factors were estimated in the following manner:

11.3.1.2 Biomass

For FM

Bulgaria follows IPCC Guidelines 2006 and applies the stock-difference method when defining carbon stock changes in living biomass. Conversion coefficients used are specific for Bulgaria and the ones given in the IPCC 2006 tables. The main database includes: forest area by type (coniferous, deciduous and out of yield), forested area by tree species and age-class structure, and the volume stock (stem wood and branches) by forest type and tree species obtained from the reporting forms (1, 2 and 3 RFs). To calculate the changes in the carbon stock of the living biomass Method 2 is used.
The emissions and removals associated with FM activities are reported for coniferous and deciduous forests, but the reported figures are the sum of the most common tree species from these forest types. Thus, the strata used in the calculations is as follow:

3. Coniferous:
    - Scots pine
    - Norway spruce
    - Black pine
    - Silver fir
    - Other conifers
4. Deciduous:
    - Oak
    - Beech
    - Poplar
    - Others

This stratification reflects the main tree species distribution in Bulgaria. The reason to put the poplars into a separate stratum is that these forests are fast growing forests and are managed in a completely different way from the rest of the broadleaved forests.
The methods for estimating the carbon stock changes follow those used in FLrFL category. For more information on biomass conversion and expansion factors used, refer to Chapter 5 on LULUCF, Forest land category.
The annual stock changes in biomass pool are obtained by estimating the difference between the years for which biomass stock by tree species is estimated divided by 5 (1990,1995, 2000, 2005, 2010, 2015). Then the stock changes by tree species are multiplied by their area on FM in order to estimate the annual emissions/removals from the pool for this activity.
Emissions/removals from subcategory "out of yield" are not estimated considering that they are insignificant as these forests cover around 0.5% of the wooded lands. Out of yield category encompass the area of mountain pine in BG, which are forests according to forest definition in the country. We report only area to be consistent with the forest definition in country.

For ARD activities

To determine the annual increase in carbon stock in biomass due to growth on lands converted to FL (ΔC_G), data on growing stock (stemwood and branches) for the first age class (1-20 years) has been used. The growing stock of the stands of Ist and IInd age classes for coniferous and deciduous forests was divided by the average age of 10 years. This was done for all years when data on volume per age-class and area (RF2 and RF3) are available – 1995, 2000, 2005, 2010, 2015. Once we obtained the weighed mean by forest type (coniferous and deciduous) for these years an average of them equals to 6.03 m^3/ha/y for the stands of Ist age class and 11.89 m^3/ha/y, which represents the average annual growth. In order to convert the average annual growth for these age classes to an average annual biomass growth, biomass conversion and expansion factors have been used as shown in the table below. To estimate the carbon stock, the coefficient for carbon content as shown in the table 255 has been used.

Table 268 Expansion and conversion factors used to convert the average annual increment of stands of Ist age class into average annual biomass growth for Ist age class

	BEF2		D		R		CF	
Age class	0-20 y	21-40 y	0-20 y	21-40 y	0-20 y	21-40 y	0-20 y	21-40 y
coniferous	1.09	1.13	0.48	0.48	0.40	0.40	0.51	0.51
deciduous	1.02	1.04	0.62	0.61	0.46	0.46	0.48	0.48
weighted mean	1.07	1.10	0.52	0.52	0.42	0.42	0.50	0.50

BEF_2 coefficient adds the biomass of the leaves and needles. The values of BEF_2 for coniferous and deciduous forests are estimated as a weighted mean considering the volumes of different coniferous and deciduous species. To estimate the average $BEF_{2,}$ data from literature sources on results from ecosystem studies for Spruce, Scots pine, Beech and Oaks for the Ist and IInd age classes were used (compiled in Korner et al.1993).

Basic wood densities for the Ist and IInd age class of coniferous and deciduous forests are estimated as a weighted mean considering the share of the volume of coniferous and deciduous species for these age classes. Country-specific data on the basic wood density of the main tree species were used (compiled by Bluskova, G., 1994; Enchev, E., 1984).

The coefficient for the ratio of the below-ground biomass to above-ground biomass is estimated as a weighted mean considering the share of the volume of coniferous and deciduous forests. The estimates are based on the default values for R (table 4.4 2006 IPCC GIs) for the biomass stock <50 tonnes d.m per ha for coniferous and <75 tonnes d.m per ha for hardwoods.

The carbon fraction is again estimated as a weighted mean.

Like this, the calculated the biomass growth equals to 2.39 tC/ha for the stands of first age class and 4.84 tC/ha for stands in second age class. The average biomass growth for the first age class (2.39 tC//ha/yr) is applied for forest cohorts up to 20 years, while the average biomass growth for the second age class (4.84 tC/ha/yr) is applied for forest cohorts greater than 21 years.

The biomass stock on lands before the conversion depends on the type of land and its vegetation. The average biomass stock for the respective land types converted to FL is:

- Annual cropland – 3,56 tC/ha
- Perennial cropland – 4.49 tC/ha
- Pastures and meadows – 6.58 tC/ha
- Shrubs and grasslands – 5.24 tC/ha
- Other land – 0 tC/ha

More information on how the average biomass stocks of these lands have been estimated can be found in the respective chapters in LULUCF sector of NIR.

For estimating biomass loss associated with deforestation, data from NFI on volume stock over bark was used. The data on volume stocks over the five years period since 1990 was expanded and converted with the related country specific (or default) expansion/conversion factors: wood density (0.43 t/m3 for coniferous, 0.60 t/m3 for deciduous), stemwood plus branches expanded to the whole aboveground tree biomass (1.08 for coniferous, 1.03 for deciduous), root-to-shoot ratios (0.29 for coniferous, 0.24 for deciduous) and C-content (0.51 tC/t d.m. for coniferous and 0.48 tC/t d.m for deciduous). Then it was estimated the share of the coniferous and deciduous stocks in the total biomass stock for the respective years. Like this the weighted means for tree biomass stock were calculated. The means were used for estimating biomass loss from deforestation for the years across the time series.

Table 269 Living forest biomass stocks which are used to calculate emissions from deforestation

		1990	1995	2000	2005	2010	2015 – 2018
Weighted mean tree biomass stocks	tC/ha	45.47	50.89	55.19	57.10	62.71	65.86

For the biomass growth on settlements after deforestation the following values were taken: 2.00 $tCha^{-1}y^{-1}$ and 0.68 $tCha^{-1}y^{-1}$ for annual and perennial plants respectively. Growth of annual plants is accounted only in the year of D, while the growth of the perennial plants at the D areas continues.

11.3.1.3 Dead wood

Due to the young age of the forests at the AR areas it is assumed that there is no dead wood and there is no change in this carbon stock at AR areas. If there was any in the young forests of AR areas it would represent a C stock increase due to the lack of dead wood in the previous land uses. So, the assumption is conservative.

For estimating changes in DW stock due to deforestation activity an average carbon stock in DW have been used. The average stock is estimated by the weighted mean of the DW stock in coniferous and deciduous forests. The resulting values are given in the table below.

Table 270 Dead wood stocks used for estimating the changes in DW pool after deforestation

		1990	1995	2000	2005	2010	2015 - 2019
DW stock	tC/ha	3.15	3.15	3.51	3.92	4.20	4.47

11.3.1.4 Litter

According to IPCC definition litter pool includes all non-living biomass in a various state of decomposition, so this means – litter layer (fresh dead plant material), fumic and humic layers. As it was explained in chapter Forest remaining forest, changes in carbon stock in soil the source of information in order to estimate a country specific value for the carbon stock in litter is EEA-MOEW. The database resulted from the implementation of the ICP "Assessment and Monitoring of Air Pollution Effects on Forests"-UN/ECE Convention on Long Range Transboundary Air Pollution.

When analyzing carbon content in litter Bulgaria follows ICP Forests Manual methodological approach http://www.icp-forests.org/pdf/FINAL_soil.pdf (see Annex 7 Soil horizon designation p.195) where litter definition is:

> OL-horizon (Litter, Förna): this organic horizon is characterized by an accumulation of mainly leaves/needles, twigs and woody materials (including bark), fruits etc. This sublayer is generally indicated as litter. It must be recognized that, while the litter is essentially unaltered, it is in some stage of decomposition from the moment it hits the floor and therefore it should be considered as part of the humus layer. There may be some fragmentation, but the plant species can still be identified. So, most of the original biomass structures are easily discernible. Leaves and/or needles may be discolored and slightly fragmented. Organic fine substance (in which the original organs are not recognizable with a naked eye) amounts to less than 10 % by volume.

According to IPCC definition this represents the "litter layer" (a horizon consisting of relatively fresh dead plant material). For Bulgaria there is no data gathered for the carbon content in this layer during the soil surveys. However, since the changes in biomass fully account for all leaves and needles (the tree biomass estimates accounts for these pools) that represent the material of the litter layer within one year. Any further accounting of this material would result in double accounting.

OF-horizon (fragmented and/or altered) is a zone immediately below the litter layer. This organic horizon is characterized by an accumulation of partly decomposed (i.e. fragmented, bleached, spotted) organic matter derived mainly from leaves/needles, twigs and woody materials. The material is sufficiently well preserved to permit identification as being of plant origin (no identification of plant species). The proportion of organic fine substance is 10% to 70% by volume. Depending on humus form, decomposition is mainly accomplished by soil fauna (mull, moder) or cellulose-decomposing fungi. Slow decomposition is characterized by a partly decomposed matted layer, permeated by hyphae.

OH-horizon (humus, humification): characterized by an accumulation of well-decomposed, amorphous organic matter. It is partially coprogenic, whereas the F horizon has not yet passed through the bodies of soil fauna. The humified H horizon is often not recognized as such because it can have friable crumb structure and may contain considerable amounts of mineral materials. It is therefore often misinterpreted and designated as the Ah horizon of the mineral soil and not as part of the forest floor as such. To qualify as organic horizon, it should fulfil the FAO requirement, as described above. The original structures and materials are not discernible. Organic fine substance amounts to more than 70% by volume. The OH is either sharply delineated from the mineral soil where humification is dependent on fungal activity (mor) or partly incorporated into the mineral soil (moder).

According to the ICP Forests Manual samples are taken separately for the different depth. OH and OF layers should be sampled together (see Table 5, p. 15 ICP Forests Manual). The data is available for each depth

The estimation for the model carbon stock in litter pool is based on data for carbon content in OFH layers available for the years 2000 – 2002. According to the data available it was estimated that the carbon stock in litter is 5.38 tC/ha.

11.3.1.5 Soil

Emissions/removals of carbon stock in the mineral soils due to AR were evaluated through the annual change in the carbon stock at the AR areas using the equation:

$$\Delta \boldsymbol{C}_{\boldsymbol{LFmineral}} = \frac{\left[\left(\boldsymbol{SOC}_{\boldsymbol{av.fl}} - \boldsymbol{SOC}_{\boldsymbol{non-frest\ land}}\right) \cdot \boldsymbol{A}_{\boldsymbol{aff}}\right]}{\boldsymbol{T}_{\boldsymbol{aff}}}$$

where:

$\Delta C_{LFmineral}$ - annual change in the carbon stock in mineral soils in the year of assessment, tones C/yr

SOC_{av} – carbon stock in forests for a certain soil type, tones C/ ha

$SOC_{non-frest\ land}$ - stable carbon stock in the soil of the previous type of land-use (croplands, grasslands and other lands), tones C/ ha

A_{aff} - total af-/reforested area after the conversion, ha

T_{aff} - duration of the transition from SOC Non forest Land to SOCref, yr

The used transition period was 20 years according to IPCC GPG.

For the stable stock of organic carbon in soils (0-30 cm) from forest ecosystems (SOCav.) a country specific value is used = 61.86 tC/ha.

For the stable stock of organic carbon in soils (0-30 cm) of previous types of land-use the country specific values obtained for annual or perennial cropland, grassland and other land are used:

- annual crops: 67.74 tC/ha
- perennial crops: 67.49 tC/ha
- Pastures and meadows: 72.77 tC/ha
- Shrubs and grasslands: 86.96 tC/ha
- other land: 51.8 (IPCC 2006)

For C stock changes in soils of D areas the same approach and values as for AR areas were used, but with an appropriate reverse equation. The soil C stock (0-30 cm) used for settlements is:

- Settlements: 19.7 tC/ha

A description of the methods of deriving all these soil C stocks can be found in the respective chapters of these subsectors.

11.3.1.6 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Deadwood is assumed not to occur on AR areas. Due to the young age of the forests at AR areas (since 1990) and the assumed lack of dead wood at areas of all other land uses it is assumed that a stock change of dead wood does not occur at AR areas. If there was any in the young forests of AR areas it would represent a C stock increase due to the lack of dead wood in the previous land uses. So, the assumption is conservative.
There is no practice of biomass burning at ARD areas in Bulgaria. Furthermore, forests are not fertilized and liming does not exist in Bulgaria. So, fertilization at AR areas and liming at ARD areas do not occur.

Emissions and removals from litter and soil under FM are reported following the T1 assumption that the pool is not a source. Justification on that is provided in Chapters 6.3.3.1.2.2 and 6.3.3.1.3.

11.3.1.7 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Emissions have been estimated for all situations where C losses in mineral soils occur (according 2006 IPCCC Guidelines), based on equations 11.1, 11.2, 11.8.
The ratio C/N in the mineral soils for categories CL and GL and their subcategories are derived based on the data gathered from the soil inventory in Bulgaria (available since 2005). For the FL category we use the default value – 15, from 2006 IPCC Guidelines. N_2O emissions from N mineralization associated with a loss of soil organic matter are presented in the table below.

Table 271 N_2O emissions in ARD land from N mineralization associated with a loss of soil organic carbon

	AR (CL to FL)	AR (GL to FL)	D (FL to SM)
1990	0.13	1.79	0.04
1991	0.26	3.62	0.14
1992	0.39	5.52	0.33
1993	0.52	7.42	0.36
1994	0.65	9.37	0.42
1995	0.78	11.35	0.42
1996	0.91	13.36	0.42
1997	1.04	15.42	0.42
1998	1.17	17.51	0.43
1999	1.30	19.63	0.51
2000	1.43	21.74	0.58
2001	1.61	25.61	0.59
2002	1.80	29.59	0.67
2003	1.99	33.56	0.73
2004	2.17	37.52	0.79
2005	2.36	41.47	0.93
2006	2.55	45.46	1.04
2007	2.74	49.55	1.25
2008	2.93	53.82	1.86
2009	3.12	57.97	1.93

	AR (CL to FL)	AR (GL to FL)	D (FL to SM)
2010	3.18	60.37	2.12
2011	3.23	62.66	2.10
2012	3.29	64.93	2.08
2013	3.35	67.32	2.39
2014	3.41	69.56	2.44
2015	3.47	71.90	2.87
2016	3.54	74.14	3.22
2017	3.60	76.31	3.57
2018	3.66	78.33	3.67
2019	3.72	80.48	4.06

11.3.1.8 Changes in data and methods since the previous submission (recalculations)

- Small changes in the distribution of other land uses in the AR estimates due to some changes in area calculations which are explained in Chapter 6.1.7.
- The losses dead wood due to deforestation have been recalculated as new approach for defining the dead wood stock in the forest have been implemented
- N_2O Emissions from N mineralization associated with a loss of soil organic matter have been recalculated in relation with the recalculation explained in the first bullet.
- The emissions from mineral soils related with the AR activities from GL have been recalculated after a found error in the estimation of the av. SOC in Shrubs and grassland subcategory.
- Recalculation in FM to include the area "out of yield" as recommended by the ERT
- Recalculation in DW estimates in FL. More information is presented in Chapter 6.3.5
- Recalculation in living biomass for 1990-2000. More information in Chapter 6.3.5
- Recalculations in HWP are due to updated information for the time series from FAO.

11.3.1.9 Uncertainty estimates

The uncertainty in the estimates is assumed to be close to those reported in FL category under the Convention reporting.

11.3.1.10 Information on other methodological issues

The methods used to estimate emissions/removals from ARD and FM activities are of the same tier method as those used for the UNFCCC reporting.

11.3.1.11 The year of the onset of an activity, if after 2008

Bulgaria reports all area subject to the activities under 3.3 and FM since 1990. This information is available in the CRF tables in NIR-2 table.
Concerning FM all forests in Bulgaria are managed, therefore all activities which are carried out in the forests are considered human-induced and those activities were already in place before the starting of the first commitment period of the Kyoto Protocol.

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 DIRECT HUMAN-INDUCED

Changes in forest area are traced only after a forest inventory has been performed. Bulgaria reports the following AR activities that occurred on or after 1990:

- Planted or seeded on grasslands and croplands (97% from the total AR units of land due to planting and seeding on GL and around 1% on CL)
- Planted or seeded on other land for protective purposes (i.e erosive lands – around 2% from the total AR units of land due to planting and seeding)
- Abandoned lands – cropland and grassland which are naturally regrown as forest (20% from the total AR units of land due to regrowth on croplands and 80% - regrowth on GL

Table 272 Identified net AR units of land for the period 1992-2012 for each district in Bulgaria[37]

District	Regrowth in ha. 1992-2000	Regrowth on CL	Regrowth on GL	Regrowth in ha 2001-2012.	Regrowth on CL	Regrowth on GL	Planted or manually seeded in ha 1992-2000	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas	Planted or manually seeded in ha 2001-2012	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas
Vidin	**1508**	257	1251	**8560**	2072	6488	**620**	-	496	124	**27**	-	27	-
Montana	**567**	186	381	**2301**	294	2007	**60**	-	56	4	**2343**	-	2313	30
Vratsa	**2397**	330	2067	**1934**	121	1813	**757**	12	735	10	**670**	-	624	46
Pleven	**4767**	1656	3111	**3199**	576	2623	**973**	122	851	-	**40**	-	40	-
Lovech	**660**	85	575	**8339**	827	7512	**348**	-	321	27	**3865**	-	3841	24
Gabrovo	**2852**	973	1879	**9245**	2370	6875	**35**	-	35	-	**18**	-	18	-
Veliko Tarnovo	**17**	-	17	**13037**	1440	11597	**715**	15	689	11	**1639**	-	1597	42
Rousse	**-**	-	-	**2643**	303	2340	**-**	-	0	-	**3573**	-	3569	4
Targovishte	**1864**	566	1298	**1898**	431	1467	**903**	25	864	14	**804**	-	804	-
Shumen	**851**	33	818	**3724**	568	3156	**1472**	4	1421	47	**41**	-	41	-
Razgrad	**-**	-	-	**665**	45	620	**775**	5	770	-	**1235**	-	1213	22
Silistra	**158**	67	91	**1614**	209	1405	**341**	-	341	-	**1646**	-	1643	3
Dobrich	**149**	-	149	**1132**	138	994	**4831**	20	4767	44	**621**	-	621	-
Varna	**873**	398	475	**980**	257	723	**1066**	1	1031	34	**718**	-	714	4
Burgas	**2034**	469	1565	**6996**	1172	5824	**1208**	6	1175	27	**640**	-	636	4
Yambol	**232**	61	171	**831**	125	706	**194**	-	189	5	**736**	-	724	12
Sliven	**568**	214	354	**1341**	222	1119	**636**	-	622	14	**76**	-	76	-
Stara Zagora	**746**	174	572	**1560**	213	1347	**1258**	5	1218	35	**353**	-	344	9
Haskovo	**1405**	509	896	**5505**	480	5025	**857**	3	806	48	**2409**	-	2405	4
Kardjali	**9**	4	5	**43**	10	33	**52**	1	49	2	**25**	-	24	1
Smolyan	**3176**	644	2532	**6769**	843	5926	**337**	-	324	13	**404**	-	401	3
Plovdiv	**2264**	416	1848	**5445**	386	5059	**2148**	16	2058	74	**678**	-	670	8
Pazardjik	**466**	65	401	**1286**	88	1198	**1170**	9	1131	30	**493**	-	481	12
Blagoevgrad	**1807**	445	1362	**6640**	857	5783	**2709**	15	2669	25	**1858**		1795	63
Kustendil	**1378**	410	968	**6937**	614	6323	**407**	10	373	24	**525**	-	509	16
Pernik	**1537**	214	1323	**2581**	335	2246	**4971**	51	4859	61	**381**	-	358	23
Sofia	**1126**	234	892	**11589**	1694	9895	**183**	-	183	-	**3326**	6	3164	156

[37] Data for AR units of lands by district for 2013, 2014 and 2015 is missing because the data for these years is extrapolated. The table with the data up to 2012 is provided for transparency reason.

District	Regrowth in ha. 1992-2000	Regrowth on CL	Regrowth on GL	Regrowth in ha 2001-2012.	Regrowth on CL	Regrowth on GL	Planted or manually seeded in ha 1992-2000	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas	Planted or manually seeded in ha 2001-2012	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas
Total	**33411**	8410	25001	**116794**	16690	100104	**29026**	320	28033	673	**29144**	6	28652	486

Table 273 Total AR estimates for the period 1990-2012

Years	AR	FLx - FLx-1	Planted or manually seeded (kha)	Naturally seeded (kha)	Dx
2014	12.32	12.17	2.43	9.73	0.15
2013	12.63	12.17	2.43	9.73	0.46
1992-2012	211.94	208.38	58.17	150.21	3.57
1991	6.99	6.94	3.23	3.71	0.05
1990	7.08	6.94	3.23	3.71	0.15
Total	250.96		69.49	177.09	4.37

According to the Annex of Decision 16/CMP.1 art. 1 b) and c)[38] natural A/Rs occurred on abandoned arable lands have to be reported under art. 3.3. as this forest regeneration is based on a human induced promotion. Bulgaria reports these units of land consistent with the requirements. The re-growth in this case is the result of the direct human induced stop of the agricultural management at these lands, which in fact leads to a direct human induced natural seeding from the adjacent forests and (re-)growth of managed forests (all forests in Bulgaria are managed and reported as such).

It is good practice to provide documentation that all A/R activities included in the identified units of land are direct-human induced. "Relevant documentation includes forest management records or other documentation that demonstrates that a decision had been taken to replant or to allow forest regeneration by other means." This requirement is described in the Annex of Decision 15/CMP.1 art.8 a).

As it is described in the NIR on 11.2.2, all units of land subject to AR activities are identified from the revision of all Forest Management Plans for all State Forest Enterprises (SFE) in Bulgaria. The new forest area identified and reported as AR units is included in FMPs, which by itself is evidence that the AR area is direct-human induced. FMPs are considered by Bulgaria as documentations that demonstrate human induced activity. In addition to this, there is a specific administrative procedure when as a result of the forest inventory assessment an agricultural land (e.g CL and Gl) is identified as becoming a forest. The basis of this procedure is the owner's decision (please see art. 83 and 84 from the Forest Law 2011(last amendment 07.08.2012, SG №60). In the case when the new forest is less than 10 years old the land owner is informed on the risk of conversion of the agricultural land into forest land. If the land owner decides to keep the former agricultural land under agricultural use, he has to submit a declaration to the Executive director of the Executive Forest Agency. After the submission of the declaration, in 3 years term, the land owner is obliged to cut the re-grown forest vegetation and return the land into an active status of agricultural management. As a consequence of this procedure, it can be assumed that the lack of back conversion of such new forests into agricultural lands afterwards represents clear evidence for the nature of a land owner's decision of an intended land use change into forests.

According to the Forest Act 2011 this procedure is described in the following articles:

Art. 83. (1) Where as a result of the inventory of forest territories it is established, that the farm territories have acquired characteristics of a forest in the meaning of this law, the persons, who have performed the inventory shall produce to the Executive director of the a list of the properties upon the lands of the populated areas.

[38] *"Afforestation" is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources*
"Reforestation" is the direct human-induced conversion of non-forested land to forested
land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989

(2) The list under Para. 1 shall be published in one local and one central daily newspaper and shall be announced in public on the internet site of the relevant regional administration, Regional directorate of forests and the Executive Forest Agency.
(3) On the basis of the list under Para. 1, the Executive director of the Executive Forest Agency or an official, authorized by him shall invite in writing the owners of the relevant properties to declare if they wish to use their properties as farm or forest territories.
(4) ***Within 6-month term*** *from receiving the invitation under Para. 3, the owner,* ***who wishes to use his property as a farm territory*** *shall submit a declaration to the Executive director of the Executive Forest Agency.*
(5) If the owner fails to submit a declaration within the term under Para. 4, the Executive director of the Executive Forest Agency shall propose to the Minister of Agriculture and Food to issue an order for change of function of the properties as forest territory. The proposal shall describe the size of the properties, the type and origin of the forest and a plan of the property shall be attached from the map of the restored ownership or from the cadastre map and taxation characteristics.
(6) The order under Para. 5 shall be sent to the owner, to the relevant Regional directorate of forests, as well as to the relevant Office of geodesy, cartography and cadastre – for reflecting the change in the cadastre map and cadastre registers, or to the Municipal office of agriculture – for reflecting the change in the map of the restored ownership.
(7) The provisions of Para. 1 – 6 shall not apply to territories, provided to sites of the national security and defense.
Art. 84. (1) Where as a result of the inventory of the forest territories it is established, that farm territories have acquired the characteristics of a forest in the meaning of this law and the owner declares in writing before the Executive director of the Executive Forest Agency that he wishes to use his property as a farm territory within the term of 3 years from submitting the declaration he shall be obliged to clean his property from the forest timber vegetation.
(2) In case that within the term of Para. 1 the owner fails to clean his property from forest-timber vegetation, the provision of Art. 83, Para. 4 – 6 shall apply.
(3) Notwithstanding of the inventory under Para. 1, unfit for farm use territories may be included on the forest territories on the basis of a written application of the owner under Art. 83, Para. 5 and 6

When the new forest is older than 10 years, then this forested area belongs to the Forest Fund at once and the land owner cannot change the designation.
The old Forest Act did not contain specific procedure as the one described in the Forest Act 2011. However, under the old Forest act (1997-2011) the following have been taken into account:
The Forest Act (1997-2011) defines the term "Forest" (*"Art. 2. (1) (amend. SG 16/03) Forest, in the context of this law is the land occupied by forest ligneous plants with area not less than 1 decar (100м^2)*."). The Forest Act regulates the way of use and management of forests. The purpose of the law is ensuring the protection of the forest territory and increasing the area covered by forest. The subject of the Act includes only forest land and land within the Forest Fund and their management is done in accordance with the Forest Management Plans, programs and projects, as prescribed in Regulation № 6 on the structure of the forests and land included in the forest fund and the hunting reserves of Republic of Bulgaria. For the purpose of the management of the forests in the Forest management plans, programs and projects and the relevant reports that are integral part of them, all Afforestation and Reforestation activities in the Forest Fund are described in the Forest Act (1997-2011) (art.42(1)
Art. 42. (amend. SG 16/03) (1) (amend. – SG 64/07; amend. – SG 80/09) The afforestation in the forest fund shall be carried out according to the forest development projects, technical projects for fighting with the erosion and landslides, plans and programs under the conditions and by the order, determined with ordinance by the Minister of Agriculture and Food.

In cases when as a result of the natural regrowth agricultural land has become forest and has met definition of "forest" given by the Forest Act, this area should be managed as forest and is subject to forest inventory and therefore included in FMPs.
(*§ 9. (new – SG 28/92) Farm lands, in which the right of ownership has been restored by the order of art. 10 of this law and which are forests in the sense of the Law of the forests, shall be subordinated to the regime of the Law of the forests and the Law of the hunting economy (**LAW OF THE OWNERSHIP AND THE USE OF THE FARM LAND**)*)
As regards Deforestation activities, Forest Act clearly inscribes all cases in which forest is taken out of the Forest Fund (existing woods). This is followed by LUC and they are transformed from forested to non-forested lands. The procedure for taking out of the Forest Fund is given in the Forest Act (please see the respective articles below). **Therefore, all changes in the function or designation of the forests are considered as deforestation and are reported as such.**
All forests in Bulgaria are protected by the Forest Act.
Art. 3. (1) Decreasing the existing woods shall not be allowed:
1. on the territory of the Republic of Bulgaria;
2. on the territory of Municipalities, in which the woods are under 10%.

Forest Act (2009):

*Art. 14. (amend. SG 16/03) (1) Forests and lands of the forest fund **shall be excluded at change of their designation for:***
1. plots for construction of power plants, dams and other hydro-technical and electric-technical facilities, obtaining of underground resources, graveyard parks, waste depots, re-loading stations;
2. tracks for linear sites;
a) located on the surface of the terrain – roads, railways, water canals, cable cars, draglifts and other facilities for technical infrastructure;
b) located under the surface of the terrain – oil pipelines, gas pipelines, heat conduits and water supply pipeline with cross section over 1500 mm;
3. creating of new or expansion of the construction boundaries of existing urbanized territories (settlements and settlement formations), as well as creating or expanding of the boundaries of separate regulated landed properties out of them;
4. (amend. – SG 64/07) creating of new or expanding of the construction boundaries of existing urbanized territories (settlements and settlement formations), as well as creating or expanding of the boundaries of separate regulated landed properties out of them in the cases when disposing actions with payment have been implemented with forests and lands of the state forest fund, in which till March 1, 2003 construction has been implemented in the sense of art. 12 of the Law of Spatial Planning;
5. creating of lands for agricultural use from land not producing timber in the state forest fund;
6. sites, connected with the national security, the defense of the country, the preservation and the reproduction of environment.
(2) The exclusion of forests and lands from the forest fund after fire shall be prohibited for a term of 20 years.
(3) Para 2 shall not be applied in the several cases:
1. when the change of the designation is connected with the defense or the security of the country;
2. when the change of the designation is connected with the fulfillment of investment projects, approved by the Council of Ministers.

Procedure for exclusion:

*Art. 14d. (new – SG 16/03) (1) (amend. - SG 30/06, in force from 12.07.2006; amend. – SG 64/07; amend. – SG 54/08; amend. – SG 80/09) **The Minister of Agriculture and Food upon proposal by the Executive director of the Executive Agency of Forests shall issue an order for excluding of the forests and the lands from the forest fund or propose to the Council of Ministers to take decision***

Forest Act 2011

Art. 73. (1) Change of the function of land properties in forest territories shall be admitted for:
1. grounds for construction of transport equipment (ports, airports, railway stations, bus-stations) production undertakings, extraction of ores and minerals, graveyards, waste depots, waste banks, depositories, electric power stations, damps,

purifying stations for drinking or waste waters and other hydro-technical and electro-technical equipment, with the exception of the fundaments of the electric line posts;
2. permanent ways of line objects, placed on the surface of the ground – roads and railway lines, including the equipment to them, water canals;
3. creating new or expanding construction borders of existing urban territories in the cases where there are adopted general territorial plans of the Municipalities or parts of them, in which the properties are situated;
4. creating or expanding separate regulated land properties, which are not state ownership, for which there is an enforced general territorial plan;
5. national sites in the meaning of the Law on State ownership, sites, related to the national security and defence of the country, to the environment protection, for whose construction there is a Council of Ministers decision, as well as Municipal sites of first importance in the meaning of the law on the Territory Planning;
6. construction of posts for lifts and tow-lifts, as well as basic equipment of the wind-generators and photo-voltaic parks;
7. construction of ski-tracks.

Procedure for exclusion:

Art. 74. (1) ***Change of function of land properties in forest territories – public state ownership shall be done by a Council of Ministers decision upon proposal of the Minister of Agriculture and Food. The change of function of forest territories – public state ownership shall be done only for construction of sites, which are state or Municipal ownership.***
(2) The change of function of land properties in forest territories apart from the ones, indicated in Para. 1 shall be done:
1. by a commission in the Regional directorate of forests – for land properties in forest territories with area up to 50 decares falling in the territorial scope of activity of the relevant Regional directorate of forests;
2. by a commission in the Executive Forest Agency – for land properties in forest territories apart from the ones, indicated in Para. 1 and in p. 1.
Art. 75. (1) ***For a change of the function of land properties in forest territories the owner or investor shall make a request for preliminary coordination before:***
1. The Minister of Agriculture and Food – for land properties in forest territories – public state ownership;
2. the relevant commission under Art. 74, Para. 2 – for land properties in forest territories apart from the ones, indicated in p. 1.
(2) The request for preliminary coordination for change of function of land properties in forest territories shall have attached the following documents:
1. a plan of the property from the cadastre map or from the map of the restored ownership, coordinated by the Relevant regional directorate of forests upon location of the property;
2. an approved task for development of a detailed territory plan, drawn up in compliance with the provisions of the Law on the Territory Planning;
3. a Municipal council decision – for land properties in forest territories – ownership of Municipalities.

11.4.2 INFORMATION ON HOW HARVESTING OR FOREST DISTURBANCE THAT IS FOLLOWED BY THE RE-ESTABLISHMENT OF FOREST IS DISTINGUISHED FROM DEFORESTATION

In KP LULUCF emission inventory for Bulgaria, currently we don't use data coming from remote sensing technology. Harvesting and forest disturbance always occur on Forest Land, while deforestation is a permanent change of land use from Forest Land to other land-use categories.
According to the Forest Law (last amendment in 2019) all harvest activities in the forests and lands with forest are planned under the FMP.
Art. 101. (1) Felling shall be conducted for restoration, growing and improving the conditions of forests and for achieving the objectives, laid down in the forestry plans and programs.
(3) The Minister of Agriculture and Food shall adopt an Ordinance, which shall determine:
Art. 102. Restoring felling shall be conducted at an age not smaller than:

1. 60 years in high-stem forests with the exception of birch and poplar trees, as well as the artificially created plantations out of their natural region of spreading;
2. 20 years and not bigger than 30 years in forests for sucker restoration;
3. 15 years for acacia forests.
Clear cuttings are forbidden by Law.
Art. 104. (1) It shall be prohibited:
1. conducting clear fell in all the forests with the exception of the poplar and low-stem forests;
When there is forest disturbance the owner of the forest should replant the area if it cannot be restored by naturally up to 7 years.
Art. 97. (1) Wood-cutting areas and burned-out areas, which cannot be restored naturally up to 7 years after the timber cutting or burning during fire shall be planted by their owner up to 2 years after expiry the 7-year period.
(2) Where the forestry plan or program envisages restoration in an artificial way, the forestation shall be done within the term of 3 years after cutting the plantation.
It is forbidden by the Law to convert burnt by wildfires area to other land use during the 20 years period after the damage, caused by wildfires.
The delimitation between deforestation[39] and harvesting and forest disturbance is taking into account when Bulgaria reports under the KP. As it was described above there are some obligations by the Law according to harvesting and replanting of the forest area in order to keep the forest fund stable. When there is a plan or a need to convert forest land to non-forest land – according to the Law the owner should exclude the forest area from the forest fund (see chapter 11.4.1).

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

In Bulgaria forests are managed and utilized based on forest management plans, projects or programs. According to this, all activities like felling are planned and described in detail. All felling activities are carried out under the Regulation for fellings. The regulation describes the type of fellings and specifies the conditions in which fellings are carried out.
Deforestation needs administrative steps as described above, so there are only two possibilities 1) Forest areas that have lost forest plant cover (e.g. clear cut areas, damaged areas): These areas remain forests by law, and there is no transition to non-forest situation of such areas allowed (obligations for replanting etc., Art. 97. (1) Forest act). 2) Deforestation areas that followed all administrative steps needed to get the permission for deforestation. Only such areas are accounted as D areas in Bulgaria.
The Regulation for felling sets up the following cuttings:

1) Renewable
    - Gradual
    - Selective
    - Clear
2) Thinning
3) Other

When any harvest is conducted the requirements for the density of the stand should be obeyed where the density is different with the different types of harvests, but no less than 0.4, which is within the framework of the Forest Definition of the KP and thus reported as Forest.
As regards clear cuts they are only done in the cases described down here and obligatory followed by afforestation:

Art. 104. (1) It shall be prohibited:

[39] (15/CMP.1 (par.8.b) "Deforestation" is the direct human-induced conversion of forested land to non-forested land.)

1. conducting clear fell in all the forests with the exception of the poplar and low-stem forests;
Art. 97. (1) Wood-cutting areas and burned-out areas, which cannot be restored naturally up to 7 years after the timber cutting or burning during fire shall be planted by their owner up to 2 years after expiry the 7-year period.
(2) Where the forestry plan or program envisages restoration in an artificial way, the forestation shall be done within the term of 3 years after cutting the plantation.

11.4.4 INFORMATION RELATED TO THE NATURAL DISTURBANCES PROVISION UNDER THE ARTICLE 3.3 OF THE KYOTO PROTOCOL

Since Bulgaria did not applied yet the provision, no additional information is needed and provided here.

11.4.5 INFORMATION ON HARVESTED WOOD PRODUCT UNDER ARTICLE 3.3 OF THE KYOTO PROTOCOL

Harvested Wood Products (HWPs) originating from *deforestation* activity are estimated assuming instantaneous oxidation. The share of HWP originating from D is estimated on the basis of the area under D and respective average biomass stock during the years. Emissions from HWPs originated from *afforestation/reforestation* activities have been included in the emissions estimated from HWPs from *forest management* activities following the recommendation of IPCC 2013 KP Supplement (IPCC 2014), where in case it is not possible to differentiate between the harvest from AR and FM, it is conservative and in line with good practice to assume that all HWP entering the accounting framework originate from FM.

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

All forests in Bulgaria are managed, therefore all activities which are carried out in the forests are considered human-induced. Therefore, all emissions and removals of all lands which were forests in 1.1.1990 are accounted as Forest Management emissions and removals, except the emissions and removals of the ARD lands since 1.1.1990 which are accounted under the Art. 3.3 activity ARD.

11.5.2 INFORMATION RELATING TO FOREST MANAGEMENT

Bulgaria has a long tradition in Forest Management which is characterized by a long-term forestry policy that takes also issues of biodiversity conservation into account. The forest management policy is based on the principles of sustainable forest resources management, which balance the ecological, economic and social functions of the forest. This is ensured with Forest Act (2011). The Forest Act and associated Ordinances define all measures which have to be taken in order to manage, protect and sustain the Bulgarian forests. This includes regulations connected with harvest (e.g. limitations for harvest in stands below the legal minimum age for the rotation period), provisions for natural and artificial regeneration, regulations around deforestation (e.g. principal ban of deforestation) and etc. Therefore, Bulgaria uses a broad definition for Forest Management.

11.5.2.1.1 Conversion of natural forest to planted forest

There is no conversion of natural forest to planted forest in Bulgaria. Therefore, emissions are not accounted for such activity.

11.5.2.2 Forest Management Reference Level

The forest management reference level (FMRL) for Bulgaria, inscribed in the appendix to the annex to Decision 2/CMP.7, is equal to –8.168 Mt CO2 eq. per year assuming instantaneous oxidation of HWP, and –7.950 Mt CO2 eq. applying first-order decay function for HWP. Bulgaria is one of the member States of the EU for which the JRC of the European Commission developed projections in collaboration with two EU modeling groups. The FMRL is the averages of the projected forest management (FM) data series for the period 2013-2020, taking account of policies implemented before mid-2009, with emissions/removals from harvested wood product (HWP) using the first order decay functions, and assuming instant oxidation. The contribution of HWP to the reference level of Bulgaria amounts to 0,218 Mt CO2 as described in the Submission of the FMRL by Bulgaria (2011). It was calculated using the C-HWP-Model, which estimates delayed emissions on the basis of the annual stock change of semi-finished wood products.

11.5.2.3 Technical correction of the FMRL

According to Decision 2/CMP.7, methodological consistency between the FMRL and reporting for forest management during the second commitment period has to be ensured, applying technical correction if necessary.
In respect to follow this recommendation Bulgaria in cooperation with JRC plan to apply technical correction at the end of the commitment period.

11.5.2.4 Information related to the natural disturbances provision under article 3.4

Since Bulgaria did not applied yet the provision, no additional information is needed and provided here.

11.5.2.5 Information of Harvested Wood Products under article 3.4

The HWP contribution to emissions and removals of CO_2 is estimated and reported under FM activities. The HWP in solid waste disposal sites is not included, assumed to be instantaneously oxidized. The input to HWP excludes firewood (and woody residuals) as its carbon stock is accounted for using instantaneous oxidation. HWP originated from deforested land is excluded from the estimate assuming instantaneous oxidation.
The annual changes in carbon stocks and associated CO_2 emissions and removals from the HWP pool are estimated, following the production approach described in the Annex to Volume 4, Chapter 12, of the 2006 IPCC Guidelines (IPCC, 2006), in line with Decision 2/CMP.7 and the guidance provided by the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP Supplement, IPCC 2014). The estimation follows the Tier 2 method - first order decay, which is based on Eq. 2.8.5 (KP Supplement, IPCC 2014). The default half-life constants were used:

- 35 years for sawnwood,
- 25 years for wood-based panels
- 2 years for paper and paperboard.

The activity data (production of sawnwood, wood-based panels and paper and paperboard) are derived from FAO forest product statistics (Food and Agriculture Organization of the United Nations: forest product statistics, http://faostat3.fao.org/download/F/FO/E). Equation 2.8.1 (IPCC, 2014) has been applied to estimate the annual fraction of the feedstock coming from domestic harvest for the

HWP categories sawnwood and wood-based panels and eq. 2.8.2 for category paper and paperboard.
The initial stock has been estimated using Equation 2.8.6 of KP Supplement with t0=1990. Default conversion factors has been applied as provided in Table 2.8.1 KP Supplement.
The FMRL of Bulgaria is based on a projection representing "business as usual scenario", so inherited emissions occurring during the second commitment period from HWP originating from forests prior to the start of the second commitment period are accounted for.

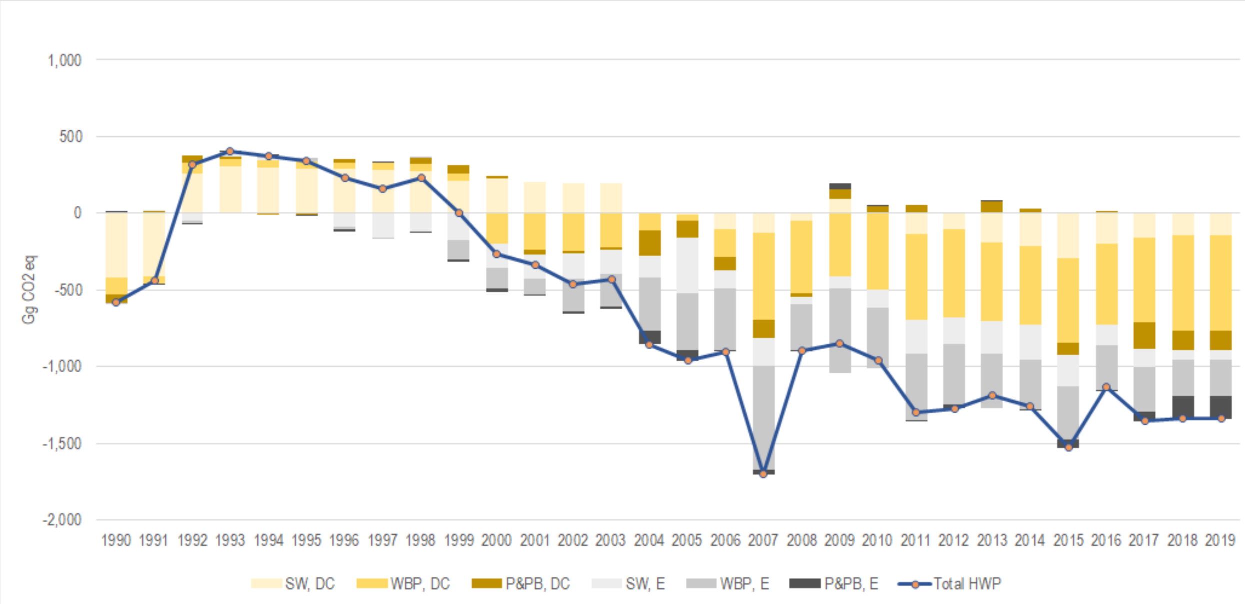


Figure 141 Emissions and removals from HWP, Gg CO2 eq

11.5.3 INFORMATION RELATING TO CROPLAND MANAGEMENT, GRAZING LAND MANAGEMENT, REVEGETATION AND WET DRAINAGE AND REWETTING, IF ELECTED, FOR THE BASE YEAR

NA for Bulgaria

11.6 OTHER INFORMATION

11.6.1 KEY CATEGORY ANALYSIS FOR ARTICLE 3.3 ACTIVITIES AND ANY ELECTED ACTIVITIES UNDER ARTICLE 3.4

All categories subject to activities under KP (Afforestation, Deforestation and Forest Management) are considered as key as the associated land use categories and sub-categories are defined as key under the UNFCCC reporting.

11.7 INFORMATION REGARDING TO ARTICLE 6

NA for Bulgaria

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 BACKGROUND INFORMATION

Annex I parties are required to report from its national registry holding of and transaction of Kyoto Protocol units and inform about related issues as specified in Decision 15/CMP.1 Section E. Information about the transactions of the Kyoto-units is attached in to this document.

12.2 SUMMARY OF INFORMATION REPORTED IN THE SEF TABLES

Information from the national registry on acquisition, holding, transfer, cancellation, retirement and carry-over of AAUs, RMUs, ERUs, CERs, tCERs and ICERs for 2018 has been reported as separate file in xlsx and xml format each by separate upload.

12.3 DISCREPANCIES AND NOTIFICATION

Further information on Kyoto Protocol units referning to the respective paragraphs on decision 15/CMP 1 will be reported.
Paragraph 12: Discrepancies identified by the transaction log;
No discrepant transaction for the reporting period, pursuant of 15/CMP.1 annex I.E paragraph 12.
Paragraph13 & § 14: No CDM notifications occurred in 2019;
No CDM notifications were received by the National Registry during the reporting period, pursuant of 15/CMP.1 annex I.E paragraph 13 & 14.
Paragraph 15: No non–replacements occurred in 2017;
No non-replacements occurred during the reporting period, pursuant of 15/CMP.1 annex I.E paragraph 15.
Paragraph16: No invalid units exist as at 31 December 2018;
No invalid units exist for the reporting period, pursuant of 15/CMP.1 annex I.E paragraph 16
Paragraph 17: Actions necessary to correct any problem causing a discrepancy.
No actions were taken or changes made to address discrepancies for the period under review.

12.4 PUBLICLY ACCSSIBLE INFORMATION

Section E of the annex to decision 15/CMP.1 outlines provisions for the national registry to support, via a user-interface, non-confidential information being made available to the public. Bulgaria has made this information available on the Executive Environment Agency's website:
http://eea.government.bg/
The actual internet address of the Bulgarian registry in the Union registry is:
https://unionregistry.ec.europa.eu/euregistry/BG/index.xhtml
The following information has been made accessible to the public in line with the requirements. This information is non-confidential. Bulgaria considers all information to be confidential that is determined to be confidential according to article 110 of the Commission Regulation (EU) No 389/2013. Accounts' holding's publicly accessible information:
http://eea.government.bg/bg/r-r/r-te/registry/main3
The registry terms and conditions, operators guide, forms and guidance for opening the holding accounts are available at the website of Executive Environment Agency:
http://eea.government.bg/bg/r-r/r-te/registry/main7
http://eea.government.bg/bg/r-r/r-te/registry/main8
http://eea.government.bg/bg/r-r/r-te/registry/main9
http://eea.government.bg/bg/r-r/r-te/registry/main10
Joint implementation (JI) projects' publicly accessible information:
http://eea.government.bg/bg/r-r/r-te/registry/main3
The information of approved Joint Implementation projects and their documentation is added on the website of the competent authority (Ministry of the Environment and Waters) of JI projects and can be downloaded from the following link:

https://www.moew.government.bg/en/approved-joint-implementation-projects/

Information according to paragraph 45 - 48 of the annex to decision 13/CMP.1:

(a) Account name: the holder of the account;

(b) Account type: the type of account (holding, cancellation or retirement);

(c) Commitment period: the commitment period with which a cancellation or retirement account is associated;

(d) Representative identifier: the representative of the account holder, using the Party identifier (the two-letter country code defined by ISO 3166) and a number unique to that representative within the Party's registry;

(e) Representative names nominated by the account holder and authorized to work with the account.

The Information includes the following Article 6 project information, for each project identifier if the Party has issued ERUs for a project:

(a) Project name: a unique name for the project;

(b) Project location: the Party and town or region in which the project is located;

(c) Years of ERU issuance: the years in which ERUs have been issued as a result of the Article 6 project;

(d) Reports: downloadable electronic versions of all publicly available documentation relating to the project, including proposals, monitoring, verification and issuance of ERUs, where relevant, subject to the confidentiality provisions in decision 9/CMP.1.

The information includes the following holding and transaction information relevant to the national registry, by serial number, for each calendar year:

(a) The total quantity of ERUs, CERs, AAUs and RMUs in each account at the beginning of the year (displayed in the year X+5, according to the Commission Regulation (EU) No 389/2013 the information is confidential until the year X+5);

(b) The total quantity of AAUs issued on the basis of the assigned amount pursuant to Article 3, paragraphs 7 and 8 (displayed in the year X+1);

(c) The total quantity of ERUs issued on the basis of Article 6 projects (displayed in the year X+1);

(d) The total quantity of ERUs, CERs, AAUs and RMUs acquired from other registries and the identity of the transferring accounts and registries (displayed in the year X+5, according to Commission Regulation (EU) No 389/2013 the information is confidential until the year X+5);

(e) The total quantity of RMUs issued on the basis of each activity under Article 3, paragraphs 3 and 4 (displayed in the year X+1)

(f) The total quantity of ERUs, CERs, AAUs and RMUs transferred to other registries and the identity of the acquiring accounts and registries (displayed in the year X+5, according to Commission regulation (EU) No 389/2013 the information is confidential until the year X+5)

(g) The total quantity of ERUs, CERs, AAUs and RMUs cancelled on the basis of activities under Article 3, paragraphs 3 and 4 (displayed in the year X+1)

(h) The total quantity of ERUs, CERs, AAUs and RMUs cancelled following determination by the Compliance Committee that the Party is not in compliance with its commitment under Article 3, paragraph 1 (displayed in the year X+1)

(i) The total quantity of other ERUs, CERs, AAUs and RMUs cancelled (displayed in the year X+1)

(j) The total quantity of ERUs, CERs, AAUs and RMUs retired (displayed in the year X+1)

(k) The total quantity of ERUs, CERs, and AAUs carried over from the previous commitment period (displayed in the year X+1)

(l) The Information does not include current holdings of ERUs, CERs, AAUs and RMUs in each account because this is confidential according to Commission Regulation (EU) No 389/2013.

12.5 CALCULATION OF THE COMMITEMENT PERIOD RESERVE CPR

Parties are required by decision 11/CMP.1 under the Kyoto Protocol and paragraph 18 of Decision 1/CMP.8 to establish and maintain a commitment period reserve as part of their responsibility to manage and account for their assigned amount. The commitment period reserve (CPR) equals the lower of either 90% of a Party's assigned amount pursuant to Article 3(7bis), (8) and (8bis) or 100% of its most recently reviewed inventory, multiplied by 8.
The national commitment period reserve is calculated in accordance with paragraph 6 of the Annex to decision 11/CMP.1 as 90% of the proposed assigned amount or 100% of eight times its most recently reviewed inventory, whichever is the lowest.
The first method calculation as 90% of the proposed assigned amount of Bulgaria gives the estimate:

CPR = 0,9 x 222 945 983 = 200 651 385 Mg CO_2 equivalent

The second method calculation as 100% of the most recently reviewed inventory (emission level 2018) of Bulgaria times eight gives the estimate:

CPR = 8 x 57 815 589 = 462 152 036 Mg CO_2 equivalent

Bulgaria has interpreted the 'most recently reviewed inventory' as the year 2018, which was reviewed in October 2020.
Therefore Bulgaria's estimated CPR is **200 651 385** Mg CO_2 equivalent.

12.6 KP-LULUCF ACCOUNTING

First commitment period In Table 274 data on accounting for the KP-LULUCF activities based on the reporting for the year 2018 are given. According to this information, Bulgaria would at the end of the commitment period be able to issue RMUs corresponding to the amount of 2.9 Tg CO_2 eq., which is Bulgaria's cap value for forest management for the whole commitment period.

Table 274 Information table on accounting for activities under Articles 3.3 and 3.4 of the Kyoto Protocol.

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Base Year(2)	NET EMISSIONS/REMOVALS									Accounting parameters	Accounting quantity (4)
		2013	2014	2015	2016	2017	2018	2019	2020	Total(3)		
	(kt CO_2 eq)											
A. Article 3.3 activities												
A.1. Afforestation/reforestation		-1596.20	-1751.69	-1894.22	-2048.63	-2202.00	-2364.37			-11857.11		-11857.11
Excluded emissions from natural disturbances(5)		NO	NO	NO	NO	NO	NO			NO		NO
Excluded subsequent removals from land subject to natural disturbances(6)		NO	NO	NO	NO	NO	NO			NO		NO
A.2. Deforestation		144.81	62.83	189.71	157.82	167.91	70.79			793.87		793.87
B. Article 3.4 activities												
B.1. Forest management										-44906.21		2793.79
Net emissions/removals		-7535.19	-7586.83	-7740.93	-7410.01	-7333.87	-7299.38			-44906.21		
Excluded emissions from natural disturbances(5)		NA	NA	NA	NA	NA	NA			NA		NA
Excluded subsequent removals from land subject to natural disturbances(6)		NO	NO	NO	NO	NO	NO			NO		NO
Any debits from newly established forest (CEF-ne)(7),(8)		NA	NA	NA	NA	NA	NA			NA		NA
Forest management reference level (FMRL)(9)											-7950.00	
Technical corrections to FMRL(10)											NA	
Forest management cap(11)											32691.37	2793.79
B.2. Cropland management (if elected)		NA	NA	NA	NA	NA	NA			NA		NA
B.3. Grazing land management (if elected)		NA	NA	NA	NA	NA	NA			NA		NA
B.4. Revegetation (if elected)	NA	NA	NA	NA	NA	NA	NA			NA		NA
B.5. Wetland drainage and rewetting (if elected)		NA	NA	NA	NA	NA	NA			NA		NA

Notes:

(2) Net emissions and removals from cropland management, grazing land management, revegetation and/or wetland drainage and rewetting, if elected, in the Party's base year, as established by decision 9/CP.2.

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

(4) The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7.4 of the Kyoto Protocol.

(5) A Party that has indicated their intent to apply the natural disturbance provisions may choose to exclude emissions from natural disturbances either annually or at the end of the commitment period.

(6) Any subsequent removals on lands from which emissions from natural disturbances have been excluded is subtracted from the accounting quantity of the respective activity.

(7) A debit is generated in case the newly established forest does not reach at least the expected carbon stock at the end of the normal harvesting period. Total debits from carbon equivalent forests are subtracted from the accounting quantity forest management.

(8) In case of a projected forest management reference level, Parties should not fill in this row.

(9) Forest management reference level as inscribed in the appendix of the annex to decision 2/CMP.7, in kt CO2 eq per year.

(10) Technical corrections in accordance with paragraphs 14 and 15 of the annex to decision 2/CMP.7 and reported in table 4(KP-I)B.1.1 in kt CO2 eq per year.

(11) For the second commitment period, additions to the assigned amount of a Party resulting from forest management shall, in accordance with paragraph 13 of the annex to decision 2/CMP.7, not exceed 3.5 per cent of the national total emissions excluding LULUCF in the base year times eight.

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

The staff of the inventory team was set out and their duties were defined in an order of the Executive Director of ExEA № 344/1.12.2020 in order to reflect relevant staffing changes of the inventory team.

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of BG have occurred in 2020. Note that the 2020 SIAR confirms that previous recommendations have been implemented and included in the annual report.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None
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	There has been a new EUCR release (version 11.5) after version 8.2.2 (the production version at the time of the last Chapter 14 submission). Due to the new release, some changes were applied to the database. The updated database model is provided in Annex A. No change was required to the 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	The changes that have been introduced with version 11.5 compared with version 8.2.2 of the national registry are presented in Annex B. It is to be noted that 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 are carried out prior to the relevant major release of the version to Production (see Annex B). 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	The use of soft tokens for authentication and signature was introduced for the registry end users.
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 reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change to the registry internet address during the reported period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	No change during the reported period.

15 INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

According to the Article 3, paragraph 14 of the Kyoto Protocol, Annex I countries shall provide information on how is striving to implement commitments in such a way as to minimize potential adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention.

Impacts on third countries are mostly indirect and frequently cannot be directly attributed to a specific policy. Therefore we cannot consider that there is an adverse social, environmental and economic impact on developing countries due to our national climate change policy.

The application of the Joint Implementation mechanism in our country aims to renew the old tehnologies and improves energy efficiency, with no transboundary effects, as well as the implementation in Bulgaria of the European Union Emission Trading Scheme.

Nonetheless Bulgaria is of the view that taking the actions on mitigation, adaptation, development technology and transfer and capacity building in developing countries is very important for international climate change policy.

In this regard, in 2012 completed the project "Bulgarian contribution to the "short-term financing" 2011-2012: Sharing Bulgarian experience of monitoring, reporting and verification of greenhouse gas in the Republic of Macedonia for participation in the European Union Emission Trading Scheme of greenhouse gases". Through this project, Bulgaria has fulfilled its obligation, which made at the summit of the European Union in December 2009, to provide short-term financing of climate activities.

According to the Article 3, paragraph 14 of the Kyoto Protocol, Annex I countries shall provide information on how give priority, in implementing the commitments under Article 3, paragraph 14, to specific actions.

The majority of Bulgarian legislation measures in the climate change area, are connected mainly with transposing of the European legislation, as well as other activities on implementation of directives, connected with the politics on climate change.

The table below summarizes how the Party gives priority to selected actions, identified in paragraph 24 of the Annex to Decision 15/CMP.1.

Table 275 Selected actions, identified in Para 24 of the Annex to Decision 15/CMP.1.

Action	Implementation by the Party
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.	**Market imperfection** The Climate Change Mitigation Act and Clean Ambient Air Act and related secondary legislation, including a permit system for meeting minimum standards in accordance with EU regulation on Large Combustion Plants (LPS), participation in the EU ETS and technical inspection (e.g. for cars) etc; The Energy Act, in its part on combined heat and power generation introduces the requirements of the related EU directives and the use preferential feed-in tariffs and mandates the state regulations to the licensed activities in the power sector and purchase obligations for the Transmission and Distribution Companies to buy all electricity produced from high efficient cogeneration, and for district heating companies to buy all utilized waste thermal energy. The Energy from Renewable Sources Act introduces the requirements of the related EU directives and the use of instruments such as green certificates and preferential feed in tariffs, mandates the state regulations to the licensed activities in the power sector and purchase obligations for the Transmission and Distribution Companies to by all electricity produced from renewable sources. It regulates the acceptance and realization of national indicative targets for consumption of bio fuels and other renewable fuels in the transport sector as a part of the total consumption of transport fuels; The Energy Efficiency Act and related secondary legislation, including obligation to adopt municipal energy efficiency programs, requirements for energy efficiency labelling, the use of minimum standards resulting

Action	Implementation by the Party
	from the EU directive on energy efficient appliances, regulations for energy efficiency labelling of various types of products (appliances, cars), obligatory audits and amendments of the Energy Performance Standards for existing buildings; The Waste Management Act and the related secondary legislation including the obligation for collecting, management and usage (or combustion) of the omitted gases from the new waste deposits; **Fiscal policy** A number of stimulating measures for the subjects of taxation were introduced in the Act on amendment and supplement of the Corporate Income Tax Act and also in the Act on amendment and supplement of the Income Taxes on Natural Persons Act ; The on-going liberalization of energy market is in line with EU policies and directives; The main instrument addressing externalities is emission trading under the EU ETS.

PART 2: ANNEXES TO THE NATIONAL INVENTORY REPORT

ANNEX 1 KEY CATEGORY ANALYSIS (KCA)

The key category analysis is performed according to the 2006 IPCC Guidelines (IPCC 2006, chapter 4): An Approach 1 level and trend assessment is applied with the proposed threshold of 95%. An Approach 2 key category analysis has also been carried out for this submission of all level assessments weighted with their relative source uncertainty. All main source categories have been disaggregated into main sub-sources (e.g. 2A, 2B, 2C etc.) and gases (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6).

The key sources are defined according to the IPCC classification. It is advisably that the key sources in superior degree are correspondent to the structure of the fuels and the activities in the country.

By Approach 1 are defined key sources accounting two rules:

- Rule A – Level assessment of the GHG emissions in absolute value expressed in Gg;

- Rule B – Trend assessment of the emissions from the base year until the current year of the inventory.

By applying rule A is used information for the volume of the source emissions only for the current year of the inventory.

The application of rule B requires information for the GHG emissions for the base year in the country. That means that the trend assessment includes additional information and gives the possibility for thorough analysis of the key sources.

The identification of key categories consists of following steps:

- Identifying categories
- Level Assessment excluding LULUCF
- Level Assessment including LULUCF
- Trend Assessment excluding LULUCF
- Trend Assessment including LULUCF

Table 276 Key category Analysis T1: Trend assessment excluding LULUCF

Source	Gas	Fuel/Cat.	1988 (BY) Gg CO_2-eq.	2019 Gg CO_2-eq.	% excl. (2019)	Trend	Contribution to Trend	cumul. %
1A1	CO2	Solid fuels	25416,6	19505,7	34,60%	0,25291	16,30%	16,30%
1A3b	CO2	Diesel Oil	2617,2	6705,4	11,89%	0,195502	12,60%	28,90%
1A2	CO2	Solid fuels	10047,7	478,1	0,85%	0,160979	10,38%	39,28%
1A1	CO2	Liquid fuels	10099,2	933,6	1,66%	0,145458	9,38%	48,66%
2F	CO2eq	Product uses as substitutes for ODS - HFCs and PFCs	0	2252,5	4,00%	0,081271	5,24%	53,90%
1A2	CO2	Liquid fuels	7319,8	1639,4	2,91%	0,070692	4,56%	58,46%
1A2	CO2	Gaseous fuels	0	1739,6	3,09%	0,062764	4,05%	62,51%
2C1	CO2	Iron and Steel Production	3481,4	31,6	0,06%	0,060613	3,91%	66,42%
1A4	CO2	Solid fuel	3548,1	441,5	0,78%	0,047008	3,03%	69,45%
1A1	CO2	Gaseous fuels	6508,6	1943,8	3,45%	0,045319	2,92%	72,37%
1A3b	CO2	LPG	0	1206,7	2,14%	0,043539	2,81%	75,18%
5D	CH4	Wastewater treatment and discharge	2724,1	399,8	0,71%	0,033896	2,18%	77,36%
5A	CH4	Solid waste disposal	3418,2	2556,5	4,53%	0,031604	2,04%	79,40%
1A4	CO2	Liquid fuel	2825,1	524,2	0,93%	0,031197	2,01%	81,41%
3Da	N2O	Direct N2O emissions from managed soils	4827,8	3172,9	5,63%	0,028841	1,86%	83,27%
1B2	CO2	Oil and Natural Gas	94,3	804,2	1,43%	0,027344	1,76%	85,03%
2A4d	CO2	DeSOx instalations	0	729,2	1,29%	0,026309	1,70%	86,73%
2B1	CO2	Ammonia Production	2557,5	600,8	1,07%	0,023689	1,53%	88,26%
1A3b	CO2	Gasoline	4217	1476,9	2,62%	0,021517	1,39%	89,65%
3A2	CH4	Sheep	1603,4	244,7	0,43%	0,019613	1,26%	90,91%
3A1	CH4	Cattle	3074,8	1076,7	1,91%	0,015696	1,01%	91,92%
1A4	CO2	Gaseous fuel	0	409,1	0,73%	0,014761	0,95%	92,87%
2B7	CO2	Soda ash production	397,6	512,1	0,91%	0,011425	0,74%	93,61%
1A3b	CO2	Gaseous fuel	0	205,3	0,36%	0,007408	0,48%	94,09%
3B3	CH4	Swine	519,9	63,3	0,11%	0,00694	0,45%	94,54%
2B2	N2O	Nitric Acid Production	1932	779,6	1,38%	0,006142	0,40%	94,94%

1A3e	CO2	Gaseous fuel	0	126,1	0,22%	0,004548	0,29%	95,23%

Table 277 Key category Analysis T1: Trend assessment including LULUCF

Source	Gas	Fuel/Cat.	1988 (BY) Gg CO_2-eq.	2019 Gg CO_2-eq.	% excl. (2019)	Trend	Contribution to Trend	cumul. %
1A1	CO2	Solid fuels	25416,61	19505,688	27,94%	0,178085	12,91%	12,91%
1A3b	CO2	Diesel Oil	2617,249	6705,39193	9,60%	0,14888	10,80%	23,71%
1A2	CO2	Solid fuels	10047,66	478,070454	0,68%	0,130628	9,47%	33,18%
1A1	CO2	Liquid fuels	10099,15	933,579228	1,34%	0,118705	8,61%	41,79%
2F	CO2eq	Product uses as substitutes for ODS - HFCs and PFCs	0	2252,54398	3,23%	0,062606	4,54%	46,33%
1A2	CO2	Liquid fuels	7319,758	1639,38008	2,35%	0,059279	4,30%	50,63%
2C1	CO2	Iron and Steel Production	3481,444	31,6310683	0,05%	0,048987	3,55%	54,18%
1A2	CO2	Gaseous fuels	0	1739,5908	2,49%	0,04835	3,51%	57,69%
4A1	CO2	Forest Land remaining Forest Land	-16262,8	-6784,25349	9,72%	0,044378	3,22%	60,91%
1A1	CO2	Gaseous fuels	6508,599	1943,80983	2,78%	0,039199	2,84%	63,75%
1A4	CO2	Solid fuel	3548,078	441,493617	0,63%	0,038549	2,80%	66,55%
1A3b	CO2	LPG	0	1206,74835	1,73%	0,03354	2,43%	68,98%
4A2	CO2	Land converted to Forest Land	-956,2	-1535,9	2,20%	0,028993	2,10%	71,08%
4G	CO2	Harvested wood products	-583,3	-1338,6	1,92%	0,02885	2,09%	73,17%
5D	CH4	Wastewater treatment and discharge	2724,1	399,8	0,57%	0,027906	2,02%	75,19%
1A4	CO2	Liquid fuel	2825,1	524,2	0,75%	0,025894	1,88%	77,07%
5A	CH4	Solid waste disposal	3418,2	2556,5	3,66%	0,022094	1,60%	78,67%
1B2	CO2	Oil and Natural Gas	94,3	804,2	1,15%	0,021002	1,52%	80,19%
2A4d	CO2	DeSOx instalations	0	729,2	1,04%	0,020267	1,47%	81,66%
2B1	CO2	Ammonia Production	2557,5	600,8	0,86%	0,019933	1,45%	83,11%
4C2	CO2	Land converted to Grassland	-1170,2	-1303,2	1,87%	0,019459	1,41%	84,52%
1A3b	CO2	Gasoline	4217	1476,9	2,12%	0,019353	1,40%	85,92%
3Da	N2O	Direct N2O emissions from managed soils	4827,8	3172,9	4,54%	0,019038	1,38%	87,30%

4B2	CO2	Land converted to Cropland	98,1	721,6	1,03%	0,018651	1,35%	88,65%
3A2	CH4	Sheep	1603,4	244,7	0,35%	0,016165	1,17%	89,82%
4E2	CO2	Land converted to Settlements	484,3	798,2	1,14%	0,015247	1,11%	90,93%
3A1	CH4	Cattle	3074,8	1076,7	1,54%	0,014117	1,02%	91,95%
1A4	CO2	Gaseous fuel	0	409,1	0,59%	0,011371	0,82%	92,77%
2B7	CO2	Soda ash production	397,6	512,1	0,73%	0,008539	0,62%	93,39%
2B2	N2O	Nitric Acid Production	1932	779,6	1,12%	0,006004	0,44%	93,83%
3B3	CH4	Swine	519,9	63,3	0,09%	0,005689	0,41%	94,24%
3B	N2O	N2O em. from Manure Management	940,9	293,5	0,42%	0,00532	0,39%	94,63%
4D2	CO2	Land converted to Wetlands	119,9	246,3	0,35%	0,005129	0,37%	95,00%
1A3e	CO2	Gaseous fuel	0	126,1	0,18%	0,003503	0,25%	95,25%

Table 278 Key category Analysis T1: Level Assessment excluding LULUCF 1988

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% excl.	cumul. %
1A1	CO2	Solid fuels	25416,6	22,17%	22,17%
1A1	CO2	Liquid fuels	10099,2	8,81%	30,97%
1A2	CO2	Solid fuels	10047,7	8,76%	39,74%
1A2	CO2	Liquid fuels	7319,8	6,38%	46,12%
1A1	CO2	Gaseous fuels	6508,6	5,68%	51,79%
1A5	CO2	Stationary - Fossil fuels	5093,8	4,44%	56,24%
3Da	N2O	Direct N2O emissions from managed soils	4827,8	4,21%	60,45%
1A3b	CO2	Gasoline	4217,0	3,68%	64,13%
1A4	CO2	Solid fuel	3548,1	3,09%	67,22%
2C1	CO2	Iron and Steel Production	3481,4	3,04%	70,26%
5A	CH4	Solid waste disposal	3418,2	2,98%	73,24%
3A1	CH4	Cattle	3074,8	2,68%	75,92%
1A4	CO2	Liquid fuel	2825,1	2,46%	78,38%
5D	CH4	Wastewater treatment and discharge	2724,1	2,38%	80,76%
1A3b	CO2	Diesel Oil	2617,2	2,28%	83,04%
2B1	CO2	Ammonia Production	2557,5	2,23%	85,27%
2A1	CO2	Cement Production	2454,5	2,14%	87,41%
1B1	CH4	Solid fuel	2079,6	1,81%	89,22%
2B2	N2O	Nitric Acid Production	1932,0	1,68%	90,91%
3A2	CH4	Sheep	1603,4	1,40%	92,31%
3Db	N2O	Indirect N2O Emissions from managed soils	1464,6	1,28%	93,58%
3B	N2O	N2O em. from Manure Management	940,9	0,82%	94,41%

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% excl.	cumul. %
2A4a	CO2	**Ceramics - Bricks and Tails**	522,5	0,46%	94,86%
3B3	CH4	**Swine**	519,9	0,45%	95,31%

Table 279 Key category Analysis T1: Level Assessment including LULUCF 1988

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% incl.	cumul. %
1A1	CO2	**Solid fuels**	25,416.6	18.3%	18.3%
4A1	CO2	**Forest Land remaining Forest Land**	16,721.0	12.1%	30.4%
1A1	CO2	**Liquid fuels**	10,099.2	7.3%	37.7%
1A2	CO2	**Solid fuels**	10,047.7	7.3%	45.0%
1A2	CO2	**Liquid fuels**	7,319.8	5.3%	50.2%
1A1	CO2	**Gaseous fuels**	6,508.6	4.7%	54.9%
1A5	CO2	**Stationary - Fossil fuels**	5,093.8	3.7%	58.6%
3Da	N2O	**Direct N2O emissions from managed soils**	4,994.7	3.6%	62.2%
5A	CH4	**Solid waste disposal**	4,922.4	3.6%	65.8%
1A3b	CO2	**Gasoline**	4,217.0	3.0%	68.8%
1A4	CO2	**Solid fuel**	3,548.1	2.6%	71.4%
2C1	CO2	**Iron and Steel Production**	3,481.4	2.5%	73.9%
3A1	CH4	**Cattle**	3,074.8	2.2%	76.1%
5D	CH4	**Wastewater treatment and discharge**	3,045.9	2.2%	78.3%
1A4	CO2	**Liquid fuel**	2,825.1	2.0%	80.4%
1A3b	CO2	**Diesel Oil**	2,617.2	1.9%	82.3%
2B1	CO2	**Ammonia Production**	2,557.5	1.8%	84.1%
2A1	CO2	**Cement Production**	2,454.5	1.8%	85.9%
1B1	CH4	**Solid fuel**	2,079.6	1.5%	87.4%
2B2	N2O	**Nitric Acid Production**	1,932.0	1.4%	88.8%
3A2	CH4	**Sheep**	1,603.4	1.2%	89.9%
3Db	N2O	**Indirect N2O Emissions from managed soils**	1,474.9	1.1%	91.0%
4C2	CO2	**Land converted to Grassland**	1,360.6	1.0%	92.0%
3B	N2O	**N2O em. from Manure Management**	1,299.2	0.9%	92.9%
4A2	CO2	**Land converted to Forest Land**	917.4	0.7%	93.6%
4B1	CO2	**Cropland remaing Cropland**	910.1	0.7%	94.2%
4G	CO2	**Harvested wood products**	586.3	0.4%	94.7%
2A4a	CO2	**Ceramics - Bricks and Tails**	522.5	0.4%	95.0%

Table 280 Key category Analysis T1: Level Assessment excluding LULUCF 2019

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% excl.	cumul. %
1A1	CO2	**Solid fuels**	19505,7	34,6%	34,6%
1A3b	CO2	**Diesel Oil**	6705,4	11,9%	46,5%

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% excl.	cumul. %
3Da	N2O	**Direct N2O emissions from managed soils**	3172,9	5,6%	52,1%
5A	CH4	**Solid waste disposal**	2556,5	4,5%	56,7%
2F	CO2eq	**Product uses as substitutes for ODS - HFCs and PFCs**	2252,5	4,0%	60,7%
1A1	CO2	**Gaseous fuels**	1943,8	3,4%	64,1%
1A2	CO2	**Gaseous fuels**	1739,6	3,1%	67,2%
1A2	CO2	**Liquid fuels**	1639,4	2,9%	70,1%
1A3b	CO2	**Gasoline**	1476,9	2,6%	72,7%
1A3b	CO2	**LPG**	1206,7	2,1%	74,9%
2A1	CO2	**Cement Production**	1127,1	2,0%	76,9%
3A1	CH4	**Cattle**	1076,7	1,9%	78,8%
1A1	CO2	**Liquid fuels**	933,6	1,7%	80,4%
3Db	N2O	**Indirect N2O Emissions from managed soils**	867,5	1,5%	82,0%
1B1	CH4	**Solid fuel**	814,5	1,4%	83,4%
1B2	CO2	**Oil and Natural Gas**	804,2	1,4%	84,8%
2B2	N2O	**Nitric Acid Production**	779,6	1,4%	86,2%
2A4d	CO2	**DeSOx instalations**	729,2	1,3%	87,5%
2B1	CO2	**Ammonia Production**	600,8	1,1%	88,6%
1A4	CO2	**Liquid fuel**	524,2	0,9%	89,5%
2B7	CO2	**Soda ash production**	512,1	0,9%	90,4%
1A2	CO2	**Solid fuels**	478,1	0,8%	91,3%
1A4	CO2	**Solid fuel**	441,5	0,8%	92,0%
1A4	CO2	**Gaseous fuel**	409,1	0,7%	92,8%
5D	CH4	**Wastewater treatment and discharge**	399,8	0,7%	93,5%
1A4	CH4	**All fuel**	296,4	0,5%	94,0%
3B	N2O	**N2O em. from Manure Management**	293,5	0,5%	94,5%
2A2	CO2	**Lime Production**	248,6	0,4%	95,0%

Table 281 Key category Analysis T1: Level Assessment including LULUCF 2019

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% incl.	cumul. %
1A1	CO2	**Solid fuels**	19505,7	27,9%	27,9%
4A1	CO2	**Forest Land remaining Forest Land**	6784,3	9,7%	37,7%
1A3b	CO2	**Diesel Oil**	6705,4	9,6%	47,3%
3Da	N2O	**Direct N2O emissions from managed soils**	3172,9	4,5%	51,8%
5A	CH4	**Solid waste disposal**	2556,5	3,7%	55,5%
2F	CO2eq	**Product uses as substitutes for ODS - HFCs and PFCs**	2252,5	3,2%	58,7%
1A1	CO2	**Gaseous fuels**	1943,8	2,8%	61,5%
1A2	CO2	**Gaseous fuels**	1739,6	2,5%	64,0%
1A2	CO2	**Liquid fuels**	1639,4	2,3%	66,3%

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% incl.	cumul. %
4A2	CO2	**Land converted to Forest Land**	1535,9	2,2%	68,5%
1A3b	CO2	**Gasoline**	1476,9	2,1%	70,6%
4G	CO2	**Harvested wood products**	1338,6	1,9%	72,5%
4C2	CO2	**Land converted to Grassland**	1303,2	1,9%	74,4%
1A3b	CO2	**LPG**	1206,7	1,7%	76,1%
2A1	CO2	**Cement Production**	1127,1	1,6%	77,8%
3A1	CH4	**Cattle**	1076,7	1,5%	79,3%
1A1	CO2	**Liquid fuels**	933,6	1,3%	80,6%
3Db	N2O	**Indirect N2O Emissions from managed soils**	867,5	1,2%	81,9%
1B1	CH4	**Solid fuel**	814,5	1,2%	83,0%
1B2	CO2	**Oil and Natural Gas**	804,2	1,2%	84,2%
4E2	CO2	**Land converted to Settlements**	798,2	1,1%	85,3%
2B2	N2O	**Nitric Acid Production**	779,6	1,1%	86,5%
2A4d	CO2	**DeSOx - instalations**	729,2	1,0%	87,5%
4B2	CO2	**Land converted to Cropland**	721,6	1,0%	88,5%
2B1	CO2	**Ammonia Production**	600,8	0,9%	89,4%
4B1	CO2	**Cropland remainig Cropland**	539,6	0,8%	90,2%
1A4	CO2	**Liquid fuel**	524,2	0,8%	90,9%
2B7	CO2	**Soda ash production**	512,1	0,7%	91,7%
1A2	CO2	**Solid fuels**	478,1	0,7%	92,3%
1A4	CO2	**Solid fuel**	441,5	0,6%	93,0%
1A4	CO2	**Gaseous fuel**	409,1	0,6%	93,6%
5D	CH4	**Wastewater treatment and discharge**	399,8	0,6%	94,1%
1A4	CH4	**All fuel**	296,4	0,4%	94,6%
3B	N2O	**N2O em. from Manure Management**	293,5	0,4%	95,0%

1.2 Approach 2 for Key Category Assessment

With the use of the uncertainty assessments for each key categories in the form of weight factor/coefficient is done, which is the Approach 2 method according to 2006 IPCC Guidelines. It is helpful in prioritising activities to improve inventory quality and to reduce overall uncertainty.
Under Approach 2, the source or sink category uncertainties are incorporated by weighting the Approach 1 level and trend assessment results with the source category's relative uncertainty.
Therefore the following equation Approach 2 has been applied for the current year submission:
*Level Assessment, with Uncertainty = Approach 1 Level Assessment * Relative Category Uncertainty*
*Trend Assessment, with Uncertainty = Approach 1 Trend Assessment * Relative Category Uncertainty*
The results of the Approach 2 category analysis, without LULUCF categories, are provided in Table 282 and Table 284 for 2019, while in Table 283 and
Table 285 the results, including LULUCF categories, are shown.

Table 282 Key category Analysis T2: Trend assessment excluding LULUCF

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment excluding LULUCF	Cumulative Percentage	T2
14	3Da	Direct N2O emissions from managed soils	N2O	0.019	250.018	4.726	0.236	0.236	1
5	2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0.052	50.990	2.630	0.131	0.367	2
33	3Db	Indirect N2O Emissions from managed soils	N2O	0.003	500.009	1.536	0.077	0.444	3
18	1B2	Oil and Natural Gas	CO2	0.015	100.125	1.467	0.073	0.517	4
16	5D	Wastewater treatment and discharge	CH4	0.017	84.812	1.430	0.071	0.588	5
29	3B	N2O em. from Manure Management	N2O	0.004	300.007	1.165	0.058	0.647	6
4	1A1	Liquid fuels	CO2	0.096	7.616	0.734	0.037	0.683	7
2	1A3b	Diesel Oil	CO2	0.114	5.831	0.665	0.033	0.716	8
25	5A	Solid waste disposal	CH4	0.007	85.440	0.594	0.030	0.746	9
34	1B1	Solid fuel	CH4	0.003	200.250	0.579	0.029	0.775	10
1	1A1	Solid fuels	CO2	0.185	2.236	0.413	0.021	0.796	11
30	1B2	Oil and Natural Gas	CH4	0.004	100.125	0.367	0.018	0.814	12
6	1A2	Liquid fuels	CO2	0.045	7.616	0.344	0.017	0.831	13
8	2C1	Iron and Steel Production	CO2	0.039	7.071	0.273	0.014	0.845	14
19	3A2	Sheep	CH4	0.013	20.066	0.251	0.013	0.857	15
3	1A2	Solid fuels	CO2	0.101	2.236	0.226	0.011	0.869	16
40	1A1	All fuel	N2O	0.001	200.022	0.205	0.010	0.879	17
13	2B2	Nitric Acid Production	N2O	0.019	10.198	0.196	0.010	0.889	18
22	3A1	Cattle	CH4	0.009	20.010	0.180	0.009	0.898	19
12	1A4	Liquid fuel	CO2	0.020	8.602	0.173	0.009	0.906	20
11	1A3b	LPG	CO2	0.029	5.831	0.168	0.008	0.915	21
31	1A4	All fuel	CH4	0.003	50.249	0.159	0.008	0.922	22
9	1A4	Solid fuel	CO2	0.029	5.385	0.157	0.008	0.930	23
47	1A2	All fuel	N2O	0.001	200.022	0.102	0.005	0.935	24
7	1A2	Gaseous fuels	CO2	0.043	2.236	0.096	0.005	0.940	25
59	5B	Biological treatment of solid waste	CH4	0.000	401.123	0.088	0.004	0.945	26
17	1A3b	Gasoline	CO2	0.015	5.831	0.087	0.004	0.949	27
26	3B3	Swine	CH4	0.004	20.007	0.087	0.004	0.953	28
20	2B1	Ammonia Production	CO2	0.011	7.280	0.080	0.004	0.957	29
52	1A4	All fuel	N2O	0.000	200.062	0.072	0.004	0.961	30
10	1A1	Gaseous fuels	CO2	0.029	2.236	0.065	0.003	0.964	31
38	3A3	Swine	CH4	0.001	50.003	0.059	0.003	0.967	32
21	1A4	Gaseous fuel	CO2	0.010	5.385	0.054	0.003	0.970	33
42	3C	Rice Cultivation	CH4	0.001	63.246	0.052	0.003	0.972	34

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment excluding LULUCF	Cumulative Percentage	T2
37	1A3b	All fuel	N2O	0.001	40.112	0.049	0.002	0.975	35
60	1B1	Solid fuel	CO2	0.000	200.250	0.042	0.002	0.977	36
24	1A3e	Gaseous fuel	CO2	0.007	5.099	0.037	0.002	0.979	37
15	2A4d	DeSOx instalations	CO2	0.017	2.121	0.036	0.002	0.981	38
35	2C2	Zinc production	CO2	0.002	15.811	0.035	0.002	0.982	39
45	3A4	Other livestock	CH4	0.001	50.040	0.035	0.002	0.984	40
49	5D	Wastewater treatment and discharge	N2O	0.000	53.852	0.026	0.001	0.985	41
36	2C2	Lead production	CO2	0.002	15.811	0.026	0.001	0.987	42
27	1A3b	Gaseous fuel	CO2	0.004	5.831	0.025	0.001	0.988	43
28	2A4a	Ceramics - Bricks and Tails	CO2	0.004	5.831	0.024	0.001	0.989	44
23	2B7	Soda ash production	CO2	0.008	2.828	0.023	0.001	0.990	45
50	2G1	Electrical equipment - SF6	CO2eq	0.000	50.990	0.019	0.001	0.991	46
32	1A2	Other fossil fuels	CO2	0.003	5.385	0.017	0.001	0.992	47
56	3F	Field burning of agricultural residues	CH4	0.000	50.090	0.015	0.001	0.993	48
72	1B2	Oil and Natural Gas	N2O	0.000	1000.012	0.015	0.001	0.994	49
55	1A3b	All fuel	CH4	0.000	40.112	0.013	0.001	0.994	50
54	2D	Non-energy products from fuels and solvent use	CO2	0.000	31.623	0.011	0.001	0.995	51
61	1A1	All fuel	CH4	0.000	50.090	0.010	0.001	0.995	52
39	1A3a	Liquid fuel	CO2	0.001	7.071	0.008	0.000	0.996	53
44	2B5b	Calcium Carbide	CO2	0.001	11.180	0.008	0.000	0.996	54
65	1A3d	Gas/diesel oil	CO2	0.000	50.249	0.008	0.000	0.996	55
51	3B2	Sheep	CH4	0.000	20.066	0.007	0.000	0.997	56
58	2G	Other product manufacture and use	CO2	0.000	31.623	0.007	0.000	0.997	57
53	3B1	Cattle	CH4	0.000	20.010	0.007	0.000	0.997	58
64	5B	Biological treatment of solid waste	N2O	0.000	42.426	0.007	0.000	0.998	59
43	1A3c	Liquid fuel	CO2	0.001	7.071	0.006	0.000	0.998	60
71	5C	Incineration and open burning of waste	CO2	0.000	100.499	0.006	0.000	0.998	61
67	1A3c	Liquid fuel	N2O	0.000	60.208	0.005	0.000	0.999	62
63	3B4	Other livestock	CH4	0.000	30.067	0.005	0.000	0.999	63
57	2A3	Glass production	CO2	0.000	14.142	0.004	0.000	0.999	64
69	3H	Urea application	CO2	0.000	50.040	0.003	0.000	0.999	65
48	1A3b	Other liquid fuels	CO2	0.001	5.831	0.003	0.000	0.999	66
70	1A2	All fuel	CH4	0.000	50.090	0.003	0.000	1.000	67
41	2A4b	Soda ash uses	CO2	0.001	2.236	0.002	0.000	1.000	68
46	2A2	Lime Production	CO2	0.001	2.828	0.002	0.000	1.000	69
68	3F	Field burning of agricultural residues	N2O	0.000	20.224	0.002	0.000	1.000	70
66	2G	Other product manufacture and use	N2O	0.000	10.050	0.001	0.000	1.000	71
75	1A3e	Gaseous fuel	N2O	0.000	150.003	0.001	0.000	1.000	72

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment excluding LULUCF	Cumulative Percentage	T2
74	**5C**	**Incineration and open burning of waste**	N2O	0.000	100.499	0.001	0.000	1.000	73
62	**2A1**	**Cement Production**	CO2	0.000	2.121	0.000	0.000	1.000	74
73	**1A3a**	**Liquid fuel**	N2O	0.000	40.311	0.000	0.000	1.000	75
77	**1A3d**	**Gas/diesel oil**	N2O	0.000	148.661	0.000	0.000	1.000	76
76	**1A3e**	**Gaseous fuel**	CH4	0.000	50.010	0.000	0.000	1.000	77
78	**1A3c**	**Liquid fuel**	CH4	0.000	60.208	0.000	0.000	1.000	78
79	**1A3d**	**Gas/diesel oil**	CH4	0.000	70.711	0.000	0.000	1.000	79
80	**1A3a**	**Liquid fuel**	CH4	0.000	40.311	0.000	0.000	1.000	80
81	**5C**	**Incineration and open burning of waste**	CH4	0.000	100.499	0.000	0.000	1.000	81
82	**1A5**	**Stationary - Fossil fuels**	CO2	0.000	8.602	0.000	0.000	1.000	82
83	**1A5**	**Stationary - Fossil fuels**	CH4	0.000	50.249	0.000	0.000	1.000	83
84	**1A5**	**Stationary - Fossil fuels**	N2O	0.000	200.062	0.000	0.000	1.000	84
85	**2B8**	**Petrochemical and carbon black production**	CH4	0.000	11.180	0.000	0.000	1.000	85
86	**2B8b**	**Ethylene**	CO2	0.000	30.414	0.000	0.000	1.000	86
87	**2B8c**	**Ethylene dichloride and vinyl chloride monomer**	CO2	0.000	20.616	0.000	0.000	1.000	87
88	**2C1**	**Iron and Steel Production**	CH4	0.000	26.926	0.000	0.000	1.000	88
89	**2C2**	**Ferroalloys Production**	CO2	0.000	25.495	0.000	0.000	1.000	89
90	**2C2**	**Ferroalloys Production**	CH4	0.000	25.495	0.000	0.000	1.000	90
91	**2H**	**Other**	CO2	0.000	31.623	0.000	0.000	1.000	91

Table 283 Key category Analysis T2: Trend assessment including LULUCF

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment including LULUCF	Cumulative Percentage	T2
5	**4A1**	**Forest Land remaining Forest Land**	CO2	0.047	492.814	23.077	0.489	0.489	1
22	**3Da**	**Direct N2O emissions from managed soils**	N2O	0.014	250.018	3.474	0.074	0.562	2
49	**4C1**	**Grassland remaining grassland**	CO2	0.001	2596.520	2.698	0.057	0.619	3
6	**2F**	**Product uses as substitutes for ODS - HFCs and PFCs**	CO2eq	0.044	50.990	2.222	0.047	0.666	4
18	**4G**	**Harvested wood products**	CO2	0.017	98.706	1.665	0.035	0.702	5
19	**5D**	**Wastewater treatment and discharge**	CH4	0.016	84.812	1.315	0.028	0.729	6
23	**1B2**	**Oil and Natural Gas**	CO2	0.012	100.125	1.235	0.026	0.756	7
35	**3B**	**N2O em. from Manure Management**	N2O	0.004	300.007	1.146	0.024	0.780	8
43	**3Db**	**Indirect N2O Emissions from managed soils**	N2O	0.002	500.009	0.992	0.021	0.801	9
17	**4A2**	**Land converted to Forest Land**	CO2	0.017	53.790	0.917	0.019	0.820	10
38	**1B1**	**Solid fuel**	CH4	0.003	200.250	0.662	0.014	0.834	11
46	**4**	**Indirect N2O Emissions from managed soils**	N2O	0.001	500.009	0.658	0.014	0.848	12
4	**1A1**	**Liquid fuels**	CO2	0.086	7.616	0.652	0.014	0.862	13

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment including LULUCF	Cumulative Percentage	T2
31	4 (III)	N Mineralization	N2O	0.006	95.463	0.558	0.012	0.874	14
2	1A3b	Diesel Oil	CO2	0.095	5.831	0.556	0.012	0.886	15
14	4C2	Land converted to Grassland	CO2	0.021	21.046	0.437	0.009	0.895	16
42	4B1	Cropland remainig Cropland	CO2	0.002	189.986	0.406	0.009	0.903	17
34	5A	Solid waste disposal	CH4	0.004	85.440	0.328	0.007	0.910	18
1	1A1	Solid fuels	CO2	0.146	2.236	0.326	0.007	0.917	19
7	1A2	Liquid fuels	CO2	0.041	7.616	0.313	0.007	0.924	20
39	1B2	Oil and Natural Gas	CH4	0.003	100.125	0.304	0.006	0.930	21
9	2C1	Iron and Steel Production	CO2	0.034	7.071	0.241	0.005	0.935	22
24	3A2	Sheep	CH4	0.011	20.066	0.226	0.005	0.940	23
3	1A2	Solid fuels	CO2	0.089	2.236	0.200	0.004	0.944	24
13	4B2	Land converted to Cropland	CO2	0.021	8.490	0.180	0.004	0.948	25
26	3A1	Cattle	CH4	0.009	20.010	0.177	0.004	0.952	26
16	2B2	Nitric Acid Production	N2O	0.017	10.198	0.174	0.004	0.956	27
52	1A1	All fuel	N2O	0.001	200.022	0.162	0.003	0.959	28
15	1A4	Liquid fuel	CO2	0.018	8.602	0.156	0.003	0.962	29
12	1A3b	LPG	CO2	0.024	5.831	0.142	0.003	0.965	30
11	1A4	Solid fuel	CO2	0.026	5.385	0.141	0.003	0.968	31
41	1A4	All fuel	CH4	0.003	50.249	0.128	0.003	0.971	32
58	1A2	All fuel	N2O	0.000	200.022	0.095	0.002	0.973	33
21	1A3b	Gasoline	CO2	0.014	5.831	0.084	0.002	0.975	34
8	1A2	Gaseous fuels	CO2	0.036	2.236	0.081	0.002	0.977	35
60	1A4	All fuel	N2O	0.000	200.062	0.078	0.002	0.978	36
33	3B3	Swine	CH4	0.004	20.007	0.077	0.002	0.980	37
25	2B1	Ammonia Production	CO2	0.010	7.280	0.076	0.002	0.982	38
71	5B	Biological treatment of solid waste	CH4	0.000	401.123	0.074	0.002	0.983	39
28	4E2	Land converted to Settlements	CO2	0.007	9.446	0.068	0.001	0.985	40
10	1A1	Gaseous fuels	CO2	0.027	2.236	0.061	0.001	0.986	41
48	3A3	Swine	CH4	0.001	50.003	0.053	0.001	0.987	42
27	1A4	Gaseous fuel	CO2	0.009	5.385	0.046	0.001	0.988	43
32	4D2	Land converted to Wetlands	CO2	0.004	10.960	0.043	0.001	0.989	44
56	3C	Rice Cultivation	CH4	0.001	63.246	0.041	0.001	0.990	45
70	1B1	Solid fuel	CO2	0.000	200.250	0.041	0.001	0.991	46
50	1A3b	All fuel	N2O	0.001	40.112	0.041	0.001	0.991	47
53	3A4	Other livestock	CH4	0.001	50.040	0.034	0.001	0.992	48
30	1A3e	Gaseous fuel	CO2	0.006	5.099	0.032	0.001	0.993	49
20	2A4d	DeSOx - instalations	CO2	0.014	2.121	0.031	0.001	0.993	50
44	2C2	Zinc production	CO2	0.002	15.811	0.029	0.001	0.994	51
45	2C2	Lead production	CO2	0.001	15.811	0.023	0.000	0.995	52

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment including LULUCF	Cumulative Percentage	T2
36	2A4a	Ceramics - Bricks and Tails	CO2	0.004	5.831	0.022	0.000	0.995	53
37	1A3b	Gaseous fuel	CO2	0.004	5.831	0.021	0.000	0.995	54
29	2B7	Soda ash production	CO2	0.007	2.828	0.019	0.000	0.996	55
67	5D	Wastewater treatment and discharge	N2O	0.000	53.852	0.017	0.000	0.996	56
66	2G1	Electrical equipment - SF6	CO2eq	0.000	50.990	0.016	0.000	0.997	57
40	1A2	Other fossil fuels	CO2	0.003	5.385	0.014	0.000	0.997	58
69	3F	Field burning of agricultural residues	CH4	0.000	50.090	0.012	0.000	0.997	59
84	1B2	Oil and Natural Gas	N2O	0.000	1000.012	0.012	0.000	0.997	60
68	1A3b	All fuel	CH4	0.000	40.112	0.012	0.000	0.998	61
61	2D	Non-energy products from fuels and solvent use	CO2	0.000	31.623	0.012	0.000	0.998	62
74	1A1	All fuel	CH4	0.000	50.090	0.008	0.000	0.998	63
47	1A3a	Liquid fuel	CO2	0.001	7.071	0.008	0.000	0.998	64
57	2B5b	Calcium Carbide	CO2	0.001	11.180	0.007	0.000	0.998	65
63	3B2	Sheep	CH4	0.000	20.066	0.007	0.000	0.999	66
65	3B1	Cattle	CH4	0.000	20.010	0.007	0.000	0.999	67
76	1A3d	Gas/diesel oil	CO2	0.000	50.249	0.006	0.000	0.999	68
78	4A1 (V)	Forest fires	CO2eq	0.000	70.332	0.006	0.000	0.999	69
72	2G	Other product manufacture and use	CO2	0.000	31.623	0.006	0.000	0.999	70
75	5B	Biological treatment of solid waste	N2O	0.000	42.426	0.006	0.000	0.999	71
82	5C	Incineration and open burning of waste	CO2	0.000	100.499	0.005	0.000	0.999	72
73	3B4	Other livestock	CH4	0.000	30.067	0.005	0.000	0.999	73
55	1A3c	Liquid fuel	CO2	0.001	7.071	0.005	0.000	0.999	74
64	2A3	Glass production	CO2	0.000	14.142	0.005	0.000	1.000	75
79	1A3c	Liquid fuel	N2O	0.000	60.208	0.005	0.000	1.000	76
81	1A2	All fuel	CH4	0.000	50.090	0.003	0.000	1.000	77
59	1A3b	Other liquid fuels	CO2	0.000	5.831	0.002	0.000	1.000	78
51	2A1	Cement Production	CO2	0.001	2.121	0.002	0.000	1.000	79
83	3H	Urea application	CO2	0.000	50.040	0.002	0.000	1.000	80
54	2A4b	Soda ash uses	CO2	0.001	2.236	0.001	0.000	1.000	81
80	3F	Field burning of agricultural residues	N2O	0.000	20.224	0.001	0.000	1.000	82
62	2A2	Lime Production	CO2	0.000	2.828	0.001	0.000	1.000	83
77	2G	Other product manufacture and use	N2O	0.000	10.050	0.001	0.000	1.000	84
88	1A3e	Gaseous fuel	N2O	0.000	150.003	0.000	0.000	1.000	85
87	5C	Incineration and open burning of waste	N2O	0.000	100.499	0.000	0.000	1.000	86
86	4A2 (V)	Forest fires	CO2eq	0.000	70.668	0.000	0.000	1.000	87
85	1A3a	Liquid fuel	N2O	0.000	40.311	0.000	0.000	1.000	88
90	1A3d	Gas/diesel oil	N2O	0.000	148.661	0.000	0.000	1.000	89
89	1A3e	Gaseous fuel	CH4	0.000	50.010	0.000	0.000	1.000	90

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment including LULUCF	Cumulative Percentage	T2
91	**1A3c**	**Liquid fuel**	CH4	0.000	60.208	0.000	0.000	1.000	91
92	**1A3d**	**Gas/diesel oil**	CH4	0.000	70.711	0.000	0.000	1.000	92
93	**1A3a**	**Liquid fuel**	CH4	0.000	40.311	0.000	0.000	1.000	93
94	**5C**	**Incineration and open burning of waste**	CH4	0.000	100.499	0.000	0.000	1.000	94
95	**1A5**	**Stationary - Fossil fuels**	CO2	0.000	8.602	0.000	0.000	1.000	95
96	**1A5**	**Stationary - Fossil fuels**	CH4	0.000	50.249	0.000	0.000	1.000	96
97	**1A5**	**Stationary - Fossil fuels**	N2O	0.000	200.062	0.000	0.000	1.000	97
98	**2B8**	**Petrochemical and carbon black production**	CH4	0.000	11.180	0.000	0.000	1.000	98
99	**2B8b**	**Ethylene**	CO2	0.000	30.414	0.000	0.000	1.000	99
100	**2B8c**	**Ethylene dichloride and vinyl chloride monomer**	CO2	0.000	20.616	0.000	0.000	1.000	100
101	**2C1**	**Iron and Steel Production**	CH4	0.000	26.926	0.000	0.000	1.000	101
102	**2C2**	**Ferroalloys Production**	CO2	0.000	25.495	0.000	0.000	1.000	102
103	**2C2**	**Ferroalloys Production**	CH4	0.000	25.495	0.000	0.000	1.000	103
104	**2H**	**Other**	CO2	0.000	31.623	0.000	0.000	1.000	104
105	**4F**	**Land converted to other land**	CO2	0.000	0.000	0.000	0.000	1.000	105

Table 284 Key category Analysis T2: Level Assessment excluding LULUCF 2019

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment excluding LULUCF	Cumulative Percentage	T2
3	**3Da**	**Direct N2O emissions from managed soils**	N2O	0.057	250.0	14.266	0.346	0.346	1
14	**3Db**	**Indirect N2O Emissions from managed soils**	N2O	0.015	500.0	7.477	0.182	0.528	2
4	**5A**	**Solid waste disposal**	CH4	0.047	85.4	4.051	0.098	0.626	3
13	**1B1**	**Solid fuel**	CH4	0.016	200.2	3.129	0.076	0.702	4
24	**3B**	**N2O em. from Manure Management**	N2O	0.008	300.0	2.459	0.060	0.762	5
5	**2F**	**Product uses as substitutes for ODS - HFCs and PFCs**	CO2eq	0.039	51.0	1.987	0.048	0.810	6
19	**1B2**	**Oil and Natural Gas**	CO2	0.012	100.1	1.189	0.029	0.839	7
17	**5D**	**Wastewater treatment and discharge**	CH4	0.013	84.8	1.132	0.027	0.866	8
1	**1A1**	**Solid fuels**	CO2	0.357	2.2	0.799	0.019	0.886	9
2	**1A3b**	**Diesel Oil**	CO2	0.109	5.8	0.633	0.015	0.901	10
30	**1B2**	**Oil and Natural Gas**	CH4	0.004	100.1	0.404	0.010	0.911	11
12	**3A1**	**Cattle**	CH4	0.020	20.0	0.391	0.010	0.921	12
36	**1A1**	**All fuel**	N2O	0.002	200.0	0.388	0.009	0.930	13
41	**1A4**	**All fuel**	N2O	0.002	200.1	0.305	0.007	0.937	14
27	**1A4**	**All fuel**	CH4	0.005	50.2	0.264	0.006	0.944	15
8	**1A2**	**Liquid fuels**	CO2	0.029	7.6	0.218	0.005	0.949	16
9	**1A3b**	**Gasoline**	CO2	0.025	5.8	0.145	0.004	0.953	17
33	**5D**	**Wastewater treatment and discharge**	N2O	0.002	53.9	0.130	0.003	0.956	18

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment excluding LULUCF	Cumulative Percentage	T2
10	**1A3b**	**LPG**	CO2	0.022	5.8	0.127	0.003	0.959	19
38	**3C**	**Rice Cultivation**	CH4	0.002	63.2	0.108	0.003	0.962	20
15	**1A1**	**Liquid fuels**	CO2	0.014	7.6	0.104	0.003	0.964	21
51	**1A2**	**All fuel**	N2O	0.001	200.0	0.101	0.002	0.966	22
16	**2B1**	**Ammonia Production**	CO2	0.014	7.3	0.099	0.002	0.969	23
53	**1B1**	**Solid fuel**	CO2	0.000	200.2	0.087	0.002	0.971	24
29	**3A2**	**Sheep**	CH4	0.004	20.1	0.086	0.002	0.973	25
22	**1A4**	**Liquid fuel**	CO2	0.009	8.6	0.078	0.002	0.975	26
40	**3A4**	**Other livestock**	CH4	0.002	50.0	0.077	0.002	0.977	27
6	**1A1**	**Gaseous fuels**	CO2	0.034	2.2	0.076	0.002	0.979	28
7	**1A2**	**Gaseous fuels**	CO2	0.032	2.2	0.072	0.002	0.980	29
63	**5B**	**Biological treatment of solid waste**	CH4	0.000	401.1	0.066	0.002	0.982	30
42	**1A3b**	**All fuel**	N2O	0.001	40.1	0.059	0.001	0.983	31
39	**2D**	**Non-energy products from fuels and solvent use**	CO2	0.002	31.6	0.054	0.001	0.985	32
23	**1A4**	**Solid fuel**	CO2	0.008	5.4	0.045	0.001	0.986	33
11	**2A1**	**Cement Production**	CO2	0.021	2.1	0.045	0.001	0.987	34
25	**1A4**	**Gaseous fuel**	CO2	0.008	5.4	0.041	0.001	0.988	35
32	**2C2**	**Zinc production**	CO2	0.002	15.8	0.039	0.001	0.989	36
49	**3H**	**Urea application**	CO2	0.001	50.0	0.029	0.001	0.990	37
26	**1A3e**	**Gaseous fuel**	CO2	0.006	5.1	0.028	0.001	0.990	38
18	**2A4d**	**DeSOx instalations**	CO2	0.013	2.1	0.027	0.001	0.991	39
21	**2B7**	**Soda ash production**	CO2	0.010	2.8	0.027	0.001	0.992	40
52	**3F**	**Field burning of agricultural residues**	CH4	0.000	50.1	0.024	0.001	0.992	41
45	**3B3**	**Swine**	CH4	0.001	20.0	0.024	0.001	0.993	42
20	**1A2**	**Solid fuels**	CO2	0.010	2.2	0.022	0.001	0.993	43
35	**2B2**	**Nitric Acid Production**	N2O	0.002	10.2	0.020	0.000	0.994	44
55	**3A3**	**Swine**	CH4	0.000	50.0	0.020	0.000	0.994	45
43	**2A3**	**Glass production**	CO2	0.001	14.1	0.019	0.000	0.995	46
31	**1A3b**	**Gaseous fuel**	CO2	0.003	5.8	0.019	0.000	0.995	47
59	**2G1**	**Electrical equipment - SF6**	CO2eq	0.000	51.0	0.016	0.000	0.996	48
58	**1A1**	**All fuel**	CH4	0.000	50.1	0.016	0.000	0.996	49
57	**1A3b**	**All fuel**	CH4	0.000	40.1	0.015	0.000	0.996	50
73	**1B2**	**Oil and Natural Gas**	N2O	0.000	1000.0	0.015	0.000	0.997	51
54	**2G**	**Other product manufacture and use**	CO2	0.000	31.6	0.013	0.000	0.997	52
34	**1A2**	**Other fossil fuels**	CO2	0.002	5.4	0.013	0.000	0.997	53
28	**2A2**	**Lime Production**	CO2	0.004	2.8	0.012	0.000	0.998	54
68	**5C**	**Incineration and open burning of waste**	CO2	0.000	100.5	0.012	0.000	0.998	55
61	**1A2**	**All fuel**	CH4	0.000	50.1	0.011	0.000	0.998	56

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment excluding LULUCF	Cumulative Percentage	T2
50	3B1	Cattle	CH4	0.001	20.0	0.010	0.000	0.998	57
44	2A4a	Ceramics - Bricks and Tails	CO2	0.001	5.8	0.008	0.000	0.999	58
60	3B4	Other livestock	CH4	0.000	30.1	0.007	0.000	0.999	59
46	1A3a	Liquid fuel	CO2	0.001	7.1	0.006	0.000	0.999	60
69	1A3d	Gas/diesel oil	CO2	0.000	50.2	0.006	0.000	0.999	61
67	5B	Biological treatment of solid waste	N2O	0.000	42.4	0.005	0.000	0.999	62
47	2C1	Iron and Steel Production	CO2	0.001	7.1	0.004	0.000	0.999	63
48	1A3c	Liquid fuel	CO2	0.001	7.1	0.004	0.000	0.999	64
71	1A3c	Liquid fuel	N2O	0.000	60.2	0.004	0.000	1.000	65
37	2A4b	Soda ash uses	CO2	0.002	2.2	0.004	0.000	1.000	66
65	3F	Field burning of agricultural residues	N2O	0.000	20.2	0.003	0.000	1.000	67
66	3B2	Sheep	CH4	0.000	20.1	0.002	0.000	1.000	68
64	2C2	Lead production	CO2	0.000	15.8	0.002	0.000	1.000	69
56	1A3b	Other liquid fuels	CO2	0.000	5.8	0.002	0.000	1.000	70
62	2G	Other product manufacture and use	N2O	0.000	10.0	0.002	0.000	1.000	71
72	5C	Incineration and open burning of waste	N2O	0.000	100.5	0.002	0.000	1.000	72
70	2B5b	Calcium Carbide	CO2	0.000	11.2	0.001	0.000	1.000	73
75	1A3e	Gaseous fuel	N2O	0.000	150.0	0.000	0.000	1.000	74
74	1A3a	Liquid fuel	N2O	0.000	40.3	0.000	0.000	1.000	75
77	1A3d	Gas/diesel oil	N2O	0.000	148.7	0.000	0.000	1.000	76
76	1A3e	Gaseous fuel	CH4	0.000	50.0	0.000	0.000	1.000	77
78	1A3c	Liquid fuel	CH4	0.000	60.2	0.000	0.000	1.000	78
79	1A3d	Gas/diesel oil	CH4	0.000	70.7	0.000	0.000	1.000	79
80	1A3a	Liquid fuel	CH4	0.000	40.3	0.000	0.000	1.000	80
81	5C	Incineration and open burning of waste	CH4	0.000	100.5	0.000	0.000	1.000	81
82	1A5	Stationary - Fossil fuels	CO2	0.000	8.6	0.000	0.000	1.000	82
83	1A5	Stationary - Fossil fuels	CH4	0.000	50.2	0.000	0.000	1.000	83
84	1A5	Stationary - Fossil fuels	N2O	0.000	200.1	0.000	0.000	1.000	84
85	2B8	Petrochemical and carbon black production	CH4	0.000	11.2	0.000	0.000	1.000	85
86	2B8b	Ethylene	CO2	0.000	30.4	0.000	0.000	1.000	86
87	2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	0.000	20.6	0.000	0.000	1.000	87
88	2C1	Iron and Steel Production	CH4	0.000	26.9	0.000	0.000	1.000	88
89	2C2	Ferroalloys Production	CO2	0.000	25.5	0.000	0.000	1.000	89
90	2C2	Ferroalloys Production	CH4	0.000	25.5	0.000	0.000	1.000	90
91	2H	Other	CO2	0.000	31.6	0.000	0.000	1.000	91

Table 285 Key category Analysis T2: Level Assessment including LULUCF 2019

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment including LULUCF	Cumulative Percentage	T2
3	**4A1**	**Forest Land remaining Forest Land**	CO2	0.087	492.814	42.820	0.497	0.497	1
4	**3Da**	**Direct N2O emissions from managed soils**	N2O	0.046	250.018	11.525	0.134	0.630	2
19	**3Db**	**Indirect N2O Emissions from managed soils**	N2O	0.012	500.009	6.040	0.070	0.701	3
46	**4C1**	**Grassland remaining grassland**	CO2	0.002	2596.520	3.967	0.046	0.747	4
5	**5A**	**Solid waste disposal**	CH4	0.038	85.440	3.273	0.038	0.784	5
18	**1B1**	**Solid fuel**	CH4	0.013	200.250	2.528	0.029	0.814	6
31	**3B**	**N2O em. from Manure Management**	N2O	0.007	300.007	1.986	0.023	0.837	7
15	**4G**	**Harvested wood products**	CO2	0.016	98.706	1.620	0.019	0.856	8
6	**2F**	**Product uses as substitutes for ODS - HFCs and PFCs**	CO2eq	0.031	50.990	1.605	0.019	0.874	9
26	**4B1**	**Cropland remaing Cropland**	CO2	0.008	189.986	1.542	0.018	0.892	10
12	**4A2**	**Land converted to Forest Land**	CO2	0.019	53.790	1.019	0.012	0.904	11
24	**1B2**	**Oil and Natural Gas**	CO2	0.010	100.125	0.961	0.011	0.915	12
22	**5D**	**Wastewater treatment and discharge**	CH4	0.011	84.812	0.915	0.011	0.926	13
1	**1A1**	**Solid fuels**	CO2	0.289	2.236	0.646	0.007	0.933	14
50	**4**	**Indirect N2O Emissions from managed soils**	N2O	0.001	500.009	0.634	0.007	0.941	15
33	**4 (III)**	**N Mineralization**	N2O	0.006	95.463	0.538	0.006	0.947	16
9	**4C2**	**Land converted to Grassland**	CO2	0.025	21.046	0.522	0.006	0.953	17
2	**1A3b**	**Diesel Oil**	CO2	0.088	5.831	0.512	0.006	0.959	18
39	**1B2**	**Oil and Natural Gas**	CH4	0.003	100.125	0.326	0.004	0.963	19
17	**3A1**	**Cattle**	CH4	0.016	20.010	0.316	0.004	0.966	20
45	**1A1**	**All fuel**	N2O	0.002	200.022	0.313	0.004	0.970	21
52	**1A4**	**All fuel**	N2O	0.001	200.062	0.247	0.003	0.973	22
35	**1A4**	**All fuel**	CH4	0.004	50.249	0.214	0.002	0.975	23
10	**1A2**	**Liquid fuels**	CO2	0.023	7.616	0.176	0.002	0.977	24
16	**4B2**	**Land converted to Cropland**	CO2	0.016	8.490	0.138	0.002	0.979	25
11	**1A3b**	**Gasoline**	CO2	0.020	5.831	0.117	0.001	0.980	26
42	**5D**	**Wastewater treatment and discharge**	N2O	0.002	53.852	0.105	0.001	0.981	27
13	**1A3b**	**LPG**	CO2	0.018	5.831	0.102	0.001	0.983	28
48	**3C**	**Rice Cultivation**	CH4	0.001	63.246	0.088	0.001	0.984	29
20	**1A1**	**Liquid fuels**	CO2	0.011	7.616	0.084	0.001	0.985	30
62	**1A2**	**All fuel**	N2O	0.000	200.022	0.082	0.001	0.986	31
21	**2B1**	**Ammonia Production**	CO2	0.011	7.280	0.080	0.001	0.987	32
25	**4E2**	**Land converted to Settlements**	CO2	0.008	9.446	0.079	0.001	0.987	33
64	**1B1**	**Solid fuel**	CO2	0.000	200.250	0.070	0.001	0.988	34
38	**3A2**	**Sheep**	CH4	0.003	20.066	0.069	0.001	0.989	35

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment including LULUCF	Cumulative Percentage	T2
29	1A4	Liquid fuel	CO2	0.007	8.602	0.063	0.001	0.990	36
51	3A4	Other livestock	CH4	0.001	50.040	0.062	0.001	0.991	37
7	1A1	Gaseous fuels	CO2	0.027	2.236	0.061	0.001	0.991	38
8	1A2	Gaseous fuels	CO2	0.026	2.236	0.058	0.001	0.992	39
74	5B	Biological treatment of solid waste	CH4	0.000	401.123	0.054	0.001	0.993	40
53	1A3b	All fuel	N2O	0.001	40.112	0.047	0.001	0.993	41
49	2D	Non-energy products from fuels and solvent use	CO2	0.001	31.623	0.044	0.001	0.994	42
36	4D2	Land converted to Wetlands	CO2	0.004	10.960	0.041	0.000	0.994	43
30	1A4	Solid fuel	CO2	0.007	5.385	0.036	0.000	0.994	44
14	2A1	Cement Production	CO2	0.017	2.121	0.036	0.000	0.995	45
32	1A4	Gaseous fuel	CO2	0.006	5.385	0.033	0.000	0.995	46
41	2C2	Zinc production	CO2	0.002	15.811	0.031	0.000	0.996	47
60	3H	Urea application	CO2	0.000	50.040	0.024	0.000	0.996	48
34	1A3e	Gaseous fuel	CO2	0.004	5.099	0.023	0.000	0.996	49
23	2A4d	DeSOx instalations	CO2	0.010	2.121	0.022	0.000	0.996	50
28	2B7	Soda ash production	CO2	0.008	2.828	0.022	0.000	0.997	51
63	3F	Field burning of agricultural residues	CH4	0.000	50.090	0.019	0.000	0.997	52
56	3B3	Swine	CH4	0.001	20.007	0.019	0.000	0.997	53
27	1A2	Solid fuels	CO2	0.008	2.236	0.018	0.000	0.997	54
44	2B2	Nitric Acid Production	N2O	0.002	10.198	0.016	0.000	0.998	55
66	3A3	Swine	CH4	0.000	50.003	0.016	0.000	0.998	56
54	2A3	Glass production	CO2	0.001	14.142	0.016	0.000	0.998	57
40	1A3b	Gaseous fuel	CO2	0.003	5.831	0.015	0.000	0.998	58
70	2G1	Electrical equipment - SF6	CO2eq	0.000	50.990	0.013	0.000	0.998	59
69	1A1	All fuel	CH4	0.000	50.090	0.013	0.000	0.998	60
68	1A3b	All fuel	CH4	0.000	40.112	0.012	0.000	0.999	61
85	1B2	Oil and Natural Gas	N2O	0.000	1000.012	0.012	0.000	0.999	62
65	2G	Other product manufacture and use	CO2	0.000	31.623	0.011	0.000	0.999	63
43	1A2	Other fossil fuels	CO2	0.002	5.385	0.010	0.000	0.999	64
37	2A2	Lime Production	CO2	0.004	2.828	0.010	0.000	0.999	65
79	5C	Incineration and open burning of waste	CO2	0.000	100.499	0.010	0.000	0.999	66
72	1A2	All fuel	CH4	0.000	50.090	0.009	0.000	0.999	67
61	3B1	Cattle	CH4	0.000	20.010	0.008	0.000	0.999	68
55	2A4a	Ceramics - Bricks and Tails	CO2	0.001	5.831	0.006	0.000	0.999	69
71	3B4	Other livestock	CH4	0.000	30.067	0.006	0.000	0.999	70
57	1A3a	Liquid fuel	CO2	0.001	7.071	0.005	0.000	1.000	71
81	4A1 (V)	Forest fires	CO2eq	0.000	70.332	0.005	0.000	1.000	72
80	1A3d	Gas/diesel oil	CO2	0.000	50.249	0.005	0.000	1.000	73

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment including LULUCF	Cumulative Percentage	T2
78	5B	Biological treatment of solid waste	N2O	0.000	42.426	0.004	0.000	1.000	74
58	2C1	Iron and Steel Production	CO2	0.000	7.071	0.004	0.000	1.000	75
59	1A3c	Liquid fuel	CO2	0.000	7.071	0.003	0.000	1.000	76
83	1A3c	Liquid fuel	N2O	0.000	60.208	0.003	0.000	1.000	77
47	2A4b	Soda ash uses	CO2	0.001	2.236	0.003	0.000	1.000	78
76	3F	Field burning of agricultural residues	N2O	0.000	20.224	0.002	0.000	1.000	79
77	3B2	Sheep	CH4	0.000	20.066	0.002	0.000	1.000	80
75	2C2	Lead production	CO2	0.000	15.811	0.002	0.000	1.000	81
67	1A3b	Other liquid fuels	CO2	0.000	5.831	0.002	0.000	1.000	82
73	2G	Other product manufacture and use	N2O	0.000	10.050	0.002	0.000	1.000	83
84	5C	Incineration and open burning of waste	N2O	0.000	100.499	0.001	0.000	1.000	84
82	2B5b	Calcium Carbide	CO2	0.000	11.180	0.001	0.000	1.000	85
88	1A3e	Gaseous fuel	N2O	0.000	150.003	0.000	0.000	1.000	86
87	4A2 (V)	Forest fires	CO2eq	0.000	70.668	0.000	0.000	1.000	87
86	1A3a	Liquid fuel	N2O	0.000	40.311	0.000	0.000	1.000	88
90	1A3d	Gas/diesel oil	N2O	0.000	148.661	0.000	0.000	1.000	89
89	1A3e	Gaseous fuel	CH4	0.000	50.010	0.000	0.000	1.000	90
91	1A3c	Liquid fuel	CH4	0.000	60.208	0.000	0.000	1.000	91
92	1A3d	Gas/diesel oil	CH4	0.000	70.711	0.000	0.000	1.000	92
93	1A3a	Liquid fuel	CH4	0.000	40.311	0.000	0.000	1.000	93
94	5C	Incineration and open burning of waste	CH4	0.000	100.499	0.000	0.000	1.000	94
95	1A5	Stationary - Fossil fuels	CO2	0.000	8.602	0.000	0.000	1.000	95
96	1A5	Stationary - Fossil fuels	CH4	0.000	50.249	0.000	0.000	1.000	96
97	1A5	Stationary - Fossil fuels	N2O	0.000	200.062	0.000	0.000	1.000	97
98	2B8	Petrochemical and carbon black production	CH4	0.000	11.180	0.000	0.000	1.000	98
99	2B8b	Ethylene	CO2	0.000	30.414	0.000	0.000	1.000	99
100	2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	0.000	20.616	0.000	0.000	1.000	100
101	2C1	Iron and Steel Production	CH4	0.000	26.926	0.000	0.000	1.000	101
102	2C2	Ferroalloys Production	CO2	0.000	25.495	0.000	0.000	1.000	102
103	2C2	Ferroalloys Production	CH4	0.000	25.495	0.000	0.000	1.000	103
104	2H	Other	CO2	0.000	31.623	0.000	0.000	1.000	104
105	4F	Land converted to other land	CO2	0.000	0.000	0.000	0.000	1.000	105

ANNEX 2 ASSESSMENT OF THE UNCERTAINTY

Introduction

The respective sectoral uncertainties are documented in detail in the sectoral chapters of this report.

Theoretical background

The assessment and propagation of uncertainties in emission inventories has been described in detail by IPCC (IPCC 2006). Principally, two different pathways may be taken to arrive at a total uncertainty, and to develop an inventory uncertainty. The "Approach 1" method is based on error propagation: assuming input information is available in form of normal distribution, and input uncertainties are statistically independent, the approach allows for reliable assessment of inventory uncertainty. More flexibility is possible in the "Approach 2" method. The Monte-Carlo approach allows any probability distribution of input parameters, and it also enables to define statistical dependencies between parameters. The most obvious dependency is a full dependency. This occurs when two values are based on the identical set of measurements. A variation or error in one value would then be fully reflected also in the other value. While "full dependency" theoretically can also be covered in error propagation, this is normally not done and only in a very limited way possible in the IPCC spreadsheets.

The general properties of error propagation allow to combine (add up) information in a way that the relative uncertainty (as percentage of the mean value) of the combination becomes lower than the relative uncertainty of any of the input parameters. This advantage of going into detail is often implicitly taken advantage of, when a problem is disassembled into sub-problems and the sub-results are being recombined. Nevertheless it is not always the most detailed level that yields results of lowest uncertainty. If measurements or assessments at the most detailed level are difficult, a more comprehensive level of information may provide the lower overall uncertainty.

As a consequence, optimizing the approach requires collecting input information at the most detailed level an inventory is prepared at. Attaching uncertainty data then may be done at a level where greatest confidence can be expected on the data. This may be the most detailed level, but more often uncertainty data will not be available, or a "balance" approach (energy balance, solvent balance) will allow more reliability at a more aggregated level.

Procedure

For the uncertainty assessment of the Bulgarian greenhouse gas inventory, the most detailed level of the inventory system was used as the base level. This "base level" of the inventory facilitates compilation of emission data for different purposes.

This approach of starting at the most detailed level the inventory offers facilitated an assessment of emission uncertainty at any level that the most reasonable uncertainty data are available. Very detailed information can be entered directly, for aggregate information the same uncertainty (as a statistically dependent entity) is applied for all input entries concerned.

Uncertainty information was taken from national studies, from international information (as e.g. in the IPCC reports) from variation presented in literature, and by contacting national experts. Structured interviews were held. The difference between an Approach 1 and an Approach 2 uncertainty approach can be explained by covariance of uncertainties between (key) source categories, which occurs when data are statistically dependent. The Approach 1 approach allows considering co-variance between years for one source category, but does not cover co-variances between source categories.

In all input and output parameters, uncertainty has been expressed as normal or lognormal probability density function. In line with the IPCC requirements, the uncertainty range is presented as the range with 95% probability of a given value being within its boundaries. Thus the boundaries were given as the 2.5 and 97.5-percentiles of the respective distribution. For a normal distribution, this is +/- 2 standard deviations from the mean.

Detailed Results of Approach 1 Uncertainty Analysis

The table on the next pages shows the detailed results of Approach 1 Uncertainty analysis. The structure of the table is identical to Table 3.2 of IPCC 2006 Guidelines. For explanations to the columns see pp. 3.30-3.31 in vol. 1 IPCC (2006).

Table 286 Approach 1 Uncertainty Calculation and Reporting, Gg CO_2-eq. (excluding LULUCF) for 2019.

IPCC Source category		GHG	Base year emissions (1988)	Year 2019 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%							
1A1	Liquid fuels	CO2	10099,2	933,6	3	7	7,6	0,127	-0,035	0,008	-0,244	0,035	0,246
1A1	Solid fuels	CO2	25416,6	19505,7	1	2	2,2	0,780	0,062	0,170	0,124	0,241	0,270
1A1	Gaseous fuels	CO2	6508,6	1943,8	1	2	2,2	0,078	-0,011	0,017	-0,021	0,024	0,032
1A1	All fuel	CH4	18,8	20,9	3	50	50,1	0,019	0,000	0,000	0,005	0,001	0,005
1A1	All fuel	N2O	136,2	109,5	3	200	200,0	0,391	0,000	0,001	0,075	0,004	0,075
1A2	Liquid fuels	CO2	7319,8	1639,4	3	7	7,6	0,223	-0,017	0,014	-0,118	0,061	0,133
1A2	Solid fuels	CO2	10047,7	478,1	1	2	2,2	0,019	-0,039	0,004	-0,077	0,006	0,077
1A2	Gaseous fuels	CO2	0,0	1739,6	1	2	2,2	0,070	0,015	0,015	0,030	0,021	0,037
1A2	Other fossil fuels	CO2	0,0	194,9	5	2	5,4	0,019	0,002	0,002	0,003	0,012	0,012
1A2	All fuel	CH4	31,7	14,6	3	50	50,1	0,013	0,000	0,000	0,000	0,001	0,001
1A2	All fuel	N2O	103,9	32,4	3	200	200,0	0,116	0,000	0,000	-0,032	0,001	0,032
1A3a	Liquid fuel	CO2	76,4	20,7	5	5	7,1	0,003	0,000	0,000	-0,001	0,001	0,001
1A3a	Liquid fuel	CH4	0,0	0,0	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3a	Liquid fuel	N2O	0,6	0,2	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Gasoline	CO2	4217,0	1476,9	3	5	5,8	0,154	-0,005	0,013	-0,025	0,055	0,060
1A3b	Diesel Oil	CO2	2617,2	6705,4	3	5	5,8	0,699	0,047	0,058	0,237	0,248	0,343
1A3b	All fuel	CH4	69,5	21,4	3	40	40,1	0,015	0,000	0,000	-0,004	0,001	0,004
1A3b	All fuel	N2O	90,3	136,6	3	40	40,1	0,098	0,001	0,001	0,032	0,005	0,033
1A3b	LPG	CO2	0,0	1206,7	3	5	5,8	0,126	0,011	0,011	0,053	0,045	0,069
1A3b	Gaseous fuel	CO2	0,0	205,3	3	5	5,8	0,021	0,002	0,002	0,009	0,008	0,012
1A3b	Other liquid fuels	CO2	0,0	22,6	3	5	5,8	0,002	0,000	0,000	0,001	0,001	0,001
1A3c	Liquid fuel	CO2	0,0	31,2	5	5	7,1	0,004	0,000	0,000	0,001	0,002	0,002
1A3c	Liquid fuel	CH4	0,0	0,0	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	N2O	0,0	3,6	5	60	60,2	0,004	0,000	0,000	0,002	0,000	0,002

IPCC Source category		GHG	Base year emissions (1988)	Year 2019 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%							
1A3d	Gas/diesel oil	CO2	0,0	6,4	50	5	50,2	0,006	0,000	0,000	0,000	0,004	0,004
1A3d	Gas/diesel oil	CH4	0,0	0,0	50	50	70,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	Gas/diesel oil	N2O	0,0	0,1	50	140	148,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	CO2	0,0	126,1	1	5	5,1	0,011	0,001	0,001	0,005	0,002	0,006
1A3e	Gaseous fuel	CH4	0,0	0,1	1	50	50,0	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	N2O	0,0	0,1	1	150	150,0	0,000	0,000	0,000	0,000	0,000	0,000
1A4	Liquid fuel	CO2	2825,1	524,2	5	7	8,6	0,081	-0,007	0,005	-0,052	0,032	0,061
1A4	Solid fuel	CO2	3548,1	441,5	2	5	5,4	0,042	-0,011	0,004	-0,056	0,011	0,057
1A4	Gaseous fuel	CO2	0,0	409,1	5	2	5,4	0,039	0,004	0,004	0,007	0,025	0,026
1A4	All fuel	CH4	334,7	296,4	5	50	50,2	0,266	0,001	0,003	0,058	0,018	0,061
1A4	All fuel	N2O	209,7	87,0	5	200	200,1	0,311	0,000	0,001	-0,027	0,005	0,027
1A5	Stationary - Fossil fuels	CO2	5093,8	0,0	5	7	8,6	0,000	-0,022	0,000	-0,152	0,000	0,152
1A5	Stationary - Fossil fuels	CH4	4,8	0,0	5	50	50,2	0,000	0,000	0,000	-0,001	0,000	0,001
1A5	Stationary - Fossil fuels	N2O	9,8	0,0	5	200	200,1	0,000	0,000	0,000	-0,008	0,000	0,008
1B1	Solid fuel	CO2	68,8	22,7	10	200	200,25	0,08	0,00	0,00	-0,02	0,00	0,02
1B1	Solid fuel	CH4	2079,6	814,5	10	200	200,2	2,916	-0,002	0,007	-0,349	0,100	0,363
1B2	Oil and Natural Gas	CO2	94,3	804,2	5	100	100,1	1,439	0,007	0,007	0,661	0,050	0,663
1B2	Oil and Natural Gas	CH4	147,7	238,0	5	100	100,1	0,426	0,001	0,002	0,145	0,015	0,145
1B2	Oil and Natural Gas	N2O	0,4	1,0	5	1000	1000,0	0,017	0,000	0,000	0,007	0,000	0,007
2A1	Cement Production	CO2	2454,5	1127,1	1,5	1,5	2,1	0,043	-0,001	0,010	-0,001	0,021	0,021
2A2	Lime Production	CO2	450,1	248,6	2	2	2,8	0,013	0,000	0,002	0,001	0,006	0,006
2A3	Glass production	CO2	186,2	76,1	10	10	14,1	0,019	0,000	0,001	-0,001	0,009	0,009
2A4a	Ceramics - Bricks and Tails	CO2	522,5	71,9	3	5	5,8	0,007	-0,002	0,001	-0,008	0,003	0,008
2A4b	Soda ash uses	CO2	126,6	72,4	2	1	2,2	0,003	0,000	0,001	0,000	0,002	0,002
2A4d	DeSOx - instalations	CO2	0,0	729,2	1,5	1,5	2,1	0,028	0,006	0,006	0,010	0,013	0,017

IPCC Source category		GHG	Base year emissions (1988)	Year 2019 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%							
2B1	Ammonia Production	CO2	2557,5	600,8	2	7	7,3	0,078	-0,006	0,005	-0,039	0,015	0,042
2B2	Nitric Acid Production	N2O	1932,0	779,6	2	10	10,2	0,142	-0,001	0,007	-0,014	0,019	0,024
2B5b	Calcium Carbide	CO2	73,9	7,1	5	10	11,2	0,001	0,000	0,000	-0,003	0,000	0,003
2B7	Soda ash production	CO2	397,6	512,1	2	2	2,8	0,026	0,003	0,004	0,006	0,013	0,014
2B8	Petrochemical and carbon black production	CH4	17,4	0,0	5	10	11,2	0,000	0,000	0,000	-0,001	0,000	0,001
2B8b	Ethylene	CO2	442,1	0,0	5	30	30,4	0,000	-0,002	0,000	-0,056	0,000	0,056
2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	1,9	0,0	5	20	20,6	0,000	0,000	0,000	0,000	0,000	0,000
2C1	Iron and Steel Production	CO2	3481,4	31,6	5	5	7,1	0,004	-0,015	0,000	-0,073	0,002	0,073
2C1	Iron and Steel Production	CH4	32,4	0,0	10	25	26,9	0,000	0,000	0,000	-0,003	0,000	0,003
2C2	Ferroalloys Production	CO2	254,9	0,0	5	25	25,5	0,000	-0,001	0,000	-0,027	0,000	0,027
2C2	Ferroalloys Production	CH4	2,3	0,0	5	25	25,5	0,000	0,000	0,000	0,000	0,000	0,000
2C2	Lead production	CO2	162,8	7,9	5	15	15,8	0,002	-0,001	0,000	-0,009	0,000	0,009
2C2	Zinc production	CO2	90,5	121,2	5	15	15,8	0,034	0,001	0,001	0,010	0,007	0,013
2D	Non-energy products from fuels and solvent use	CO2	229,2	100,5	10	30	31,6	0,057	0,000	0,001	-0,003	0,012	0,013
2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0,0	1818,6	10	50	51,0	1,658	0,016	0,016	0,793	0,224	0,824
2G	Other product manufacture and use	N2O	32,6	12,4	10	1	10,0	0,002	0,000	0,000	0,000	0,002	0,002
2G	Other product manufacture and use	CO2	28,8	24,4	10	30	31,6	0,014	0,000	0,000	0,003	0,003	0,004
2G1	Electrical equipment - SF6	CO2eq	3,3	18,3	10	50	51,0	0,017	0,000	0,000	0,007	0,002	0,008
2H	Other	CO2	0,0	0,0	10	30	31,6	0,000	0,000	0,000	0,000	0,000	0,000
3A1	Cattle	CH4	3074,8	1076,7	0,64	20	20,0	0,385	-0,004	0,009	-0,074	0,008	0,074
3A2	Sheep	CH4	1603,4	244,7	1,63	20	20,1	0,088	-0,005	0,002	-0,094	0,005	0,094
3A3	Swine	CH4	151,6	21,5	0,51	50	50,0	0,019	0,000	0,000	-0,023	0,000	0,023
3A4	Other livestock	CH4	241,4	92,0	2	50	50,0	0,082	0,000	0,001	-0,011	0,002	0,011
3B	N2O em. from Manure Management	N2O	940,9	293,5	2	300	300,0	1,574	-0,001	0,003	-0,433	0,007	0,433
3B1	Cattle	CH4	473,2	218,5	25	20	32,0	0,125	0,000	0,002	-0,002	0,067	0,067

IPCC Source category		GHG	Base year emissions (1988)	Year 2019 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%							
3B2	Sheep	CH4	46,8	7,1	50	20	53,9	0,007	0,000	0,000	-0,003	0,004	0,005
3B3	Swine	CH4	519,9	63,3	25	20	32,0	0,036	-0,002	0,001	-0,033	0,020	0,039
3B4	Other livestock	CH4	44,0	14,6	50	30	58,3	0,015	0,000	0,000	-0,002	0,009	0,009
3C	Rice Cultivation	CH4	127,0	106,5	20	60	63,2	0,120	0,000	0,001	0,023	0,026	0,035
3Da	Direct N2O emissions from managed soils	N2O	4827,8	3172,9	3	200	200,0	11,345	0,007	0,028	1,426	0,117	1,430
3Db	Indirect N2O Emissions from managed soils	N2O	1464,6	867,5	3	500	500,0	7,754	0,001	0,008	0,667	0,032	0,668
3F	Field burning of agricultural residues	CH4	29,1	29,4	3	50	50,1	0,026	0,000	0,000	0,007	0,001	0,007
3F	Field burning of agricultural residues	N2O	8,3	8,2	3	20	20,2	0,003	0,000	0,000	0,001	0,000	0,001
3H	Urea application	CO2	62,2	33,0	2	50	50,0	0,030	0,000	0,000	0,001	0,001	0,001
5A	Solid waste disposal	CH4	3418,2	2556,5	30	80	85,4	3,905	0,008	0,022	0,620	0,946	1,131
5B	Biological treatment of solid waste	CH4	0,0	9,6	30	400	401,1	0,069	0,000	0,000	0,033	0,004	0,034
5B	Biological treatment of solid waste	N2O	0,0	6,8	30	30	42,4	0,005	0,000	0,000	0,002	0,003	0,003
5C	Incineration and open burning of waste	CO2	18,5	6,9	10	100	100,5	0,012	0,000	0,000	-0,002	0,001	0,002
5C	Incineration and open burning of waste	CH4	0,0	0,0	10	100	100,5	0,000	0,000	0,000	0,000	0,000	0,000
5C	Incineration and open burning of waste	N2O	1,4	1,0	10	100	100,5	0,002	0,000	0,000	0,000	0,000	0,000
5D	Wastewater treatment and discharge	CH4	2724,1	399,8	67	52	84,8	0,606	-0,008	0,003	-0,421	0,330	0,535
5D	Wastewater treatment and discharge	N2O	239,1	137,6	20	50	53,9	0,132	0,000	0,001	0,009	0,034	0,035
Total			**114801,0**	**55955,3**				**14.91**					**2.43**
%			**100,0**	**100,0**									
National Total			**114801,0**	**55955,3**									

Table 287 Approach 1 Uncertainty Calculation and Reporting, Gg CO_2-eq. (excluding LULUCF) for 1988.

IPCC Source category		GHG	Base year emissions (1988)	Year 1988 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 1988	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A1	Liquid fuels	CO2	10099,15	10099,15	3	7	7,6	0,671	0,000	0,088	0,000	0,374	0,374
1A1	Solid fuels	CO2	25416,61	25416,61	1	2	2,2	0,496	0,000	0,222	0,000	0,313	0,313
1A1	Gaseous fuels	CO2	6508,60	6508,60	1	2	2,2	0,127	0,000	0,057	0,000	0,080	0,080
1A1	All fuel	CH4	18,85	18,85	3	50	50,1	0,008	0,000	0,000	0,000	0,001	0,001
1A1	All fuel	N2O	136,19	136,19	3	200	200,0	0,238	0,000	0,001	0,000	0,005	0,005
1A2	Liquid fuels	CO2	7319,76	7319,76	3	7	7,6	0,486	0,000	0,064	0,000	0,271	0,271
1A2	Solid fuels	CO2	10047,66	10047,66	1	2	2,2	0,196	0,000	0,088	0,000	0,124	0,124
1A2	Gaseous fuels	CO2	0,00	0,00	1	2	2,2	0,000	0,000	0,000	0,000	0,000	0,000
1A2	Other fossil fuels	CO2	0,00	0,00	5	2	5,4	0,000	0,000	0,000	0,000	0,000	0,000
1A2	All fuel	CH4	31,74	31,74	3	50	50,1	0,014	0,000	0,000	0,000	0,001	0,001
1A2	All fuel	N2O	103,95	103,95	3	200	200,0	0,181	0,000	0,001	0,000	0,004	0,004
1A3a	Liquid fuel	CO2	76,35	76,35	5	5	7,1	0,005	0,000	0,001	0,000	0,005	0,005
1A3a	Liquid fuel	CH4	0,01	0,01	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3a	Liquid fuel	N2O	0,65	0,65	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Gasoline	CO2	4217,04	4217,04	3	5	5,8	0,214	0,000	0,037	0,000	0,156	0,156
1A3b	Diesel Oil	CO2	2617,25	2617,25	3	5	5,8	0,133	0,000	0,023	0,000	0,097	0,097
1A3b	All fuel	CH4	69,50	69,50	3	40	40,1	0,024	0,000	0,001	0,000	0,003	0,003
1A3b	All fuel	N2O	90,27	90,27	3	40	40,1	0,032	0,000	0,001	0,000	0,003	0,003
1A3b	LPG	CO2	0,00	0,00	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Gaseous fuel	CO2	0,00	0,00	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Other liquid fuels	CO2	0,00	0,00	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	CO2	0,00	0,00	5	5	7,1	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	CH4	0,00	0,00	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	N2O	0,00	0,00	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000

IPCC Source category		GHG	Base year emissions (1988)	Year 1988 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 1988	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A3d	Gas/diesel oil	CO2	0,00	0,00	50	5	50,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	Gas/diesel oil	CH4	0,00	0,00	50	50	70,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	Gas/diesel oil	N2O	0,00	0,00	50	140	148,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	CO2	0,00	0,00	1	5	5,1	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	CH4	0,00	0,00	1	50	50,0	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	N2O	0,00	0,00	1	150	150,0	0,000	0,000	0,000	0,000	0,000	0,000
1A4	Liquid fuel	CO2	2825,06	2825,06	5	7	8,6	0,212	0,000	0,025	0,000	0,174	0,174
1A4	Solid fuel	CO2	3548,08	3548,08	2	5	5,4	0,167	0,000	0,031	0,000	0,088	0,088
1A4	Gaseous fuel	CO2	0,00	0,00	5	2	5,4	0,000	0,000	0,000	0,000	0,000	0,000
1A4	All fuel	CH4	334,66	334,66	5	50	50,2	0,147	0,000	0,003	0,000	0,021	0,021
1A4	All fuel	N2O	209,71	209,71	5	200	200,1	0,366	0,000	0,002	0,000	0,013	0,013
1A5	Stationary - Fossil fuels	CO2	5093,82	5093,82	5	7	8,6	0,382	0,000	0,044	0,000	0,314	0,314
1A5	Stationary - Fossil fuels	CH4	4,82	4,82	5	50	50,2	0,002	0,000	0,000	0,000	0,000	0,000
1A5	Stationary - Fossil fuels	N2O	9,79	9,79	5	200	200,1	0,017	0,000	0,000	0,000	0,001	0,001
1B1	Solid fuel	CO2	68,81	68,81	10	200	200,25	0,12	0,00	0,00	0,00	0,01	0,01
1B1	Solid fuel	CH4	2079,64	2079,64	10	200	200,2	3,632	0,000	0,018	0,000	0,256	0,256
1B2	Oil and Natural Gas	CO2	94,31	94,31	5	100	100,1	0,082	0,000	0,001	0,000	0,006	0,006
1B2	Oil and Natural Gas	CH4	147,70	147,70	5	100	100,1	0,129	0,000	0,001	0,000	0,009	0,009
1B2	Oil and Natural Gas	N2O	0,40	0,40	5	1000	1000,0	0,003	0,000	0,000	0,000	0,000	0,000
2A1	Cement Production	CO2	2454,46	2454,46	1,5	1,5	2,1	0,045	0,000	0,021	0,000	0,045	0,045
2A2	Lime Production	CO2	450,07	450,07	2	2	2,8	0,011	0,000	0,004	0,000	0,011	0,011
2A3	Glass production	CO2	186,24	186,24	10	10	14,1	0,023	0,000	0,002	0,000	0,023	0,023
2A4a	Ceramics - Bricks and Tails	CO2	522,51	522,51	3	5	5,8	0,027	0,000	0,005	0,000	0,019	0,019
2A4b	Soda ash uses	CO2	126,58	126,58	2	1	2,2	0,002	0,000	0,001	0,000	0,003	0,003
2A4d	DeSOx - instalations	CO2	0,00	0,00	1,5	1,5	2,1	0,000	0,000	0,000	0,000	0,000	0,000

IPCC Source category		GHG	Base year emissions (1988)	Year 1988 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 1988	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
2B1	Ammonia Production	CO2	2557,48	2557,48	2	7	7,3	0,162	0,000	0,022	0,000	0,063	0,063
2B2	Nitric Acid Production	N2O	1932,03	1932,03	2	10	10,2	0,172	0,000	0,017	0,000	0,048	0,048
2B5b	Calcium Carbide	CO2	73,90	73,90	5	10	11,2	0,007	0,000	0,001	0,000	0,005	0,005
2B7	Soda ash production	CO2	397,64	397,64	2	2	2,8	0,010	0,000	0,003	0,000	0,010	0,010
2B8	Petrochemical and carbon black production	CH4	17,43	17,43	5	10	11,2	0,002	0,000	0,000	0,000	0,001	0,001
2B8b	Ethylene	CO2	442,12	442,12	5	30	30,4	0,117	0,000	0,004	0,000	0,027	0,027
2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	1,89	1,89	5	20	20,6	0,000	0,000	0,000	0,000	0,000	0,000
2C1	Iron and Steel Production	CO2	3481,44	3481,44	5	5	7,1	0,215	0,000	0,030	0,000	0,215	0,215
2C1	Iron and Steel Production	CH4	32,42	32,42	10	25	26,9	0,008	0,000	0,000	0,000	0,004	0,004
2C2	Ferroalloys Production	CO2	254,94	254,94	5	25	25,5	0,057	0,000	0,002	0,000	0,016	0,016
2C2	Ferroalloys Production	CH4	2,28	2,28	5	25	25,5	0,001	0,000	0,000	0,000	0,000	0,000
2C2	Lead production	CO2	162,82	162,82	5	15	15,8	0,022	0,000	0,001	0,000	0,010	0,010
2C2	Zinc production	CO2	90,47	90,47	5	15	15,8	0,012	0,000	0,001	0,000	0,006	0,006
2D	Non-energy products from fuels and solvent use	CO2	229,17	229,17	10	30	31,6	0,063	0,000	0,002	0,000	0,028	0,028
2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0,00	0,00	10	50	51,0	0,000	0,000	0,000	0,000	0,000	0,000
2G	Other product manufacture and use	N2O	32,60	32,60	10	1	10,0	0,003	0,000	0,000	0,000	0,004	0,004
2G	Other product manufacture and use	CO2	28,79	28,79	10	30	31,6	0,008	0,000	0,000	0,000	0,004	0,004
2G1	Electrical equipment - SF6	CO2eq	3,30	3,30	10	50	51,0	0,001	0,000	0,000	0,000	0,000	0,000
2H	Other	CO2	0,00	0,00	10	30	31,6	0,000	0,000	0,000	0,000	0,000	0,000
3A1	Cattle	CH4	3074,85	3074,85	0,64	20	20,0	0,537	0,000	0,027	0,000	0,024	0,024
3A2	Sheep	CH4	1603,36	1603,36	1,63	20	20,1	0,281	0,000	0,014	0,000	0,032	0,032
3A3	Swine	CH4	151,58	151,58	0,51	50	50,0	0,066	0,000	0,001	0,000	0,001	0,001
3A4	Other livestock	CH4	241,41	241,41	2	50	50,0	0,105	0,000	0,002	0,000	0,006	0,006
3B	N2O em. from Manure Management	N2O	940,88	940,88	2	300	300,0	2,462	0,000	0,008	0,000	0,023	0,023
3B1	Cattle	CH4	473,23	473,23	25	20	32,0	0,132	0,000	0,004	0,000	0,146	0,146

IPCC Source category		GHG	Base year emissions (1988)	Year 1988 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 1988	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
3B2	Sheep	CH4	46,81	46,81	50	20	53,9	0,022	0,000	0,000	0,000	0,029	0,029
3B3	Swine	CH4	519,93	519,93	25	20	32,0	0,145	0,000	0,005	0,000	0,160	0,160
3B4	Other livestock	CH4	43,98	43,98	50	30	58,3	0,022	0,000	0,000	0,000	0,027	0,027
3C	Rice Cultivation	CH4	126,99	126,99	20	60	63,2	0,070	0,000	0,001	0,000	0,031	0,031
3Da	Direct N2O emissions from managed soils	N2O	4827,82	4827,82	3	200	200,0	8,422	0,000	0,042	0,000	0,179	0,179
3Db	Indirect N2O Emissions from managed soils	N2O	1464,63	1464,63	3	500	500,0	6,387	0,000	0,013	0,000	0,054	0,054
3F	Field burning of agricultural residues	CH4	29,06	29,06	3	50	50,1	0,013	0,000	0,000	0,000	0,001	0,001
3F	Field burning of agricultural residues	N2O	8,34	8,34	3	20	20,2	0,001	0,000	0,000	0,000	0,000	0,000
3H	Urea application	CO2	62,17	62,17	2	50	50,0	0,027	0,000	0,001	0,000	0,002	0,002
5A	Solid waste disposal	CH4	3418,23	3418,23	30	80	85,4	2,547	0,000	0,030	0,000	1,265	1,265
5B	Biological treatment of solid waste	CH4	0,00	0,00	30	400	401,1	0,000	0,000	0,000	0,000	0,000	0,000
5B	Biological treatment of solid waste	N2O	0,00	0,00	30	30	42,4	0,000	0,000	0,000	0,000	0,000	0,000
5C	Incineration and open burning of waste	CO2	18,51	18,51	10	100	100,5	0,016	0,000	0,000	0,000	0,002	0,002
5C	Incineration and open burning of waste	CH4	0,00	0,00	10	100	100,5	0,000	0,000	0,000	0,000	0,000	0,000
5C	Incineration and open burning of waste	N2O	1,45	1,45	10	100	100,5	0,001	0,000	0,000	0,000	0,000	0,000
5D	Wastewater treatment and discharge	CH4	2724,06	2724,06	67	52	84,8	2,015	0,000	0,024	0,000	2,251	2,251
5D	Wastewater treatment and discharge	N2O	239,07	239,07	20	50	53,9	0,112	0,000	0,002	0,000	0,059	0,059
Total			**114801,0**	**114801,0**				**11.98**					**2.72**
%			**100,0**	**100,0**									
National Total			**114801,0**	**114801,0**									

Table 288 Tier 1 Uncertainty Calculation and Reporting, Gg CO_2-eq.(Including LULUCF) for 2019.

IPCC Source category		GHG	Base year emissions (1988)	Year 2019 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A1	Liquid fuels	CO2	10099,2	933,6	3	7	7,6	0,153	-0,041	0,010	-0,289	0,041	0,292
1A1	Solid fuels	CO2	25416,6	19505,7	1	2	2,2	0,940	0,075	0,204	0,150	0,288	0,325
1A1	Gaseous fuels	CO2	6508,6	1943,8	1	2	2,2	0,094	-0,013	0,020	-0,025	0,029	0,038
1A1	All fuel	CH4	18,8	20,9	3	50	50,1	0,023	0,000	0,000	0,006	0,001	0,006
1A1	All fuel	N2O	136,2	109,5	3	200	200,0	0,472	0,000	0,001	0,091	0,005	0,091
1A2	Liquid fuels	CO2	7319,8	1639,4	3	7	7,6	0,269	-0,020	0,017	-0,140	0,073	0,157
1A2	Solid fuels	CO2	10047,7	478,1	1	2	2,2	0,023	-0,046	0,005	-0,092	0,007	0,092
1A2	Gaseous fuels	CO2	0,0	1739,6	1	2	2,2	0,084	0,018	0,018	0,036	0,026	0,045
1A2	Other fossil fuels	CO2	0,0	194,9	5	2	5,4	0,023	0,002	0,002	0,004	0,014	0,015
1A2	All fuel	CH4	31,7	14,6	3	50	50,1	0,016	0,000	0,000	0,000	0,001	0,001
1A2	All fuel	N2O	103,9	32,4	3	200	200,0	0,140	0,000	0,000	-0,038	0,001	0,038
1A3a	Liquid fuel	CO2	76,4	20,7	5	5	7,1	0,003	0,000	0,000	-0,001	0,002	0,002
1A3a	Liquid fuel	CH4	0,0	0,0	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3a	Liquid fuel	N2O	0,6	0,2	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Gasoline	CO2	4217,0	1476,9	3	5	5,8	0,186	-0,006	0,015	-0,030	0,065	0,072
1A3b	Diesel Oil	CO2	2617,2	6705,4	3	5	5,8	0,843	0,057	0,070	0,284	0,297	0,411
1A3b	All fuel	CH4	69,5	21,4	3	40	40,1	0,018	0,000	0,000	-0,005	0,001	0,005
1A3b	All fuel	N2O	90,3	136,6	3	40	40,1	0,118	0,001	0,001	0,039	0,006	0,039
1A3b	LPG	CO2	0,0	1206,7	3	5	5,8	0,152	0,013	0,013	0,063	0,054	0,083
1A3b	Gaseous fuel	CO2	0,0	205,3	3	5	5,8	0,026	0,002	0,002	0,011	0,009	0,014
1A3b	Other liquid fuels	CO2	0,0	22,6	3	5	5,8	0,003	0,000	0,000	0,001	0,001	0,002
1A3c	Liquid fuel	CO2	0,0	31,2	5	5	7,1	0,005	0,000	0,000	0,002	0,002	0,003
1A3c	Liquid fuel	CH4	0,0	0,0	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	N2O	0,0	3,6	5	60	60,2	0,005	0,000	0,000	0,002	0,000	0,002

IPCC Source category		GHG	Base year emissions (1988)	Year 2019 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A3d	Gas/diesel oil	CO2	0,0	6,4	50	5	50,2	0,007	0,000	0,000	0,000	0,005	0,005
1A3d	Gas/diesel oil	CH4	0,0	0,0	50	50	70,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	Gas/diesel oil	N2O	0,0	0,1	50	140	148,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	CO2	0,0	126,1	1	5	5,1	0,014	0,001	0,001	0,007	0,002	0,007
1A3e	Gaseous fuel	CH4	0,0	0,1	1	50	50,0	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	N2O	0,0	0,1	1	150	150,0	0,000	0,000	0,000	0,000	0,000	0,000
1A4	Liquid fuel	CO2	2825,1	524,2	5	7	8,6	0,097	-0,009	0,005	-0,062	0,039	0,073
1A4	Solid fuel	CO2	3548,1	441,5	2	5	5,4	0,051	-0,013	0,005	-0,067	0,013	0,068
1A4	Gaseous fuel	CO2	0,0	409,1	5	2	5,4	0,048	0,004	0,004	0,009	0,030	0,031
1A4	All fuel	CH4	334,7	296,4	5	50	50,2	0,321	0,001	0,003	0,070	0,022	0,073
1A4	All fuel	N2O	209,7	87,0	5	200	200,1	0,375	0,000	0,001	-0,031	0,006	0,031
1A5	Stationary - Fossil fuels	CO2	5093,8	0,0	5	7	8,6	0,000	-0,026	0,000	-0,181	0,000	0,181
1A5	Stationary - Fossil fuels	CH4	4,8	0,0	5	50	50,2	0,000	0,000	0,000	-0,001	0,000	0,001
1A5	Stationary - Fossil fuels	N2O	9,8	0,0	5	200	200,1	0,000	0,000	0,000	-0,010	0,000	0,010
1B1	Solid fuel	CO2	68,8	22,7	10	200	200,2	0,098	0,000	0,000	-0,022	0,003	0,023
1B1	Solid fuel	CH4	2079,6	814,5	10	200	200,2	3,517	-0,002	0,009	-0,404	0,120	0,422
1B2	Oil and Natural Gas	CO2	94,3	804,2	5	100	100,1	1,736	0,008	0,008	0,793	0,059	0,795
1B2	Oil and Natural Gas	CH4	147,7	238,0	5	100	100,1	0,514	0,002	0,002	0,174	0,018	0,175
1B2	Oil and Natural Gas	N2O	0,4	1,0	5	1000	1000,0	0,021	0,000	0,000	0,008	0,000	0,008
2A1	Cement Production	CO2	2454,5	1127,1	1,5	1,5	2,1	0,052	-0,001	0,012	-0,001	0,025	0,025
2A2	Lime Production	CO2	450,1	248,6	2	2	2,8	0,015	0,000	0,003	0,001	0,007	0,007
2A3	Glass production	CO2	186,2	76,1	10	10	14,1	0,023	0,000	0,001	-0,001	0,011	0,011
2A4a	Ceramics - Bricks and Tails	CO2	522,5	71,9	3	5	5,8	0,009	-0,002	0,001	-0,009	0,003	0,010
2A4b	Soda ash uses	CO2	126,6	72,4	2	1	2,2	0,003	0,000	0,001	0,000	0,002	0,002
2A4d	DeSOx - instalations	CO2	0,0	729,2	1,5	1,5	2,1	0,033	0,008	0,008	0,011	0,016	0,020

IPCC Source category		GHG	Base year emissions (1988)	Year 2019 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
2B1	Ammonia Production	CO2	2557,5	600,8	2	7	7,3	0,094	-0,007	0,006	-0,047	0,018	0,050
2B2	Nitric Acid Production	N2O	1932,0	779,6	2	10	10,2	0,171	-0,002	0,008	-0,016	0,023	0,028
2B5b	Calcium Carbide	CO2	73,9	7,1	5	10	11,2	0,002	0,000	0,000	-0,003	0,001	0,003
2B7	Soda ash production	CO2	397,6	512,1	2	2	2,8	0,031	0,003	0,005	0,007	0,015	0,017
2B8	Petrochemical and carbon black production	CH4	17,4	0,0	5	10	11,2	0,000	0,000	0,000	-0,001	0,000	0,001
2B8b	Ethylene	CO2	442,1	0,0	5	30	30,4	0,000	-0,002	0,000	-0,067	0,000	0,067
2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	1,9	0,0	5	20	20,6	0,000	0,000	0,000	0,000	0,000	0,000
2C1	Iron and Steel Production	CO2	3481,4	31,6	5	5	7,1	0,005	-0,017	0,000	-0,086	0,002	0,087
2C1	Iron and Steel Production	CH4	32,4	0,0	10	25	26,9	0,000	0,000	0,000	-0,004	0,000	0,004
2C2	Ferroalloys Production	CO2	254,9	0,0	5	25	25,5	0,000	-0,001	0,000	-0,032	0,000	0,032
2C2	Ferroalloys Production	CH4	2,3	0,0	5	25	25,5	0,000	0,000	0,000	0,000	0,000	0,000
2C2	Lead production	CO2	162,8	7,9	5	15	15,8	0,003	-0,001	0,000	-0,011	0,001	0,011
2C2	Zinc production	CO2	90,5	121,2	5	15	15,8	0,041	0,001	0,001	0,012	0,009	0,015
2D	Non-energy products from fuels and solvent use	CO2	229,2	100,5	10	30	31,6	0,069	0,000	0,001	-0,003	0,015	0,015
2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0,0	1818,6	10	50	51,0	1,999	0,019	0,019	0,950	0,269	0,988
2G	Other product manufacture and use	N2O	32,6	12,4	10	1	10,0	0,003	0,000	0,000	0,000	0,002	0,002
2G	Other product manufacture and use	CO2	28,8	24,4	10	30	31,6	0,017	0,000	0,000	0,003	0,004	0,005
2G1	Electrical equipment - SF6	CO2eq	3,3	18,3	10	50	51,0	0,020	0,000	0,000	0,009	0,003	0,009
2H	Other	CO2	0,0	0,0	10	30	31,6	0,000	0,000	0,000	0,000	0,000	0,000
3A1	Cattle	CH4	3074,8	1076,7	0,64	20	20,0	0,465	-0,004	0,011	-0,086	0,010	0,087
3A2	Sheep	CH4	1603,4	244,7	1,63	20	20,1	0,106	-0,006	0,003	-0,111	0,006	0,111
3A3	Swine	CH4	151,6	21,5	0,51	50	50,0	0,023	-0,001	0,000	-0,027	0,000	0,027
3A4	Other livestock	CH4	241,4	92,0	2	50	50,0	0,099	0,000	0,001	-0,013	0,003	0,013
3B	N2O em. from Manure Management	N2O	940,9	293,5	2	300	300,0	1,898	-0,002	0,003	-0,510	0,009	0,510
3B1	Cattle	CH4	473,2	218,5	25	20	32,0	0,151	0,000	0,002	-0,002	0,081	0,081

IPCC Source category		GHG	Base year emissions (1988)	Year 2019 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
3B2	Sheep	CH4	46,8	7,1	50	20	53,9	0,008	0,000	0,000	-0,003	0,005	0,006
3B3	Swine	CH4	519,9	63,3	25	20	32,0	0,044	-0,002	0,001	-0,039	0,023	0,046
3B4	Other livestock	CH4	44,0	14,6	50	30	58,3	0,018	0,000	0,000	-0,002	0,011	0,011
3C	Rice Cultivation	CH4	127,0	106,5	20	60	63,2	0,145	0,000	0,001	0,028	0,031	0,042
3Da	Direct N2O emissions from managed soils	N2O	4827,8	3172,9	3	200	200,0	13,684	0,009	0,033	1,740	0,141	1,746
3Db	Indirect N2O Emissions from managed soils	N2O	1464,6	867,5	3	500	500,0	9,353	0,002	0,009	0,824	0,038	0,824
3F	Field burning of agricultural residues	CH4	29,1	29,4	3	50	50,1	0,032	0,000	0,000	0,008	0,001	0,008
3F	Field burning of agricultural residues	N2O	8,3	8,2	3	20	20,2	0,004	0,000	0,000	0,001	0,000	0,001
3H	Urea application	CO2	62,2	33,0	2	50	50,0	0,036	0,000	0,000	0,002	0,001	0,002
4A1	Forest Land remaining Forest Land	CO2	-16262,8	-6784,3	30	80	85,4	-12,498	0,011	-0,071	0,920	-3,008	3,145
4A2	Land converted to Forest Land	CO2	-956,2	-1535,9	30	400	401,1	-13,284	-0,011	-0,016	-4,484	-0,681	4,535
4A1 (V)	Forest fires	CO2eq	1,7	20,8	30	30	42,4	0,019	0,000	0,000	0,006	0,009	0,011
4A2 (V)	Forest fires	CO2eq	0,1	1,4	10	100	100,5	0,003	0,000	0,000	0,001	0,000	0,001
4B1	Cropland remainig Cropland	CO2	-920,5	-539,6	10	100	100,5	-1,169	-0,001	-0,006	-0,098	-0,080	0,126
4B2	Land converted to Cropland	CO2	98,1	721,6	10	100	100,5	1,564	0,007	0,008	0,704	0,107	0,712
4C1	Grassland remaining grassland	CO2	177,1	76,9	67	52	84,8	0,141	0,000	0,001	-0,005	0,076	0,076
4C2	Land converted to Grassland	CO2	-1170,2	-1303,2	20	50	53,9	-1,513	-0,008	-0,014	-0,385	-0,385	0,544
4D2	Land converted to Wetlands	CO2	119,9	246,3	10	25	26,5	0,141	0,002	0,003	0,048	0,036	0,060
4E2	Land converted to Settlements	CO2	484,3	798,2	10	74	75,0	1,291	0,006	0,008	0,438	0,118	0,453
4F	Land converted to other land	CO2	0,0	0,0	10	50	51,0	0,000	0,000	0,000	0,000	0,000	0,000
4G	Harvested wood products	CO2	-583,3	-1338,6	10	73	73,7	-2,127	-0,011	-0,014	-0,806	-0,198	0,830
4	Indirect N2O Emissions from managed soils	N2O	34,1	74,3	3	500	500,0	0,801	0,001	0,001	0,302	0,003	0,302
5A	Solid waste disposal	CH4	3418,2	2556,5	30	80	85,4	3,905	0,008	0,022	0,620	0,946	1,131
5B	Biological treatment of solid waste	CH4	0,0	9,6	30	400	401,1	0,069	0,000	0,000	0,033	0,004	0,034
5B	Biological treatment of solid waste	N2O	0,0	6,8	30	30	42,4	0,005	0,000	0,000	0,002	0,003	0,003

IPCC Source category		GHG	Base year emissions (1988)	Year 2019 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
5C	Incineration and open burning of waste	CO2	18,5	6,9	10	100	100,5	0,012	0,000	0,000	-0,002	0,001	0,002
5C	Incineration and open burning of waste	CH4	0,0	0,0	10	100	100,5	0,000	0,000	0,000	0,000	0,000	0,000
5C	Incineration and open burning of waste	N2O	1,4	1,0	10	100	100,5	0,002	0,000	0,000	0,000	0,000	0,000
5D	Wastewater treatment and discharge	CH4	2724,1	399,8	67	52	84,8	0,606	-0,008	0,003	-0,421	0,330	0,535
5D	Wastewater treatment and discharge	N2O	239,1	137,6	20	50	53,9	0,132	0,000	0,001	0,009	0,034	0,035
1A1	Liquid fuels	CO2	10099,2	933,6	3	7	7,6	0,153	-0,041	0,010	-0,289	0,041	0,292
Total			**95823,3**	**46393,3**				**25.73**					**6.34**
%			**100,0**	**100,0**									
National Total			**95823,3**	**46393,3**									

** Considering LULUCF sector, values for the uncertainty related to activity data and emission factor have been assigned by expert judgment, taking into account the final combined uncertainty.*

Table 289 Tier 1 Uncertainty Calculation and Reporting, Gg CO_2-eq.(Including LULUCF) for 1988.

IPCC Source category		GHG	Base year emissions (1988)	Year 1988 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 1988	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A1	Liquid fuels	CO2	10099,2	10099,2	3	7	7,6	0,804	0,000	0,106	0,000	0,448	0,448
1A1	Solid fuels	CO2	25416,6	25416,6	1	2	2,2	0,594	0,000	0,266	0,000	0,376	0,376
1A1	Gaseous fuels	CO2	6508,6	6508,6	1	2	2,2	0,152	0,000	0,068	0,000	0,096	0,096
1A1	All fuel	CH4	18,8	18,8	3	50	50,1	0,010	0,000	0,000	0,000	0,001	0,001
1A1	All fuel	N2O	136,2	136,2	3	200	200,0	0,285	0,000	0,001	0,000	0,006	0,006
1A2	Liquid fuels	CO2	7319,8	7319,8	3	7	7,6	0,583	0,000	0,076	0,000	0,325	0,325
1A2	Solid fuels	CO2	10047,7	10047,7	1	2	2,2	0,235	0,000	0,105	0,000	0,148	0,148
1A2	Gaseous fuels	CO2	0,0	0,0	1	2	2,2	0,000	0,000	0,000	0,000	0,000	0,000
1A2	Other fossil fuels	CO2	0,0	0,0	5	2	5,4	0,000	0,000	0,000	0,000	0,000	0,000
1A2	All fuel	CH4	31,7	31,7	3	50	50,1	0,017	0,000	0,000	0,000	0,001	0,001
1A2	All fuel	N2O	103,9	103,9	3	200	200,0	0,217	0,000	0,001	0,000	0,005	0,005
1A3a	Liquid fuel	CO2	76,4	76,4	5	5	7,1	0,006	0,000	0,001	0,000	0,006	0,006
1A3a	Liquid fuel	CH4	0,0	0,0	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3a	Liquid fuel	N2O	0,6	0,6	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Gasoline	CO2	4217,0	4217,0	3	5	5,8	0,257	0,000	0,044	0,000	0,187	0,187
1A3b	Diesel Oil	CO2	2617,2	2617,2	3	5	5,8	0,159	0,000	0,027	0,000	0,116	0,116
1A3b	All fuel	CH4	69,5	69,5	3	40	40,1	0,029	0,000	0,001	0,000	0,003	0,003
1A3b	All fuel	N2O	90,3	90,3	3	40	40,1	0,038	0,000	0,001	0,000	0,004	0,004
1A3b	LPG	CO2	0,0	0,0	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Gaseous fuel	CO2	0,0	0,0	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Other liquid fuels	CO2	0,0	0,0	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	CO2	0,0	0,0	5	5	7,1	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	CH4	0,0	0,0	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	N2O	0,0	0,0	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	Gas/diesel oil	CO2	0,0	0,0	50	5	50,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	Gas/diesel oil	CH4	0,0	0,0	50	50	70,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	Gas/diesel oil	N2O	0,0	0,0	50	140	148,7	0,000	0,000	0,000	0,000	0,000	0,000

IPCC Source category		GHG	Base year emissions (1988)	Year 1988 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 1988	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A3e	Gaseous fuel	CO2	0,0	0,0	1	5	5,1	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	CH4	0,0	0,0	1	50	50,0	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	N2O	0,0	0,0	1	150	150,0	0,000	0,000	0,000	0,000	0,000	0,000
1A4	Liquid fuel	CO2	2825,1	2825,1	5	7	8,6	0,254	0,000	0,030	0,000	0,209	0,209
1A4	Solid fuel	CO2	3548,1	3548,1	2	5	5,4	0,200	0,000	0,037	0,000	0,105	0,105
1A4	Gaseous fuel	CO2	0,0	0,0	5	2	5,4	0,000	0,000	0,000	0,000	0,000	0,000
1A4	All fuel	CH4	334,7	334,7	5	50	50,2	0,176	0,000	0,003	0,000	0,025	0,025
1A4	All fuel	N2O	209,7	209,7	5	200	200,1	0,438	0,000	0,002	0,000	0,015	0,015
1A5	Stationary - Fossil fuels	CO2	5093,8	5093,8	5	7	8,6	0,458	0,000	0,053	0,000	0,376	0,376
1A5	Stationary - Fossil fuels	CH4	4,8	4,8	5	50	50,2	0,003	0,000	0,000	0,000	0,000	0,000
1A5	Stationary - Fossil fuels	N2O	9,8	9,8	5	200	200,1	0,020	0,000	0,000	0,000	0,001	0,001
1B1	Solid fuel	CO2	68,8	68,8	10	200	200,2	0,098	0,000	0,000	-0,022	0,003	0,023
1B1	Solid fuel	CH4	2079,6	2079,6	10	200	200,2	4,352	0,000	0,022	0,000	0,307	0,307
1B2	Oil and Natural Gas	CO2	94,3	94,3	5	100	100,1	0,099	0,000	0,001	0,000	0,007	0,007
1B2	Oil and Natural Gas	CH4	147,7	147,7	5	100	100,1	0,155	0,000	0,002	0,000	0,011	0,011
1B2	Oil and Natural Gas	N2O	0,4	0,4	5	1000	1000,0	0,004	0,000	0,000	0,000	0,000	0,000
2A1	Cement Production	CO2	2454,5	2454,5	1,5	1,5	2,1	0,054	0,000	0,026	0,000	0,054	0,054
2A2	Lime Production	CO2	450,1	450,1	2	2	2,8	0,013	0,000	0,005	0,000	0,013	0,013
2A3	Glass production	CO2	186,2	186,2	10	10	14,1	0,028	0,000	0,002	0,000	0,028	0,028
2A4a	Ceramics - Bricks and Tails	CO2	522,5	522,5	3	5	5,8	0,032	0,000	0,005	0,000	0,023	0,023
2A4b	Soda ash uses	CO2	126,6	126,6	2	1	2,2	0,003	0,000	0,001	0,000	0,004	0,004
2A4d	DeSOx - instalations	CO2	0,0	0,0	1,5	1,5	2,1	0,000	0,000	0,000	0,000	0,000	0,000
2B1	Ammonia Production	CO2	2557,5	2557,5	2	7	7,3	0,195	0,000	0,027	0,000	0,076	0,076
2B2	Nitric Acid Production	N2O	1932,0	1932,0	2	10	10,2	0,206	0,000	0,020	0,000	0,057	0,057
2B5b	Calcium Carbide	CO2	73,9	73,9	5	10	11,2	0,009	0,000	0,001	0,000	0,005	0,005
2B7	Soda ash production	CO2	397,6	397,6	2	2	2,8	0,012	0,000	0,004	0,000	0,012	0,012
2B8	Petrochemical and carbon black production	CH4	17,4	17,4	5	10	11,2	0,002	0,000	0,000	0,000	0,001	0,001
2B8b	Ethylene	CO2	442,1	442,1	5	30	30,4	0,141	0,000	0,005	0,000	0,033	0,033

IPCC Source category		GHG	Base year emissions (1988)	Year 1988 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 1988	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	1,9	1,9	5	20	20,6	0,000	0,000	0,000	0,000	0,000	0,000
2C1	Iron and Steel Production	CO2	3481,4	3481,4	5	5	7,1	0,257	0,000	0,036	0,000	0,257	0,257
2C1	Iron and Steel Production	CH4	32,4	32,4	10	25	26,9	0,009	0,000	0,000	0,000	0,005	0,005
2C2	Ferroalloys Production	CO2	254,9	254,9	5	25	25,5	0,068	0,000	0,003	0,000	0,019	0,019
2C2	Ferroalloys Production	CH4	2,3	2,3	5	25	25,5	0,001	0,000	0,000	0,000	0,000	0,000
2C2	Lead production	CO2	162,8	162,8	5	15	15,8	0,027	0,000	0,002	0,000	0,012	0,012
2C2	Zinc production	CO2	90,5	90,5	5	15	15,8	0,015	0,000	0,001	0,000	0,007	0,007
2D	Non-energy products from fuels and solvent use	CO2	229,2	229,2	10	30	31,6	0,076	0,000	0,002	0,000	0,034	0,034
2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0,0	0,0	10	50	51,0	0,000	0,000	0,000	0,000	0,000	0,000
2G	Other product manufacture and use	N2O	32,6	32,6	10	1	10,0	0,003	0,000	0,000	0,000	0,005	0,005
2G	Other product manufacture and use	CO2	28,8	28,8	10	30	31,6	0,010	0,000	0,000	0,000	0,004	0,004
2G1	Electrical equipment - SF6	CO2eq	3,3	3,3	10	50	51,0	0,002	0,000	0,000	0,000	0,000	0,000
2H	Other	CO2	0,0	0,0	10	30	31,6	0,000	0,000	0,000	0,000	0,000	0,000
3A1	Cattle	CH4	3074,8	3074,8	0,64	20	20,0	0,643	0,000	0,032	0,000	0,029	0,029
3A2	Sheep	CH4	1603,4	1603,4	1,63	20	20,1	0,336	0,000	0,017	0,000	0,039	0,039
3A3	Swine	CH4	151,6	151,6	0,51	50	50,0	0,079	0,000	0,002	0,000	0,001	0,001
3A4	Other livestock	CH4	241,4	241,4	2	50	50,0	0,126	0,000	0,003	0,000	0,007	0,007
3B	N2O em. from Manure Management	N2O	940,9	940,9	2	300	300,0	2,950	0,000	0,010	0,000	0,028	0,028
3B1	Cattle	CH4	473,2	473,2	25	20	32,0	0,158	0,000	0,005	0,000	0,175	0,175
3B2	Sheep	CH4	46,8	46,8	50	20	53,9	0,026	0,000	0,000	0,000	0,035	0,035
3B3	Swine	CH4	519,9	519,9	25	20	32,0	0,174	0,000	0,005	0,000	0,192	0,192
3B4	Other livestock	CH4	44,0	44,0	50	30	58,3	0,027	0,000	0,000	0,000	0,033	0,033
3C	Rice Cultivation	CH4	127,0	127,0	20	60	63,2	0,084	0,000	0,001	0,000	0,038	0,038
3Da	Direct N2O emissions from managed soils	N2O	4827,8	4827,8	3	200	200,0	10,092	0,000	0,050	0,000	0,214	0,214
3Db	Indirect N2O Emissions from managed soils	N2O	1464,6	1464,6	3	500	500,0	7,653	0,000	0,015	0,000	0,065	0,065
3F	Field burning of agricultural residues	CH4	29,1	29,1	3	50	50,1	0,015	0,000	0,000	0,000	0,001	0,001
3F	Field burning of agricultural residues	N2O	8,3	8,3	3	20	20,2	0,002	0,000	0,000	0,000	0,000	0,000

IPCC Source category		GHG	Base year emissions (1988)	Year 1988 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 1988	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
3H	Urea application	CO2	62,2	62,2	2	50	50,0	0,033	0,000	0,001	0,000	0,002	0,002
4A1	Forest Land remaining Forest Land	CO2	-16262,8	-16262,8	30	80	85,4	-14,521	0,000	-0,170	0,000	-7,211	7,211
4A2	Land converted to Forest Land	CO2	-956,2	-956,2	30	400	401,1	-4,008	0,000	-0,010	0,000	-0,424	0,424
4A1 (V)	Forest fires	CO2eq	1,7	1,7	30	30	42,4	0,001	0,000	0,000	0,000	0,001	0,001
4A2 (V)	Forest fires	CO2eq	0,1	0,1	10	100	100,5	0,000	0,000	0,000	0,000	0,000	0,000
4B1	Cropland remainig Cropland	CO2	-920,5	-920,5	10	100	100,5	-0,967	0,000	-0,010	0,000	-0,136	0,136
4B2	Land converted to Cropland	CO2	98,1	98,1	10	100	100,5	0,103	0,000	0,001	0,000	0,014	0,014
4C1	Grassland remaining grassland	CO2	177,1	177,1	67	52	84,8	0,141	0,000	0,001	-0,005	0,076	0,076
4C2	Land converted to Grassland	CO2	-1170,2	-1170,2	20	50	53,9	-0,659	0,000	-0,012	0,000	-0,346	0,346
4D2	Land converted to Wetlands	CO2	119,9	119,9	10	25	26,5	0,033	0,000	0,001	0,000	0,018	0,018
4E2	Land converted to Settlements	CO2	484,3	484,3	10	74	75,0	0,380	0,000	0,005	0,000	0,072	0,072
4F	Land converted to other land	CO2	0,0	0,0	10	50	51,0	0,000	0,000	0,000	0,000	0,000	0,000
4G	Harvested wood products	CO2	-583,3	-583,3	10	73	73,7	-0,449	0,000	-0,006	0,000	-0,086	0,086
4	Indirect N2O Emissions from managed soils	N2O	34,1	34,1	3	500	500,0	0,178	0,000	0,000	0,000	0,002	0,002
5A	Solid waste disposal	CH4	3418,2	3418,2	30	80	85,4	3,052	0,000	0,036	0,000	1,516	1,516
5B	Biological treatment of solid waste	CH4	0,0	0,0	30	400	401,1	0,000	0,000	0,000	0,000	0,000	0,000
5B	Biological treatment of solid waste	N2O	0,0	0,0	30	30	42,4	0,000	0,000	0,000	0,000	0,000	0,000
5C	Incineration and open burning of waste	CO2	18,5	18,5	10	100	100,5	0,019	0,000	0,000	0,000	0,003	0,003
5C	Incineration and open burning of waste	CH4	0,0	0,0	10	100	100,5	0,000	0,000	0,000	0,000	0,000	0,000
5C	Incineration and open burning of waste	N2O	1,4	1,4	10	100	100,5	0,002	0,000	0,000	0,000	0,000	0,000
5D	Wastewater treatment and discharge	CH4	2724,1	2724,1	67	52	84,8	2,414	0,000	0,028	0,000	2,697	2,697
5D	Wastewater treatment and discharge	N2O	239,1	239,1	20	50	53,9	0,135	0,000	0,002	0,000	0,071	0,071
Total			**95689,6**	**95689,6**				**20.86**					**7.93**
%			**100**	**100**									
National Total			**95823,3**	**95823,3**									

** Considering LULUCF sector, values for the uncertainty related to activity data and emission factor have been assigned by expert judgment, taking into account the final combined uncertainty.*

ANNEX 3 DETAILED METHODOLOGICAL DESCRIPTION AND DATA FOR ESTIMATING CO2 EMISSIONS FROM FOSSIL FUEL COMBUSTION

The emission estimates were prepared according to the following allocation between Eurostat energy balance categories and CRF categories and by using the following corresponding NCVs in the calculation model:

Eurostat Category	CRF Category	NCV applied
Indigenous Production		Production (net)
Underground Production		
Surface Production		
From Other Sources		
From Other Sources - Oil		
From Other Sources - Natural Gas		
From Other Sources - Renewables		
Total Imports (Balance)		Imports (net)
Total Exports (Balance)		Exports (net)
International Marine Bunkers		
Stock Changes (National Territory)		
Inland Consumption (Calculated)		
Statistical Differences		
Transformation Sector		
Main Activity Producer Electricity Plants	1A1ai	Used in Main Activity Plants (net)
Main Activity Producer CHP Plants	1A1aii	Used in Main Activity Plants (net)
Main Activity Producer Heat Plants	1A1aiii	Used in Main Activity Plants (net)
Autoproducer Electricity Plants	1A2gviii	Used in industry (net)
Autoproducer CHP Plants	1A2gviii	Used in industry (net)
Autoproducer Heat Plants	1A2gviii	Used in industry (net)
Patent Fuel Plants (Transformation)		Used in industry (net)
Coke Ovens (Transformation)		Used in coke ovens (net)
BKB/PB plants (Transformation)		Used in industry (net)
Gas Works (Transformation)		
Blast Furnaces (Transformation)		Used in blast furnaces (net)
Coal Liquefaction Plants (Transformation)		
For Blended Natural Gas		
Not elsewhere specified (Transformation)		
Energy Sector		
Own Use in Electricity, CHP and Heat Plants	1A1ai	Used in Main Activity Plants (net)
Coal Mines	1A1ci	Production (net)
Patent Fuel Plants (Energy)	1A1ci	Production (net)
Coke Ovens (Energy)	1A1ci	Used in coke ovens (net)
BKB/PB plants (Energy)	1A1ci	Production (net)
Gas Works (Energy)		
Blast Furnaces (Energy)	1A2a	Used in blast furnaces (net)
Oil refineries	1A1b	Used in industry (net)
Coal Liquefaction Plants (Energy)		
Not elsewhere specified (Energy industry own use)	1A1ciii	For Other Uses (net)
Distribution Losses		
Total Final Consumption		
Total Non-Energy Use		
Non-Energy Use Industry/Transformation/Energy		
Of which: Non-Energy Use-Chemical/Petrochem		
Non-Energy Use in Transport		
Non-Energy Use in Other Sectors		
Final Energy Consumption		
Industry Sector		
Iron and Steel	1A2a	Used in industry (net)

Eurostat Category	CRF Category	NCV applied
Chemical and petrochemical	1A2c	Used in industry (net)
Non-Ferrous Metals	1A2b	Used in industry (net)
Non-Metallic Minerals	1A2f	Used in industry (net)
Transport Equipment	1A2gii	Used in industry (net)
Machinery	1A2gi	Used in industry (net)
Mining and Quarrying	1A2giii	Used in industry (net)
Food, Beverages and Tobacco	1A2e	Used in industry (net)
Paper, Pulp and Printing	1A2d	Used in industry (net)
Wood and Wood Products	1A2giv	Used in industry (net)
Construction	1A2gv	Used in industry (net)
Textiles and Leather	1A2gvi	Used in industry (net)
Not elsewhere specified (Industry)	1A2gviii	Used in industry (net)
Transport Sector		
Rail	1A3c	
Domestic Navigation	1A3d	
Not elsewhere specified (Transport)	1A3eii	
Other Sectors		
Commercial and Public Services	1A4ai	For Other Uses (net)
Residential	1A4bi	For Other Uses (net)
Agriculture/Forestry	1A4ci	For Other Uses (net)
Fishing	1A4ci	For Other Uses (net)
Not elsewhere specified (Other)	1A5a	For Other Uses (net)

For the sectoral approach were considered all fuels for which there was reported energy consumption.

Solid fuels:	**Liquid fuels:**
Anthracite Coking Coal Other Bituminous Coal Sub-bituminous Coal Lignite/Brown Coal Coke Oven Coke Coal Tar BKB/PB Coke Oven Gas Blast Furnace Gas	Crude Oil Refinery Gas LPG Motor Gasoline Aviation Gasoline Kerosene Type Jet Fuel Gas-Diesel Oil Residual Fuel Oil Petroleum Coke Other Products
Gaseous fuels: Natural Gas	

In order to avoid double counting in the Energy sector, the following categories were not considered:

- Lignite/Brown coal used in BKB Plants (Transformation). The quantities which were considered instead are BKBs in all sectors.
- Coking coal used in Coke Ovens (Transformation). The quantities which were considered instead are:
  - Coke oven coke used in Blast Furnaces (Transformation) and Iron and Steel industry sector
  - Coke oven gas used in Autoproducer CHP Plants, Blast Furnaces (Energy) and Iron and Steel industry sector.
- Blast Furnace Gas used in Autoproducer CHP Plants, Blast Furnaces (Energy) and Iron and Steel industry sector and also the quantities of Coke oven coke used in Blast Furnaces (Transformation). These fuels are accounted under the Industrial processes sector since the emissions are calculated based on mass balance approach.

In addition, following the recommendation of the Technical review of GHG inventories under the EU Effort Sharing Decision (ESD) in 2012, we revised the methodology concerning Iron & Steel sector in order to remove the double counting with the IP sector. The following quantities were disregarded from the Energy sector:

- Coke Oven Gas reported under blast furnaces;
- Blast Furnace Gas reported under blast furnaces, Autoproducers and Iron & Steel subcategories;
- Coke oven coke in blast furnaces.

ANNEX 4 CO2 REFERENCE APPROACH AND COMPARISON WITH SECTORAL APPROACH, AND RELEVANT INFORMATION ON THE NATIONAL ENERGY BALANCE

For the reference approach both fuels were considered for which there was reported energy and non-energy consumption.

Solid fuels:	Liquid fuels:
Anthracite Coking Coal Other Bituminous Coal Sub-bituminous Coal Lignite/Brown Coal Coke Oven Coke Coal Tar BKB/PB	Crude Oil LPG Motor Gasoline Aviation Gasoline Kerosene Type Jet Fuel Other Kerosene Gas-Diesel Oil Residual Fuel Oil Petroleum Coke
Gaseous fuels: Natural Gas	Other Products Naphtha White spirit Lubricants Bitumen Paraffin waxes Refinery Feedstocks

In order to avoid double counting, the apparent consumption for different fuels was calculated according to the 2006 IPCC Guidelines, Vol. 2, Ch. 6.4.1.

The carbon used as feedstock, reductant, or as non-energy products has been excluded from the estimates.

For the purposes of the reference approach only were calculated weighted average net calorific value for solid fuels from production, imports and exports for each fuel and each year:

Table 290 Weighted average net calorific value for solid fuels

[MJ/t]	Anthracite	Coking Coal	Other Bituminous Coal	Sub-bituminous Coal	Lignite / Brown Coal	BKB	Coke Oven Coke
1988	24.259	24.702	25.076	-	7.034	20.097	28.200
1989	24.259	24.702	25.076	-	7.034	20.097	28.200
1990	25.413	25.880	25.686	-	6.682	18.367	25.061
1991	26.140	25.880	26.705	11.643	6.268	18.367	26.380
1992	24.617	27.215	24.077	11.669	6.813	18.359	26.380
1993	23.559	32.481	23.363	11.776	6.838	18.569	31.059
1994	24.953	31.863	24.847	11.583	6.733	18.680	30.019
1995	26.234	30.148	25.740	11.537	6.584	18.683	29.832
1996	24.227	32.804	24.541	11.643	6.680	18.722	29.714
1997	24.948	32.709	25.404	-	7.014	18.757	30.061
1998	25.352	32.658	25.583	-	7.014	17.917	30.141
1999	26.024	32.659	25.725	-	7.025	17.077	30.220
2000	23.266	33.412	23.260	-	6.762	15.739	30.117
2001	24.794	30.480	24.987	-	7.036	16.082	29.969
2002	25.352	27.457	25.660	-	7.089	16.459	30.031
2003	24.359	29.326	24.946	-	7.106	16.490	29.955
2004	24.804	28.610	24.227	-	7.161	15.976	27.423
2005	24.465	28.638	24.365	-	7.079	15.125	27.270
2006	24.916	25.122	25.131	-	7.010	11.712	29.700
2007	23.899	27.973	24.645	-	6.973	11.504	28.500

[MJ/t]	Anthracite	Coking Coal	Other Bituminous Coal	Sub-bituminous Coal	Lignite / Brown Coal	BKB	Coke Oven Coke
2008	22.728	28.610	25.527	-	6.987	12.568	28.500
2009	25.200	-	25.756	-	7.006	12.212	28.500
2010	24.812	-	26.253	-	7.004	12.768	28.500
2011	24.349	-	26.755	-	6.973	13.064	28.500
2012	26.155	-	25.563	-	6.992	12.475	28.500
2013	26.379	-	25.737	-	6.961	10.175	28.500
2014	28.711	-	26.681	-	6.820	12.191	28.500
2015	28.811	-	27.615	-	6.799	13.429	28.500
2016	30.231	-	26.737	-	6.810	11.636	28.500
2017	29.772	-	24.000	-	6.918	12.625	28.500
2018	29.901	-	26.657	-	6.981	12.938	28.500
2019	29.871	-	25.421	-	6.972	11.686	28.500

For the sectoral approach were used the NCVs per sector, as indicated in the National Energy Balance.

ANNEX 5 NATIONAL ENERGY BALANCE

The national energy balance will be provided to the ERT during the review due to the confidentiality of information.

ANNEX 6 ASSESSMENT OF COMPLETENESS AND (POTENTIAL) SOURCES AND SINKS OF GREENHOUSE GAS EMISSIONS AND REMOVALS EXCLUDED FOR THE ANNUAL INVENTORY SUBMISSION

Provided in Chapter 1.7

ANNEX 7 VEHICLE FLEET AND MILEAGE DATA FOR ROAD TRANSPORT

Table 291 Vehicle fleet data for Road transport (number of vehicles) 1988-2003

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
PC Gasoline Small	PRE ECE	527486	555663	525315	488467	446732	433523	415328	388541	356030	314911	286702	267748	247929	229590	214437	209367
PC Gasoline Small	ECE 15/00-01	-	-	23493	48846	74918	81284	82671	81874	79171	73638	70217	68368	65658	62676	59912	59356
PC Gasoline Small	ECE 15/02	-	-	11746	24423	37459	54189	72553	91062	108840	123008	140858	147072	136211	124408	112562	103932
PC Gasoline Small	ECE 15/03	-	-	9789	20353	31216	45158	60461	75885	90700	102507	117381	136178	155079	175154	182903	172318
PC Gasoline Small	ECE 15/04	-	-	8443	17554	26924	38949	52148	65451	78228	88412	101242	117453	133756	151071	170900	200904
PC Gasoline Small	Euro 1	-	-	-	-	8470	18380	29531	41183	52739	62584	74320	88685	103289	118821	136485	162530
PC Gasoline Small	Euro 2	-	-	-	-	-	-	-	-	10006	19790	30216	42066	54437	67632	82395	102790
PC Gasoline Small	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	11369	23540	36873	53667
PC Gasoline Small	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	PRE ECE	565259	582380	538517	489805	438193	415987	389876	356824	319887	276824	246579	225305	204123	184944	169008	161448
PC Gasoline Medium	ECE 15/00-01	-	-	24083	48980	73486	77996	77605	75190	71134	64732	60390	57530	54057	50488	47220	45771
PC Gasoline Medium	ECE 15/02	-	-	12042	24490	36743	51997	68107	83628	97791	108130	121146	123758	112144	100216	88715	80145
PC Gasoline Medium	ECE 15/03	-	-	10035	20408	30619	43331	56756	69690	81492	90109	100955	114591	127679	141094	144155	132878
PC Gasoline Medium	ECE 15/04	-	-	8655	17602	26409	37373	48952	60108	70287	77719	87073	98835	110123	121693	134695	154922
PC Gasoline Medium	Euro 1	-	-	-	-	8309	17637	27721	37821	47385	55015	63920	74626	85039	95715	107570	125331
PC Gasoline Medium	Euro 2	-	-	-	-	-	-	-	-	8990	17397	25988	35397	44818	54480	64939	79264
PC Gasoline Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	9360	18963	29061	41384
PC Gasoline Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	PRE ECE	128039	131915	121978	110943	99251	94220	88305	80817	72451	62696	55846	51026	46228	41884	38275	36562
PC Gasoline Large	ECE 15/00-01	-	-	5455	11094	16645	17666	17577	17030	16111	14661	13677	13029	12243	11434	10694	10365
PC Gasoline Large	ECE 15/02	-	-	2727	5547	8322	11777	15426	18941	22148	24490	27437	28028	25398	22696	20091	18150
PC Gasoline Large	ECE 15/03	-	-	2273	4623	6935	9814	12855	15784	18457	20408	22864	25952	28916	31953	32646	30092
PC Gasoline Large	ECE 15/04	-	-	1960	3987	5982	8465	11087	13614	15919	17602	19720	22384	24940	27560	30504	35084
PC Gasoline Large	Euro 1	-	-	-	-	1882	3995	6279	8566	10732	12460	14477	16901	19259	21676	24361	28383
PC Gasoline Large	Euro 2	-	-	-	-	-	-	-	-	2036	3940	5886	8017	10150	12338	14707	17950
PC Gasoline Large	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	2120	4294	6581	9372
PC Gasoline Large	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
PC Gasoline Hybrid Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Conventional	-	-	3103	6239	9279	12260	15180	18042	20582	23021	25376	27576	29206	30675	31839	32466
PC Diesel Small	Euro 1	-	-	-	-	127	345	656	1057	1522	2051	2633	3319	4084	4906	5867	7074
PC Diesel Small	Euro 2	-	-	-	-	-	-	-	-	289	649	1070	1574	2152	2793	3542	4474
PC Diesel Small	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	450	972	1585	2336
PC Diesel Small	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Conventional	-	-	4775	9598	14274	18859	23349	27749	31654	35403	39022	42402	44905	47162	48948	49909
PC Diesel Medium	Euro 1	-	-	-	-	196	531	1009	1626	2341	3154	4048	5104	6280	7543	9019	10875
PC Diesel Medium	Euro 2	-	-	-	-	-	-	-	-	444	997	1646	2421	3309	4294	5445	6878
PC Diesel Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	691	1494	2437	3591
PC Diesel Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Conventional	-	-	3049	6017	8785	11393	13843	16142	18065	19818	21422	22824	23695	24390	24805	24778
PC Diesel Large	Euro 1	-	-	-	-	121	321	598	946	1336	1766	2222	2747	3313	3901	4571	5399
PC Diesel Large	Euro 2	-	-	-	-	-	-	-	-	254	558	904	1303	1746	2220	2759	3415
PC Diesel Large	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	365	773	1235	1783
PC Diesel Large	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG Medium	Conventional	-	-	-	-	-	-	-	-	-	10792	21043	30720	39244	47000	53775	59116
PC LPG Medium	Euro 1	-	-	-	-	-	-	-	-	-	961	2183	3697	5488	7517	9909	12882
PC LPG Medium	Euro 2	-	-	-	-	-	-	-	-	-	304	888	1754	2892	4279	5982	8147
PC LPG Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	604	1489	2677	4253
PC LPG Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline <3,5 t	Conventional	135352	142020	149053	159989	166819	176241	179613	180343	175061	166798	164525	165167	161589	159309	159730	162111

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
LCV Gasoline <3,5 t	Euro 1	-	-	-	-	4430	9677	15310	21240	26741	31770	38047	39815	40490	41575	43507	46194
LCV Gasoline <3,5 t	Euro 2	-	-	-	-	-	-	-	-	4160	8237	12682	17696	22599	27975	29411	30992
LCV Gasoline <3,5 t	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	4222	8711	13738	19539
LCV Gasoline <3,5 t	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline <3,5 t	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline <3,5 t	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel <3,5 t	Conventional	51685	53074	54498	55957	55968	55919	55806	55624	54253	52849	51410	51212	50030	48779	48402	47993
LCV Diesel <3,5 t	Euro 1	-	-	-	-	1486	3070	4757	6551	8287	10066	11889	12345	12536	12730	13184	13676
LCV Diesel <3,5 t	Euro 2	-	-	-	-	-	-	-	-	1289	2610	3963	5487	6997	8566	8912	9175
LCV Diesel <3,5 t	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	1307	2667	4163	5785
LCV Diesel <3,5 t	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel <3,5 t	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel <3,5 t	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Gasoline >3,5 t	Conventional	2762	2898	3042	3265	3495	3794	3978	4114	4203	4220	4393	4544	4671	4848	5028	5282
HDV Diesel Rigid <=7,5 t	Conventional	6093	6083	6069	6053	5878	5698	5515	5328	5033	4746	4466	4300	4058	3818	3653	3489
HDV Diesel Rigid <=7,5 t	Euro I	-	-	-	-	156	313	470	627	769	904	1033	1037	1017	996	995	994
HDV Diesel Rigid <=7,5 t	Euro II	-	-	-	-	-	-	-	-	120	234	344	461	567	670	673	667
HDV Diesel Rigid <=7,5 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	106	209	314	421
HDV Diesel Rigid <=7,5 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid <=7,5 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid <=7,5 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5 - 12 t	Conventional	2585	2611	2636	2662	2618	2571	2523	2472	2370	2269	2169	2123	2038	1952	1902	1853
HDV Diesel Rigid 7,5 - 12 t	Euro I	-	-	-	-	70	141	215	291	362	432	502	512	511	509	518	528
HDV Diesel Rigid 7,5 - 12 t	Euro II	-	-	-	-	-	-	-	-	56	112	167	227	285	343	350	354
HDV Diesel Rigid 7,5 - 12 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	53	107	164	223
HDV Diesel Rigid 7,5 - 12 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5 - 12 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5 - 12 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12 - 14 t	Conventional	855	859	862	865	846	826	805	784	746	710	674	655	624	593	573	554
HDV Diesel Rigid 12 - 14 t	Euro I	-	-	-	-	22	45	69	92	114	135	156	158	156	155	156	158
HDV Diesel Rigid 12 - 14 t	Euro II	-	-	-	-	-	-	-	-	18	35	52	70	87	104	106	106
HDV Diesel Rigid 12 - 14 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	16	32	49	67
HDV Diesel Rigid 12 - 14 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12 - 14 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12 - 14 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 14 - 20 t	Conventional	2800	2809	2817	2824	2757	2689	2618	2545	2420	2298	2178	2113	2009	1907	1840	1774
HDV Diesel Rigid 14 - 20 t	Euro I	-	-	-	-	73	148	223	300	370	438	504	509	503	498	501	506
HDV Diesel Rigid 14 - 20 t	Euro II	-	-	-	-	-	-	-	-	58	113	168	226	281	335	339	339
HDV Diesel Rigid 14 - 20 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	53	104	158	214
HDV Diesel Rigid 14 - 20 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
HDV Diesel Rigid 14 - 20 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 14 - 20 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 20 - 26 t	Conventional	2455	2456	2456	2455	2389	2322	2253	2182	2068	1955	1846	1783	1689	1595	1532	1469
HDV Diesel Rigid 20 - 26 t	Euro I	-	-	-	-	63	127	192	257	316	372	427	430	423	416	417	419
HDV Diesel Rigid 20 - 26 t	Euro II	-	-	-	-	-	-	-	-	49	97	142	191	236	280	282	281
HDV Diesel Rigid 20 - 26 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	44	87	132	177
HDV Diesel Rigid 20 - 26 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 20 - 26 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 20 - 26 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26 - 28 t	Conventional	369	378	386	394	393	391	388	385	374	363	351	348	339	329	325	321
HDV Diesel Rigid 26 - 28 t	Euro I	-	-	-	-	10	21	33	45	57	69	81	84	85	86	89	91
HDV Diesel Rigid 26 - 28 t	Euro II	-	-	-	-	-	-	-	-	9	18	27	37	47	58	60	61
HDV Diesel Rigid 26 - 28 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	9	18	28	39
HDV Diesel Rigid 26 - 28 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26 - 28 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26 - 28 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28 - 32 t	Conventional	280	290	301	313	316	319	321	323	318	313	307	309	304	299	299	299
HDV Diesel Rigid 28 - 32 t	Euro I	-	-	-	-	8	18	27	38	49	60	71	74	76	78	82	85
HDV Diesel Rigid 28 - 32 t	Euro II	-	-	-	-	-	-	-	-	8	15	24	33	43	53	55	57
HDV Diesel Rigid 28 - 32 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	8	16	26	36
HDV Diesel Rigid 28 - 32 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28 - 32 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28 - 32 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32 t	Conventional	199	203	206	210	209	207	205	202	196	189	183	180	175	169	167	164
HDV Diesel Rigid >32 t	Euro I	-	-	-	-	6	11	17	24	30	36	42	43	44	44	45	47
HDV Diesel Rigid >32 t	Euro II	-	-	-	-	-	-	-	-	5	9	14	19	24	30	31	31
HDV Diesel Rigid >32 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	5	9	14	20
HDV Diesel Rigid >32 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 14 - 20 t	Conventional	81	99	117	136	152	168	183	198	207	216	224	236	244	250	260	270
HDV Diesel Articulated 14 - 20 t	Euro I	-	-	-	-	4	9	16	23	32	41	52	57	61	65	71	77
HDV Diesel Articulated 14 - 20 t	Euro II	-	-	-	-	-	-	-	-	5	11	17	25	34	44	48	52
HDV Diesel Articulated 14 - 20 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	6	14	22	33
HDV Diesel Articulated 14 - 20 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 14 - 20 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 14 - 20 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 20 - 28 t	Conventional	274	279	283	288	285	282	278	275	265	256	246	243	235	226	222	218
HDV Diesel Articulated 20 - 28 t	Euro I	-	-	-	-	8	15	24	32	40	49	57	58	59	59	61	62
HDV Diesel Articulated 20 - 28 t	Euro II	-	-	-	-	-	-	-	-	6	13	19	26	33	40	41	42

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
HDV Diesel Articulated 20 - 28 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	6	12	19	26
HDV Diesel Articulated 20 - 28 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 20 - 28 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 20 - 28 t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 28 - 34 t	Conventional	431	427	424	420	404	389	374	358	335	313	291	277	259	240	227	214
HDV Diesel Articulated 28 - 34 t	Euro I	-	-	-	-	11	21	32	42	51	60	67	67	65	63	62	61
HDV Diesel Articulated 28 - 34 t	Euro II	-	-	-	-	-	-	-	-	8	15	22	30	36	42	42	41
HDV Diesel Articulated 28 - 34 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	7	13	20	26
HDV Diesel Articulated 28 - 34 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 28 - 34 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 28 - 34 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 34 - 40 t	Conventional	2588	2566	2542	2516	2423	2329	2233	2137	1998	1863	1733	1648	1534	1423	1341	1259
HDV Diesel Articulated 34 - 40 t	Euro I	-	-	-	-	64	128	190	252	305	355	401	397	384	371	365	359
HDV Diesel Articulated 34 - 40 t	Euro II	-	-	-	-	-	-	-	-	47	92	134	177	215	250	247	241
HDV Diesel Articulated 34 - 40 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	40	78	115	152
HDV Diesel Articulated 34 - 40 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 34 - 40 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 34 - 40 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 40 - 50 t	Conventional	1953	1996	2041	2086	2078	2067	2054	2039	1980	1921	1861	1846	1796	1744	1724	1702
HDV Diesel Articulated 40 - 50 t	Euro I	-	-	-	-	55	113	175	240	302	366	430	445	450	455	469	485
HDV Diesel Articulated 40 - 50 t	Euro II	-	-	-	-	-	-	-	-	47	95	143	198	251	306	317	325
HDV Diesel Articulated 40 - 50 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	47	95	148	205
HDV Diesel Articulated 40 - 50 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 40 - 50 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 40 - 50 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 50 - 60 t	Conventional	43	46	49	52	54	56	58	59	60	60	60	61	61	61	62	63
HDV Diesel Articulated 50 - 60 t	Euro I	-	-	-	-	1	3	5	7	9	11	14	15	15	16	17	18
HDV Diesel Articulated 50 - 60 t	Euro II	-	-	-	-	-	-	-	-	1	3	5	7	9	11	11	12
HDV Diesel Articulated 50 - 60 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	2	3	5	8
HDV Diesel Articulated 50 - 60 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 50 - 60 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 50 - 60 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15 t	Conventional	563	667	774	979	1128	1336	1448	1466	1396	1309	1348	1366	1353	1354	1358	1381
BUS Diesel Urban Midi <=15 t	Euro I	-	-	-	-	30	73	122	170	210	244	304	319	315	314	314	318
BUS Diesel Urban Midi <=15 t	Euro II	-	-	-	-	-	-	-	-	33	63	101	142	182	228	238	242
BUS Diesel Urban Midi <=15 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	36	76	118	168
BUS Diesel Urban Midi <=15 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Standard 15 - 18 t	Conventional	1126	1334	1549	1959	2256	2672	2897	2931	2792	2617	2696	2733	2706	2708	2716	2763

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
BUS Diesel Urban Standard 15 - 18 t	Euro I	-	-	-	-	60	146	245	341	419	488	607	639	631	629	628	637
BUS Diesel Urban Standard 15 - 18 t	Euro II	-	-	-	-	-	-	-	-	65	126	202	284	365	456	476	484
BUS Diesel Urban Standard 15 - 18 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	73	151	237	335
BUS Diesel Urban Standard 15 - 18 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Standard 15 - 18 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Standard 15 - 18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Articulated >18 t	Conventional	188	222	258	326	376	445	483	489	465	436	449	455	451	451	453	460
BUS Diesel Urban Articulated >18 t	Euro I	-	-	-	-	10	24	41	57	70	81	101	106	105	105	105	106
BUS Diesel Urban Articulated >18 t	Euro II	-	-	-	-	-	-	-	-	11	21	34	47	61	76	79	81
BUS Diesel Urban Articulated >18 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	12	25	39	56
BUS Diesel Urban Articulated >18 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Articulated >18 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Articulated >18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Standard <=18 t	Conventional	3574	4200	4838	6070	6934	8148	8763	8797	8313	7731	7901	7947	7808	7752	7714	7786
BUS Diesel Coach Standard <=18 t	Euro I	-	-	-	-	184	445	740	1022	1248	1441	1780	1857	1819	1800	1785	1794
BUS Diesel Coach Standard <=18 t	Euro II	-	-	-	-	-	-	-	-	194	374	593	825	1053	1305	1353	1365
BUS Diesel Coach Standard <=18 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	209	433	673	945
BUS Diesel Coach Standard <=18 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Standard <=18 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Standard <=18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Articulated >18 t	Conventional	36	42	49	61	70	82	89	89	84	78	80	80	79	78	78	79
BUS Diesel Coach Articulated >18 t	Euro I	-	-	-	-	2	4	7	10	13	15	18	19	18	18	18	18
BUS Diesel Coach Articulated >18 t	Euro II	-	-	-	-	-	-	-	-	2	4	6	8	11	13	14	14
BUS Diesel Coach Articulated >18 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	2	4	7	10
BUS Diesel Coach Articulated >18 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Articulated >18 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Articulated >18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	Euro I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	Euro II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	EEV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOP Gasoline 2-stroke <50 cm³	Conventional	276901	279077	281270	282137	282792	283963	284571	285901	286760	288690	281749	284031	282436	280919	279343	273219
MOP Gasoline 2-stroke <50 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	3611	7371	11288	15125
MOP Gasoline 2-stroke <50 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4883
MOP Gasoline 2-stroke <50 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOP Gasoline 2-stroke <50 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 2-stroke >50 cm³	Conventional	44998	45124	45235	44769	44324	44027	43612	43043	42578	42053	40888	40344	39277	38249	37283	35838
MOT Gasoline 2-stroke >50 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	502	1004	1507	1984
MOT Gasoline 2-stroke >50 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	641
MOT Gasoline 2-stroke >50 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
MOT Gasoline 2-stroke >50 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke <250 cm³	Conventional	51709	52888	54089	54625	55203	55982	56632	57097	57712	58262	57919	58451	58220	58028	57912	57018
MOT Gasoline 4-stroke <250 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	744	1523	2340	3156
MOT Gasoline 4-stroke <250 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1019
MOT Gasoline 4-stroke <250 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke <250 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke 250 - 750 cm³	Conventional	86181	88146	90149	91042	92005	93304	94387	95161	96186	97103	96532	97418	97033	96714	96520	95030
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	1241	2538	3900	5261
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1699
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke >750 cm³	Conventional	34472	35258	36060	36417	36802	37322	37755	38064	38474	38841	38613	38967	38813	38686	38608	38012
MOT Gasoline 4-stroke >750 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	496	1015	1560	2104
MOT Gasoline 4-stroke >750 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	679
MOT Gasoline 4-stroke >750 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke >750 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 292 Vehicle fleet data for Road transport (number of vehicles) 2004-2019

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PC Gasoline Small	PRE ECE	203484	194412	107714	107944	107212	98395	88623	79490	72686	66201	59525	54632	46519	35110	30441	27023
PC Gasoline Small	ECE 15/00-01	57930	54864	29640	26567	22126	15136	7621	-	-	-	-	-	-	-	-	-
PC Gasoline Small	ECE 15/02	92354	76668	33874	33517	32293	28080	23186	18147	13334	8264	2990	-	-	-	-	-
PC Gasoline Small	ECE 15/03	157536	136545	64926	68265	70832	67577	62911	57934	53960	49582	41861	32632	18477	7260	2449	-
PC Gasoline Small	ECE 15/04	233898	266502	165084	181536	197781	199037	196497	193106	193388	192819	188374	182741	150894	101642	85701	72614
PC Gasoline Small	Euro 1	191325	220091	146072	174573	205969	223774	237858	240742	222105	201713	187715	176214	153973	111323	102841	98548
PC Gasoline Small	Euro 2	125655	149136	101620	124207	149419	165110	178141	190550	206981	223162	248528	254158	229125	173679	150773	140041
PC Gasoline Small	Euro 3	72894	93436	67525	86465	108016	123149	136411	149229	165275	181242	180227	202650	226335	221354	224779	225629
PC Gasoline Small	Euro 4	-	11220	13901	23362	34589	44364	53609	62720	73280	83947	93365	103136	113232	122213	141402	156194
PC Gasoline Small	Euro 5	-	-	-	-	-	-	5393	10816	16587	22520	25287	37098	43978	45044	42586	42358
PC Gasoline Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	5002	9921	15705	17408	19539
PC Gasoline Small	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5803	13026
PC Gasoline Medium	PRE ECE	153521	141447	77914	77931	74068	66642	58022	51425	45993	40970	36027	32334	26922	19867	16840	14614
PC Gasoline Medium	ECE 15/00-01	43706	39917	21440	19180	15286	10251	4989	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	ECE 15/02	69678	55781	24503	24198	22309	19019	15180	11740	8437	5114	1810	-	-	-	-	-
PC Gasoline Medium	ECE 15/03	118854	99345	46963	49285	48934	45769	41188	37480	34144	30685	25336	19314	10693	4108	1355	-
PC Gasoline Medium	ECE 15/04	176467	193897	119411	131061	136638	134806	128649	124928	122370	119330	114011	108157	87328	57514	47410	39268
PC Gasoline Medium	Euro 1	144347	160129	105660	126034	142295	151561	155728	155745	140541	124834	113612	104294	89110	62992	56892	53293
PC Gasoline Medium	Euro 2	94802	108506	73505	89672	103227	111828	116631	123274	130971	138108	150419	150427	132602	98276	83408	75732
PC Gasoline Medium	Euro 3	54995	67981	48844	62424	74623	83408	89309	96542	104581	112165	109080	119941	130988	125254	124348	122016
PC Gasoline Medium	Euro 4	-	8163	10055	16866	23896	30048	35099	40576	46370	51953	56508	61042	65531	69154	78224	84467

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PC Gasoline Medium	Euro 5	-	-	-	-	-	-	3531	6997	10495	13937	15305	21957	25452	25488	23558	22906
PC Gasoline Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	2961	5742	8887	9630	10567
PC Gasoline Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3210	7044
PC Gasoline Large	PRE ECE	34766	31919	17656	17703	16859	15013	13131	11644	10414	9276	8157	7321	6095	4498	3812	3308
PC Gasoline Large	ECE 15/00-01	9897	9008	4859	4357	3479	2309	1129	-	-	-	-	-	-	-	-	-
PC Gasoline Large	ECE 15/02	15779	12587	5553	5497	5078	4284	3436	2658	1910	1158	410	-	-	-	-	-
PC Gasoline Large	ECE 15/03	26916	22418	10642	11196	11138	10311	9321	8486	7731	6948	5736	4373	2421	930	307	-
PC Gasoline Large	ECE 15/04	39962	43755	27060	29772	31101	30368	29115	28287	27707	27018	25814	24487	19771	13021	10733	8890
PC Gasoline Large	Euro 1	32689	36135	23944	28630	32389	34143	35243	35265	31822	28265	25723	23613	20175	14261	12880	12065
PC Gasoline Large	Euro 2	21469	24485	16657	20370	23496	25192	26395	27913	29655	31270	34057	34058	30021	22249	18883	17145
PC Gasoline Large	Euro 3	12454	15340	11069	14180	16986	18790	20212	21860	23679	25396	24697	27155	29656	28357	28151	27623
PC Gasoline Large	Euro 4	-	1842	2279	3831	5439	6769	7943	9187	10499	11763	12794	13820	14836	15656	17709	19122
PC Gasoline Large	Euro 5	-	-	-	-	-	-	799	1584	2376	3156	3465	4971	5762	5770	5333	5186
PC Gasoline Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	670	1300	2012	2180	2392
PC Gasoline Large	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	727	1595
PC Gasoline Hybrid Medium	Euro 4	-	-	-	-	-	6	46	102	267	422	704	893	1340	2264	3633	5189
PC Gasoline Hybrid Medium	Euro 5	-	-	-	-	-	-	5	18	60	113	191	321	520	835	1094	1407
PC Gasoline Hybrid Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	43	117	291	447	649
PC Gasoline Hybrid Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	149	433
PC Diesel Small	Conventional	32761	32509	49057	65343	77983	82357	83893	85024	89515	92767	94261	94618	86372	65147	58031	52339
PC Diesel Small	Euro 1	8411	9815	17860	27301	37332	45145	52673	58704	59639	59054	60441	61751	61601	50359	50324	51766
PC Diesel Small	Euro 2	5524	6651	12425	19424	27083	33310	39449	46465	55578	65334	80022	89065	91667	78567	73779	73562
PC Diesel Small	Euro 3	3205	4167	8256	13522	19578	24845	30208	36389	44379	53061	58030	71015	90551	100134	109993	118521
PC Diesel Small	Euro 4	-	500	1700	3653	6269	8950	11872	15294	19677	24577	30062	36142	45302	55286	69194	82047
PC Diesel Small	Euro 5	-	-	-	-	-	-	1194	2637	4454	6593	8142	13000	17595	20376	20839	22250
PC Diesel Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	1753	3969	7104	8518	10264
PC Diesel Small	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2839	6842
PC Diesel Medium	Conventional	50359	49938	75413	100492	119886	126537	128868	130643	137537	142525	144813	145353	132679	100069	89134	80386
PC Diesel Medium	Euro 1	12929	15077	27454	41986	57393	69363	80911	90202	91634	90730	92856	94862	94627	77354	77296	79507
PC Diesel Medium	Euro 2	8491	10216	19099	29873	41635	51179	60598	71396	85394	100377	122938	136822	140813	120683	113322	112983
PC Diesel Medium	Euro 3	4926	6401	12691	20796	30098	38172	46402	55914	68187	81522	89152	109094	139098	153811	168946	182034
PC Diesel Medium	Euro 4	-	769	2613	5619	9638	13752	18236	23500	30233	37759	46184	55522	69589	84921	106279	126015
PC Diesel Medium	Euro 5	-	-	-	-	-	-	1835	4053	6843	10129	12509	19971	27028	31299	32008	34174
PC Diesel Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	2693	6097	10913	13084	15764
PC Diesel Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4361	10509
PC Diesel Large	Conventional	24487	23509	35365	46349	53604	55108	54768	54537	56112	56809	56375	55245	49216	36214	31457	27655
PC Diesel Large	Euro 1	6287	7098	12875	19365	25662	30208	34387	37655	37384	36164	36148	36055	35101	27993	27279	27352
PC Diesel Large	Euro 2	4129	4810	8957	13778	18616	22289	25753	29804	34839	40010	47859	52003	52233	43674	39993	38869
PC Diesel Large	Euro 3	2395	3013	5952	9591	13458	16624	19721	23341	27819	32494	34706	41464	51597	55662	59624	62624
PC Diesel Large	Euro 4	-	362	1225	2591	4309	5989	7750	9810	12334	15050	17979	21102	25813	30732	37508	43352

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PC Diesel Large	Euro 5	-	-	-	-	-	-	780	1692	2792	4037	4869	7591	10026	11327	11296	11756
PC Diesel Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	1024	2262	3949	4618	5423
PC Diesel Large	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1539	3615
PC LPG Medium	Conventional	56540	53258	48960	46168	43242	40289	37112	34706	37765	40134	46839	47305	41222	29985	27012	24357
PC LPG Medium	Euro 1	14516	16079	17824	19289	20701	22085	23301	23963	25161	25549	30033	30873	29400	23178	23425	24091
PC LPG Medium	Euro 2	9534	10895	12400	13724	15018	16295	17451	18967	23448	28266	39763	44529	43749	36161	34343	34235
PC LPG Medium	Euro 3	5531	6826	8240	9554	10856	12154	13363	14854	18723	22956	28835	35505	43217	46088	51200	55157
PC LPG Medium	Euro 4	-	820	1696	2581	3476	4378	5252	6243	8302	10633	14938	18070	21621	25446	32209	38183
PC LPG Medium	Euro 5	-	-	-	-	-	-	528	1077	1879	2852	4046	6500	8397	9378	9700	10355
PC LPG Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	876	1894	3270	3965	4777
PC LPG Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1322	3184
PC CNG Medium	Euro 4	2979	5958	8882	11892	14883	17860	20692	19337	19248	19098	19834	20942	20862	20084	21916	23699
PC CNG Medium	Euro 5	-	-	-	-	-	-	113	211	319	427	500	772	978	1171	1264	1394
PC CNG Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	104	221	408	517	643
PC CNG Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	172	429
LCV Gasoline <3,5 t	Conventional	163491	160845	52019	44691	38302	33936	30418	27048	24145	21579	18841	16452	11544	7051	5670	4604
LCV Gasoline <3,5 t	Euro 1	48863	50567	17258	16569	16994	16568	15136	13290	12973	13053	13299	13460	10495	7208	6615	6248
LCV Gasoline <3,5 t	Euro 2	32531	33402	11309	12145	12992	13719	13151	12824	12342	12152	12616	12787	11825	9275	8918	8879
LCV Gasoline <3,5 t	Euro 3	25958	32388	12957	13166	12753	11694	12732	13525	14287	14456	14067	14414	13593	12130	11966	11728
LCV Gasoline <3,5 t	Euro 4	-	8062	5529	9051	9904	9051	7604	7085	7948	8726	8206	7946	7416	7551	8253	7928
LCV Gasoline <3,5 t	Euro 5	-	-	-	-	3301	6034	7863	9166	9773	11331	12826	14055	12877	11134	10971	12403
LCV Gasoline <3,5 t	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	1839	4228	6051	7723	10242	11684
LCV Diesel <3,5 t	Conventional	47472	45458	64419	72921	77175	78023	79164	79087	77566	74622	69920	65562	55093	37916	31489	26249
LCV Diesel <3,5 t	Euro 1	14188	14291	21372	27036	34242	38092	39392	38858	41677	45139	49354	53641	50085	38759	36737	35624
LCV Diesel <3,5 t	Euro 2	9446	9440	14005	19816	26178	31541	34225	37496	39648	42021	46818	50960	56432	49872	49532	50624
LCV Diesel <3,5 t	Euro 3	7537	9153	16046	21482	25696	26885	33135	39544	45899	49991	52204	57442	64869	65225	66458	66866
LCV Diesel <3,5 t	Euro 4	-	2279	6847	14769	19956	20810	19788	20715	25533	30174	30452	31667	35393	40603	45835	45201
LCV Diesel <3,5 t	Euro 5	-	-	-	-	6652	13873	20465	26801	31395	39183	47597	56010	61451	59873	60933	70713
LCV Diesel <3,5 t	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	6824	16849	28878	41528	56884	66614
HDV Gasoline >3,5 t	Conventional	5527	5822	2022	1951	1923	1857	1774	1693	1663	1659	1667	1701	1506	1267	1278	1295
HDV Diesel Rigid <=7,5 t	Conventional	3322	3200	4070	4360	4489	4358	4492	4087	3814	3485	3095	2743	2173	1406	1094	851
HDV Diesel Rigid <=7,5 t	Euro I	993	1006	1350	1616	1992	2127	2235	2008	2049	2108	2184	2244	1976	1437	1276	1155
HDV Diesel Rigid <=7,5 t	Euro II	661	665	885	1185	1523	1762	1942	1938	1950	1963	2072	2132	2226	1849	1721	1641
HDV Diesel Rigid <=7,5 t	Euro III	527	644	1014	1284	1495	1502	1880	2043	2257	2335	2311	2403	2559	2419	2309	2168
HDV Diesel Rigid <=7,5 t	Euro IV	-	160	433	883	1161	1162	1123	1070	1256	1409	1348	1325	1396	1506	1592	1466
HDV Diesel Rigid <=7,5 t	Euro V	-	-	-	-	387	775	1161	1385	1544	1830	2107	2344	2424	2220	2117	2293
HDV Diesel Rigid <=7,5 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	302	705	1139	1540	1976	2160
HDV Diesel Rigid 7,5 - 12 t	Conventional	1800	1696	2383	2581	2720	2650	2733	2633	2533	2391	2197	2020	1664	1123	914	746
HDV Diesel Rigid 7,5 - 12 t	Euro I	538	533	790	957	1207	1294	1360	1294	1361	1446	1551	1653	1513	1147	1066	1013
HDV Diesel Rigid 7,5 - 12 t	Euro II	358	352	518	701	922	1071	1181	1248	1295	1346	1471	1570	1704	1476	1437	1439

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
HDV Diesel Rigid 7,5 - 12 t	Euro III	286	342	593	760	905	913	1144	1317	1499	1602	1640	1770	1959	1931	1928	1901
HDV Diesel Rigid 7,5 - 12 t	Euro IV	-	85	253	523	703	707	683	690	834	967	957	976	1069	1202	1330	1285
HDV Diesel Rigid 7,5 - 12 t	Euro V	-	-	-	-	234	471	706	892	1025	1255	1495	1726	1856	1773	1768	2010
HDV Diesel Rigid 7,5 - 12 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	214	519	872	1229	1650	1894
HDV Diesel Rigid 12 - 14 t	Conventional	533	498	695	742	773	761	758	728	693	646	587	532	433	288	231	186
HDV Diesel Rigid 12 - 14 t	Euro I	159	156	230	275	343	371	377	358	372	391	414	436	393	294	269	252
HDV Diesel Rigid 12 - 14 t	Euro II	106	103	151	202	262	308	328	345	354	364	393	414	443	379	363	358
HDV Diesel Rigid 12 - 14 t	Euro III	85	100	173	219	257	262	317	364	410	433	438	467	510	495	487	473
HDV Diesel Rigid 12 - 14 t	Euro IV	-	25	74	150	200	203	189	191	228	261	255	257	278	308	336	320
HDV Diesel Rigid 12 - 14 t	Euro V	-	-	-	-	67	135	196	247	280	339	399	455	483	455	447	501
HDV Diesel Rigid 12 - 14 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	57	137	227	315	417	472
HDV Diesel Rigid 14 - 20 t	Conventional	1705	1580	2191	2400	2464	2408	2365	2290	2172	2020	1827	1653	1339	887	709	568
HDV Diesel Rigid 14 - 20 t	Euro I	510	497	727	890	1093	1175	1177	1125	1167	1222	1290	1353	1217	907	827	771
HDV Diesel Rigid 14 - 20 t	Euro II	339	328	476	652	836	973	1023	1086	1110	1137	1224	1285	1372	1167	1115	1095
HDV Diesel Rigid 14 - 20 t	Euro III	271	318	546	707	820	830	990	1145	1286	1353	1364	1448	1577	1527	1496	1446
HDV Diesel Rigid 14 - 20 t	Euro IV	-	79	233	486	637	642	591	600	715	817	796	799	860	950	1032	978
HDV Diesel Rigid 14 - 20 t	Euro V	-	-	-	-	212	428	611	776	879	1061	1244	1412	1494	1401	1372	1530
HDV Diesel Rigid 14 - 20 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	178	425	702	972	1281	1441
HDV Diesel Rigid 20 - 26 t	Conventional	1405	1279	1793	1989	1957	1895	1886	1799	1692	1559	1397	1251	1002	656	517	408
HDV Diesel Rigid 20 - 26 t	Euro I	420	402	595	737	868	925	938	884	909	943	986	1023	911	671	603	554
HDV Diesel Rigid 20 - 26 t	Euro II	280	266	390	540	664	766	815	853	865	878	936	972	1026	863	814	788
HDV Diesel Rigid 20 - 26 t	Euro III	223	258	447	586	652	653	789	900	1001	1045	1043	1096	1180	1128	1092	1040
HDV Diesel Rigid 20 - 26 t	Euro IV	-	64	191	403	506	505	471	471	557	631	608	604	644	702	753	703
HDV Diesel Rigid 20 - 26 t	Euro V	-	-	-	-	169	337	487	610	685	819	951	1069	1117	1036	1001	1100
HDV Diesel Rigid 20 - 26 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	136	321	525	718	934	1036
HDV Diesel Rigid 26 - 28 t	Conventional	316	293	428	493	512	512	502	512	500	479	447	418	350	240	198	165
HDV Diesel Rigid 26 - 28 t	Euro I	94	92	142	183	227	250	250	251	269	290	316	342	318	245	231	224
HDV Diesel Rigid 26 - 28 t	Euro II	63	61	93	134	174	207	217	243	256	270	299	325	358	315	312	318
HDV Diesel Rigid 26 - 28 t	Euro III	50	59	107	145	170	177	210	256	296	321	334	366	412	412	419	420
HDV Diesel Rigid 26 - 28 t	Euro IV	-	15	45	100	132	137	125	134	165	194	195	202	225	257	289	284
HDV Diesel Rigid 26 - 28 t	Euro V	-	-	-	-	44	91	130	173	202	252	304	357	390	379	384	444
HDV Diesel Rigid 26 - 28 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	44	107	183	263	358	418
HDV Diesel Rigid 28 - 32 t	Conventional	299	284	409	483	504	506	516	524	517	501	473	446	377	261	218	183
HDV Diesel Rigid 28 - 32 t	Euro I	89	89	136	179	224	247	257	257	278	303	334	365	343	267	255	249
HDV Diesel Rigid 28 - 32 t	Euro II	59	59	89	131	171	205	223	248	264	282	316	347	386	344	343	353
HDV Diesel Rigid 28 - 32 t	Euro III	47	57	102	142	168	174	216	262	306	336	353	391	444	449	461	466
HDV Diesel Rigid 28 - 32 t	Euro IV	-	14	43	98	130	135	129	137	170	203	206	215	242	280	318	315
HDV Diesel Rigid 28 - 32 t	Euro V	-	-	-	-	43	90	133	178	209	263	322	381	421	413	423	493
HDV Diesel Rigid 28 - 32 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	46	115	198	286	394	465
HDV Diesel Rigid >32 t	Conventional	161	150	216	243	258	254	252	254	247	236	219	204	170	116	96	79

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
HDV Diesel Rigid >32 t	Euro I	48	47	72	90	115	124	125	125	133	143	155	167	155	119	112	108
HDV Diesel Rigid >32 t	Euro II	32	31	47	66	88	103	109	120	126	133	147	159	174	153	151	153
HDV Diesel Rigid >32 t	Euro III	26	30	54	72	86	88	105	127	146	158	164	179	201	200	202	202
HDV Diesel Rigid >32 t	Euro IV	-	8	23	49	67	68	63	66	81	95	96	99	109	125	140	137
HDV Diesel Rigid >32 t	Euro V	-	-	-	-	22	45	65	86	100	124	149	174	190	184	186	214
HDV Diesel Rigid >32 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	21	52	89	127	173	201
HDV Diesel Articulated 14 - 20 t	Conventional	279	282	403	460	555	560	563	594	600	594	572	551	475	335	285	243
HDV Diesel Articulated 14 - 20 t	Euro I	83	89	134	170	246	274	280	292	323	359	404	451	431	342	332	329
HDV Diesel Articulated 14 - 20 t	Euro II	55	58	88	125	188	226	243	282	307	335	383	428	486	440	448	468
HDV Diesel Articulated 14 - 20 t	Euro III	44	57	100	135	185	193	236	297	355	398	427	483	559	576	601	618
HDV Diesel Articulated 14 - 20 t	Euro IV	-	14	43	93	143	149	141	156	198	240	249	266	305	358	414	418
HDV Diesel Articulated 14 - 20 t	Euro V	-	-	-	-	48	100	146	201	243	312	389	470	529	529	551	654
HDV Diesel Articulated 14 - 20 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	56	142	249	367	514	616
HDV Diesel Articulated 20 - 28 t	Conventional	214	204	278	322	339	329	336	332	322	307	285	264	220	150	123	102
HDV Diesel Articulated 20 - 28 t	Euro I	64	64	92	120	151	161	167	163	173	186	201	216	200	153	144	138
HDV Diesel Articulated 20 - 28 t	Euro II	43	42	60	88	115	133	145	157	165	173	191	205	225	197	194	196
HDV Diesel Articulated 20 - 28 t	Euro III	34	41	69	95	113	113	141	166	191	206	212	231	259	258	260	259
HDV Diesel Articulated 20 - 28 t	Euro IV	-	10	30	65	88	88	84	87	106	124	124	128	141	160	179	175
HDV Diesel Articulated 20 - 28 t	Euro V	-	-	-	-	29	59	87	112	130	161	194	226	245	236	238	274
HDV Diesel Articulated 20 - 28 t	Euro VI	-	-	-	-	-	-	-	-	-	-	28	68	115	164	222	258
HDV Diesel Articulated 28 - 34 t	Conventional	200	180	238	270	251	230	233	209	188	165	140	118	88	53	37	26
HDV Diesel Articulated 28 - 34 t	Euro I	60	57	79	100	111	112	116	103	101	100	99	96	80	54	44	35
HDV Diesel Articulated 28 - 34 t	Euro II	40	37	52	73	85	93	101	99	96	93	94	92	90	69	59	50
HDV Diesel Articulated 28 - 34 t	Euro III	32	36	59	79	84	79	97	104	111	111	105	103	103	91	79	66
HDV Diesel Articulated 28 - 34 t	Euro IV	-	9	25	55	65	61	58	55	62	67	61	57	56	56	54	45
HDV Diesel Articulated 28 - 34 t	Euro V	-	-	-	-	22	41	60	71	76	87	95	101	98	83	72	70
HDV Diesel Articulated 28 - 34 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	14	30	46	58	68	66
HDV Diesel Articulated 34 - 40 t	Conventional	1177	1021	1414	1617	1493	1336	1289	1197	1072	934	785	652	478	282	195	131
HDV Diesel Articulated 34 - 40 t	Euro I	352	321	469	600	663	652	641	588	576	565	554	533	435	288	228	177
HDV Diesel Articulated 34 - 40 t	Euro II	234	212	308	439	507	540	557	567	548	526	525	507	490	371	307	252
HDV Diesel Articulated 34 - 40 t	Euro III	187	206	352	476	497	460	539	598	634	625	586	571	563	485	412	333
HDV Diesel Articulated 34 - 40 t	Euro IV	-	51	150	328	386	356	322	314	353	378	342	315	307	302	284	225
HDV Diesel Articulated 34 - 40 t	Euro V	-	-	-	-	129	238	333	406	434	490	534	557	534	445	378	352
HDV Diesel Articulated 34 - 40 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	77	168	251	309	353	331
HDV Diesel Articulated 40 - 50 t	Conventional	1677	1596	2239	2526	2722	2817	2632	2720	2658	2547	2378	2222	1860	1276	1056	877
HDV Diesel Articulated 40 - 50 t	Euro I	501	502	743	936	1208	1375	1310	1336	1428	1541	1679	1818	1691	1304	1232	1190
HDV Diesel Articulated 40 - 50 t	Euro II	334	331	487	686	923	1139	1138	1290	1359	1435	1592	1727	1905	1678	1661	1691
HDV Diesel Articulated 40 - 50 t	Euro III	266	321	558	744	906	971	1102	1360	1573	1707	1776	1947	2190	2194	2228	2234
HDV Diesel Articulated 40 - 50 t	Euro IV	-	80	238	512	704	751	658	712	875	1030	1036	1073	1195	1366	1537	1510
HDV Diesel Articulated 40 - 50 t	Euro V	-	-	-	-	235	501	680	922	1076	1338	1619	1898	2075	2014	2043	2362

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
HDV Diesel Articulated 40 - 50 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	232	571	975	1397	1907	2225
HDV Diesel Articulated 50 - 60 t	Conventional	63	62	88	105	112	116	117	120	120	118	112	107	91	64	54	45
HDV Diesel Articulated 50 - 60 t	Euro I	19	19	29	39	50	56	58	59	65	71	79	87	83	65	62	61
HDV Diesel Articulated 50 - 60 t	Euro II	13	13	19	28	38	47	51	57	61	66	75	83	93	84	84	87
HDV Diesel Articulated 50 - 60 t	Euro III	10	12	22	31	37	40	49	60	71	79	84	93	107	109	113	115
HDV Diesel Articulated 50 - 60 t	Euro IV	-	3	9	21	29	31	29	32	40	48	49	51	58	68	78	78
HDV Diesel Articulated 50 - 60 t	Euro V	-	-	-	-	10	21	30	41	49	62	76	91	101	100	104	122
HDV Diesel Articulated 50 - 60 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	11	27	48	70	97	115
BUS Diesel Urban Midi <=15 t	Conventional	815	853	1037	1026	1028	984	921	848	768	699	613	536	426	292	237	191
BUS Diesel Urban Midi <=15 t	Euro I	187	195	236	276	327	354	354	329	350	381	418	438	387	298	276	259
BUS Diesel Urban Midi <=15 t	Euro II	143	149	181	220	243	272	280	300	307	313	351	382	423	386	371	369
BUS Diesel Urban Midi <=15 t	Euro III	129	170	254	285	307	295	338	366	392	403	380	437	490	492	494	448
BUS Diesel Urban Midi <=15 t	Euro IV	-	45	115	200	263	260	217	207	257	297	295	257	262	291	339	337
BUS Diesel Urban Midi <=15 t	Euro V	-	-	-	-	88	173	225	238	212	226	290	337	361	306	275	347
BUS Diesel Urban Midi <=15 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	23	53	109	172	232	270
BUS Diesel Urban Standard 15 - 18 t	Conventional	1631	1707	2074	2051	2055	1968	1842	1697	1536	1397	1225	1072	852	584	473	382
BUS Diesel Urban Standard 15 - 18 t	Euro I	374	390	471	551	653	708	708	658	700	761	835	877	775	597	552	519
BUS Diesel Urban Standard 15 - 18 t	Euro II	286	298	362	440	485	544	561	599	615	626	702	763	846	773	743	737
BUS Diesel Urban Standard 15 - 18 t	Euro III	259	341	508	570	615	590	677	733	784	806	760	873	979	983	987	896
BUS Diesel Urban Standard 15 - 18 t	Euro IV	-	90	230	401	525	520	434	414	514	595	590	514	524	582	677	674
BUS Diesel Urban Standard 15 - 18 t	Euro V	-	-	-	-	175	347	450	476	423	452	579	675	721	612	551	695
BUS Diesel Urban Standard 15 - 18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	46	106	218	344	464	540
BUS Diesel Urban Articulated >18 t	Conventional	272	284	346	342	343	328	307	283	256	233	204	179	142	97	79	64
BUS Diesel Urban Articulated >18 t	Euro I	62	65	79	92	109	118	118	110	117	127	139	146	129	99	92	86
BUS Diesel Urban Articulated >18 t	Euro II	48	50	60	73	81	91	93	100	102	104	117	127	141	129	124	123
BUS Diesel Urban Articulated >18 t	Euro III	43	57	85	95	102	98	113	122	131	134	127	146	163	164	165	149
BUS Diesel Urban Articulated >18 t	Euro IV	-	15	38	67	88	87	72	69	86	99	98	86	87	97	113	112
BUS Diesel Urban Articulated >18 t	Euro V	-	-	-	-	29	58	75	79	71	75	97	112	120	102	92	116
BUS Diesel Urban Articulated >18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	8	18	36	57	77	90
BUS Diesel Coach Standard <=18 t	Conventional	4560	4675	5659	5761	5644	5247	4868	4495	4036	3644	3171	2754	2173	1476	1189	952
BUS Diesel Coach Standard <=18 t	Euro I	1046	1068	1286	1548	1795	1888	1871	1743	1839	1986	2162	2253	1975	1509	1387	1292
BUS Diesel Coach Standard <=18 t	Euro II	798	818	989	1235	1332	1451	1482	1587	1616	1633	1817	1961	2157	1955	1865	1837
BUS Diesel Coach Standard <=18 t	Euro III	724	933	1385	1601	1688	1573	1789	1940	2061	2102	1968	2243	2496	2487	2479	2233
BUS Diesel Coach Standard <=18 t	Euro IV	-	246	627	1125	1443	1387	1148	1097	1350	1551	1527	1322	1336	1473	1700	1679
BUS Diesel Coach Standard <=18 t	Euro V	-	-	-	-	481	924	1190	1260	1113	1180	1500	1733	1839	1549	1383	1731
BUS Diesel Coach Standard <=18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	120	272	556	870	1165	1345
BUS Diesel Coach Articulated >18 t	Conventional	46	47	57	58	57	53	49	45	41	37	32	28	22	15	12	10
BUS Diesel Coach Articulated >18 t	Euro I	11	11	13	16	18	19	19	18	19	20	22	23	20	15	14	13
BUS Diesel Coach Articulated >18 t	Euro II	8	8	10	12	13	15	15	16	16	16	18	20	22	20	19	19
BUS Diesel Coach Articulated >18 t	Euro III	7	9	14	16	17	16	18	20	21	21	20	23	25	25	25	23

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUS Diesel Coach Articulated >18 t	Euro IV	-	2	6	11	15	14	12	11	14	16	15	13	13	15	17	17
BUS Diesel Coach Articulated >18 t	Euro V	-	-	-	-	5	9	12	13	11	12	15	18	19	16	14	17
BUS Diesel Coach Articulated >18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	1	3	6	9	12	14
BUS CNG Urban	Euro I	22	42	59	73	84	97	108	127	140	153	173	187	149	121	124	123
BUS CNG Urban	Euro II	3	6	8	12	15	20	24	32	38	44	59	73	78	79	90	100
BUS CNG Urban	Euro III	3	7	12	16	19	21	29	40	49	57	64	84	90	101	119	122
BUS CNG Urban	EEV	-	2	5	11	22	31	38	48	59	74	102	124	134	157	204	260
MOP Gasoline 2-stroke <50 cm³	Conventional	40334	42519	27593	30636	33607	35465	36394	36590	37137	37472	38351	38667	38283	38012	37375	37563
MOP Gasoline 2-stroke <50 cm³	Euro 1	2870	3736	2913	3703	4261	4199	5043	6227	7235	7393	7202	7635	8556	9185	9348	9188
MOP Gasoline 2-stroke <50 cm³	Euro 2	1483	2412	2150	3037	4426	4560	4250	4562	5733	7059	7374	7290	7807	8884	9960	9746
MOP Gasoline 2-stroke <50 cm³	Euro 3	-	-	716	2024	4507	7042	9296	10639	11735	13555	16056	18292	20043	21186	22453	24574
MOP Gasoline 2-stroke <50 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	847	1677	2642
MOT Gasoline 2-stroke >50 cm³	Conventional	13084	12775	5363	5819	6256	6178	6403	6183	6070	5966	6028	6056	5971	5857	5732	5703
MOT Gasoline 2-stroke >50 cm³	Euro 1	931	1123	566	703	793	731	887	1052	1182	1177	1132	1196	1334	1415	1434	1395
MOT Gasoline 2-stroke >50 cm³	Euro 2	481	725	418	577	824	794	748	771	937	1124	1159	1142	1218	1369	1527	1480
MOT Gasoline 2-stroke >50 cm³	Euro 3	-	-	139	384	839	1227	1635	1798	1918	2158	2524	2865	3126	3264	3443	3731
MOT Gasoline 2-stroke >50 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	131	257	401
MOT Gasoline 4-stroke <250 cm³	Conventional	21330	21789	9027	10133	11073	11914	12057	12109	12227	12371	12874	13331	13556	13724	13874	14273
MOT Gasoline 4-stroke <250 cm³	Euro 1	1518	1914	953	1225	1404	1411	1671	2061	2382	2441	2418	2632	3030	3316	3470	3491
MOT Gasoline 4-stroke <250 cm³	Euro 2	784	1236	703	1004	1458	1532	1408	1510	1888	2330	2475	2513	2764	3207	3697	3703
MOT Gasoline 4-stroke <250 cm³	Euro 3	-	-	234	669	1485	2366	3080	3521	3863	4475	5390	6306	7097	7649	8335	9337
MOT Gasoline 4-stroke <250 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	306	622	1004
MOT Gasoline 4-stroke 250 - 750 cm³	Conventional	35550	36314	15044	16888	18455	19856	20096	20181	20378	20618	21457	22218	22593	22874	23123	23788
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 1	2530	3191	1588	2041	2340	2351	2785	3435	3970	4068	4030	4387	5049	5527	5783	5819
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 2	1307	2060	1172	1674	2430	2553	2347	2516	3146	3884	4126	4189	4607	5346	6162	6172
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 3	-	-	391	1116	2475	3943	5133	5868	6439	7458	8983	10511	11829	12749	13891	15562
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	510	1037	1673
MOT Gasoline 4-stroke >750 cm³	Conventional	14220	14526	6018	6755	7382	7942	8038	8072	8151	8247	8583	8887	9037	9149	9249	9515
MOT Gasoline 4-stroke >750 cm³	Euro 1	1012	1276	635	817	936	940	1114	1374	1588	1627	1612	1755	2020	2211	2313	2327
MOT Gasoline 4-stroke >750 cm³	Euro 2	523	824	469	670	972	1021	939	1007	1258	1554	1650	1676	1843	2138	2465	2469
MOT Gasoline 4-stroke >750 cm³	Euro 3	-	-	156	446	990	1577	2053	2347	2576	2983	3593	4204	4731	5100	5556	6225
MOT Gasoline 4-stroke >750 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	204	415	669

Table 293 Mileage data for Road transport (average km/year/vehicle) 1988-2003

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
PC Gasoline Small	PRE ECE	9 797	10 472	9 158	4 111	4 980	5 440	5 187	5 448	4 456	2 846	3 565	3 306	2 587	2 086	2 135	1 887
PC Gasoline Small	ECE 15/00-01	-	-	11 031	4 952	5 998	6 553	6 247	6 562	5 367	3 428	4 294	3 982	3 116	2 513	2 571	2 272
PC Gasoline Small	ECE 15/02	-	-	11 170	5 014	6 074	6 636	6 326	6 645	5 435	3 471	4 348	4 033	3 155	2 545	2 604	2 301
PC Gasoline Small	ECE 15/03	-	-	13 164	5 909	7 158	7 820	7 455	7 831	6 404	4 091	5 124	4 752	3 718	2 999	3 068	2 712
PC Gasoline Small	ECE 15/04	-	-	17 684	7 938	9 616	10 505	10 016	10 520	8 604	5 496	6 884	6 384	4 995	4 029	4 122	3 643

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
PC Gasoline Small	Euro 1	-	-	-	-	11 576	12 647	12 057	12 665	10 357	6 616	8 287	7 685	6 013	4 850	4 962	4 386
PC Gasoline Small	Euro 2	-	-	-	-	-	-	-	-	12 001	7 666	9 602	8 905	6 967	5 620	5 749	5 082
PC Gasoline Small	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	8 039	6 484	6 634	5 863
PC Gasoline Small	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	PRE ECE	10 500	11 223	9 815	4 406	5 337	5 831	5 559	5 839	4 775	3 050	3 821	3 543	2 772	2 236	2 288	2 022
PC Gasoline Medium	ECE 15/00-01	-	-	11 751	5 275	6 390	6 981	6 655	6 991	5 717	3 652	4 574	4 242	3 319	2 677	2 739	2 421
PC Gasoline Medium	ECE 15/02	-	-	12 328	5 534	6 704	7 324	6 982	7 334	5 998	3 831	4 799	4 451	3 482	2 809	2 874	2 540
PC Gasoline Medium	ECE 15/03	-	-	14 131	6 343	7 684	8 394	8 003	8 406	6 875	4 391	5 501	5 101	3 991	3 219	3 294	2 911
PC Gasoline Medium	ECE 15/04	-	-	19 004	8 531	10 334	11 289	10 763	11 305	9 246	5 906	7 397	6 860	5 367	4 330	4 429	3 915
PC Gasoline Medium	Euro 1	-	-	-	-	12 788	13 970	13 319	13 990	11 441	7 308	9 154	8 490	6 642	5 358	5 481	4 845
PC Gasoline Medium	Euro 2	-	-	-	-	-	-	-	-	12 902	8 241	10 323	9 574	7 490	6 042	6 181	5 463
PC Gasoline Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	8 643	6 972	7 133	6 304
PC Gasoline Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	PRE ECE	11 042	11 803	10 322	4 633	5 613	6 132	5 846	6 141	5 022	3 208	4 018	3 726	2 915	2 352	2 406	2 126
PC Gasoline Large	ECE 15/00-01	-	-	12 348	5 543	6 715	7 335	6 993	7 346	6 008	3 837	4 807	4 458	3 488	2 813	2 878	2 544
PC Gasoline Large	ECE 15/02	-	-	12 563	5 640	6 832	7 463	7 115	7 474	6 112	3 904	4 890	4 535	3 548	2 862	2 928	2 588
PC Gasoline Large	ECE 15/03	-	-	14 901	6 689	8 103	8 852	8 439	8 865	7 250	4 631	5 801	5 379	4 209	3 395	3 473	3 070
PC Gasoline Large	ECE 15/04	-	-	19 769	8 874	10 750	11 744	11 197	11 761	9 618	6 144	7 696	7 137	5 584	4 504	4 608	4 073
PC Gasoline Large	Euro 1	-	-	-	-	13 101	14 313	13 646	14 333	11 722	7 487	9 379	8 698	6 805	5 489	5 616	4 963
PC Gasoline Large	Euro 2	-	-	-	-	-	-	-	-	13 771	8 796	11 018	10 218	7 995	6 449	6 597	5 831
PC Gasoline Large	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	8 901	7 179	7 345	6 492
PC Gasoline Large	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Conventional	-	-	24 523	16 848	11 748	10 626	6 630	6 408	11 001	19 220	21 900	22 288	18 899	20 155	19 690	24 354
PC Diesel Small	Euro 1	-	-	-	-	13 235	11 971	7 469	7 219	12 394	21 653	24 672	25 109	21 291	22 706	22 182	27 436
PC Diesel Small	Euro 2	-	-	-	-	-	-	-	-	14 598	25 504	29 060	29 574	25 078	26 744	26 127	32 315
PC Diesel Small	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	28 456	30 346	29 646	36 668
PC Diesel Small	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
PC Diesel Small	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Conventional	-	-	24 523	16 848	11 748	10 626	6 630	6 408	11 001	19 220	21 900	22 288	18 899	20 155	19 690	24 354
PC Diesel Medium	Euro 1	-	-	-	-	13 235	11 971	7 469	7 219	12 394	21 653	24 672	25 109	21 291	22 706	22 182	27 436
PC Diesel Medium	Euro 2	-	-	-	-	-	-	-	-	14 598	25 504	29 060	29 574	25 078	26 744	26 127	32 315
PC Diesel Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	28 456	30 346	29 646	36 668
PC Diesel Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Conventional	-	-	27 081	18 606	12 973	11 735	7 321	7 076	12 149	21 225	24 185	24 613	20 871	22 257	21 744	26 894
PC Diesel Large	Euro 1	-	-	-	-	14 698	13 295	8 295	8 017	13 764	24 047	27 400	27 885	23 646	25 216	24 634	30 470
PC Diesel Large	Euro 2	-	-	-	-	-	-	-	-	15 474	27 034	30 804	31 348	26 582	28 348	27 694	34 254
PC Diesel Large	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	31 075	33 139	32 375	40 043
PC Diesel Large	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG Medium	Conventional	-	-	-	-	-	-	-	-	-	93 763	41 952	39 369	69 642	73 468	70 463	64 097
PC LPG Medium	Euro 1	-	-	-	-	-	-	-	-	-	106 427	47 619	44 686	79 048	83 391	79 980	72 754
PC LPG Medium	Euro 2	-	-	-	-	-	-	-	-	-	112 996	50 558	47 444	83 927	88 538	84 916	77 244
PC LPG Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	87 975	92 809	89 012	80 971
PC LPG Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG Medium	Euro 6 d-temp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline <3,5 t	Conventional	26 880	28 732	25 127	11 279	13 663	14 927	14 231	14 948	12 224	7 808	9 781	9 071	7 097	5 724	5 857	5 176
LCV Gasoline <3,5 t	Euro 1	-	-	-	-	15 726	17 180	16 379	17 204	14 070	8 987	11 257	10 440	8 168	6 589	6 741	5 958
LCV Gasoline <3,5 t	Euro 2	-	-	-	-	-	-	-	-	15 739	10 053	12 593	11 678	9 137	7 370	7 540	6 664
LCV Gasoline <3,5 t	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	10 365	8 361	8 554	7 560
LCV Gasoline <3,5 t	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline <3,5 t	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline <3,5 t	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel <3,5 t	Conventional	49 295	45 810	25 255	17 351	12 098	10 943	6 828	6 599	11 330	19 794	22 554	22 953	19 464	20 756	20 278	25 081
LCV Diesel <3,5 t	Euro 1	-	-	-	-	14 035	12 696	7 921	7 656	13 144	22 963	26 165	26 628	22 580	24 080	23 524	29 096

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
LCV Diesel <3,5 t	Euro 2	-	-	-	-	-	-	-	-	14 459	25 261	28 783	29 292	24 839	26 489	25 878	32 008
LCV Diesel <3,5 t	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	27 101	28 901	28 234	34 922
LCV Diesel <3,5 t	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel <3,5 t	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel <3,5 t	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Gasoline >3,5 t	Conventional	35 364	37 800	33 057	14 839	17 976	19 638	18 722	19 666	16 083	10 273	12 868	11 934	9 337	7 531	7 705	6 810
HDV Diesel Rigid <=7,5 t	Conventional	71 364	66 318	36 562	25 119	17 515	15 843	9 885	9 554	16 402	28 655	32 651	33 229	28 177	30 049	29 356	36 309
HDV Diesel Rigid <=7,5 t	Euro I	-	-	-	-	20 536	18 575	11 590	11 202	19 231	33 598	38 284	38 961	33 037	35 232	34 419	42 572
HDV Diesel Rigid <=7,5 t	Euro II	-	-	-	-	-	-	-	-	22 657	39 584	45 104	45 902	38 924	41 509	40 552	50 157
HDV Diesel Rigid <=7,5 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	45 548	48 573	47 453	58 693
HDV Diesel Rigid <=7,5 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid <=7,5 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid <=7,5 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5 - 12 t	Conventional	73 413	68 222	37 611	25 840	18 018	16 298	10 168	9 828	16 873	29 478	33 589	34 183	28 986	30 912	30 199	37 352
HDV Diesel Rigid 7,5 - 12 t	Euro I	-	-	-	-	22 626	20 466	12 769	12 342	21 189	37 018	42 180	42 926	36 400	38 818	37 923	46 906
HDV Diesel Rigid 7,5 - 12 t	Euro II	-	-	-	-	-	-	-	-	24 885	43 477	49 540	50 416	42 751	45 591	44 539	55 089
HDV Diesel Rigid 7,5 - 12 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	50 558	53 917	52 673	65 149
HDV Diesel Rigid 7,5 - 12 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5 - 12 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5 - 12 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12 - 14 t	Conventional	64 021	59 494	32 800	22 534	15 713	14 213	8 867	8 571	14 714	25 707	29 292	29 810	25 278	26 957	26 335	32 573
HDV Diesel Rigid 12 - 14 t	Euro I	-	-	-	-	20 523	18 564	11 582	11 195	19 219	33 577	38 259	38 936	33 016	35 209	34 397	42 545
HDV Diesel Rigid 12 - 14 t	Euro II	-	-	-	-	-	-	-	-	22 975	40 140	45 737	46 546	39 470	42 092	41 121	50 861
HDV Diesel Rigid 12 - 14 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	49 244	52 515	51 304	63 456
HDV Diesel Rigid 12 - 14 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12 - 14 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12 - 14 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 14 - 20 t	Conventional	80 574	74 877	41 280	28 361	19 775	17 887	11 160	10 787	18 519	32 354	36 865	37 517	31 814	33 927	33 144	40 995
HDV Diesel Rigid 14 - 20 t	Euro I	-	-	-	-	24 797	22 430	13 994	13 526	23 221	40 570	46 227	47 045	39 893	42 542	41 561	51 405
HDV Diesel Rigid 14 - 20 t	Euro II	-	-	-	-	-	-	-	-	26 760	46 752	53 272	54 214	45 972	49 026	47 895	59 240
HDV Diesel Rigid 14 - 20 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	53 301	56 841	55 530	68 683
HDV Diesel Rigid 14 - 20 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 14 - 20 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 14 - 20 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 20 - 26 t	Conventional	80 694	74 988	41 341	28 403	19 805	17 914	11 177	10 803	18 546	32 401	36 920	37 573	31 861	33 977	33 193	41 056
HDV Diesel Rigid 20 - 26 t	Euro I	-	-	-	-	25 127	22 728	14 181	13 706	23 531	41 110	46 843	47 671	40 424	43 109	42 115	52 090
HDV Diesel Rigid 20 - 26 t	Euro II	-	-	-	-	-	-	-	-	26 983	47 141	53 715	54 665	46 355	49 434	48 293	59 732
HDV Diesel Rigid 20 - 26 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	55 054	58 710	57 356	70 942
HDV Diesel Rigid 20 - 26 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 20 - 26 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
HDV Diesel Rigid 20 - 26 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26 - 28 t	Conventional	80 372	74 689	41 177	28 289	19 726	17 842	11 132	10 760	18 472	32 272	36 773	37 423	31 734	33 842	33 061	40 892
HDV Diesel Rigid 26 - 28 t	Euro I	-	-	-	-	24 279	21 961	13 702	13 244	22 737	39 722	45 262	46 062	39 060	41 654	40 693	50 332
HDV Diesel Rigid 26 - 28 t	Euro II	-	-	-	-	-	-	-	-	26 138	45 665	52 033	52 953	44 903	47 885	46 781	57 862
HDV Diesel Rigid 26 - 28 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	52 764	56 268	54 971	67 991
HDV Diesel Rigid 26 - 28 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26 - 28 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26 - 28 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28 - 32 t	Conventional	80 555	74 859	41 270	28 354	19 771	17 883	11 158	10 784	18 514	32 346	36 857	37 508	31 806	33 919	33 136	40 985
HDV Diesel Rigid 28 - 32 t	Euro I	-	-	-	-	24 597	22 248	13 881	13 417	23 034	40 242	45 854	46 664	39 570	42 198	41 225	50 990
HDV Diesel Rigid 28 - 32 t	Euro II	-	-	-	-	-	-	-	-	26 503	46 302	52 759	53 692	45 530	48 554	47 434	58 669
HDV Diesel Rigid 28 - 32 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	54 062	57 653	56 323	69 664
HDV Diesel Rigid 28 - 32 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28 - 32 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28 - 32 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32 t	Conventional	99 250	92 232	50 848	34 934	24 359	22 033	13 747	13 287	22 811	39 852	45 410	46 213	39 187	41 790	40 826	50 497
HDV Diesel Rigid >32 t	Euro I	-	-	-	-	26 878	24 312	15 169	14 661	25 170	43 974	50 106	50 992	43 240	46 112	45 048	55 719
HDV Diesel Rigid >32 t	Euro II	-	-	-	-	-	-	-	-	30 885	53 958	61 483	62 570	53 058	56 582	55 277	68 370
HDV Diesel Rigid >32 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	61 111	65 170	63 667	78 747
HDV Diesel Rigid >32 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 14 - 20 t	Conventional	104 949	97 528	53 768	36 940	25 757	23 298	14 536	14 050	24 121	42 141	48 017	48 867	41 438	44 190	43 171	53 396
HDV Diesel Articulated 14 - 20 t	Euro I	-	-	-	-	31 126	28 154	17 566	16 978	29 148	50 924	58 025	59 051	50 074	53 400	52 168	64 525
HDV Diesel Articulated 14 - 20 t	Euro II	-	-	-	-	-	-	-	-	34 874	60 928	69 425	70 652	59 911	63 891	62 417	77 201
HDV Diesel Articulated 14 - 20 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	74 698	79 660	77 822	96 256
HDV Diesel Articulated 14 - 20 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 14 - 20 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 14 - 20 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 20 - 28 t	Conventional	116 367	108 139	59 618	40 959	28 560	25 833	16 118	15 578	26 745	46 726	53 242	54 183	45 946	48 998	47 868	59 206
HDV Diesel Articulated 20 - 28 t	Euro I	-	-	-	-	33 928	30 689	19 147	18 507	31 772	55 508	63 249	64 368	54 582	58 208	56 865	70 334
HDV Diesel Articulated 20 - 28 t	Euro II	-	-	-	-	-	-	-	-	38 045	66 467	75 736	77 075	65 358	69 699	68 091	84 220
HDV Diesel Articulated 20 - 28 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	79 207	84 468	82 519	102 066
HDV Diesel Articulated 20 - 28 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 20 - 28 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 20 - 28 t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 28 - 34 t	Conventional	124 931	116 097	64 005	43 973	30 661	27 734	17 304	16 725	28 713	50 164	57 160	58 171	49 327	52 604	51 390	63 563
HDV Diesel Articulated 28 - 34 t	Euro I	-	-	-	-	35 979	32 544	20 305	19 625	33 693	58 864	67 073	68 259	57 881	61 726	60 302	74 586
HDV Diesel Articulated 28 - 34 t	Euro II	-	-	-	-	-	-	-	-	40 297	70 402	80 220	81 639	69 228	73 826	72 123	89 207
HDV Diesel Articulated 28 - 34 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	83 490	89 036	86 982	107 586

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
HDV Diesel Articulated 28 - 34 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 28 - 34 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 28 - 34 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 34 - 40 t	Conventional	119 136	110 712	61 036	41 933	29 239	26 448	16 501	15 949	27 381	47 837	54 508	55 472	47 039	50 164	49 006	60 614
HDV Diesel Articulated 34 - 40 t	Euro I	-	-	-	-	37 590	34 001	21 214	20 504	35 201	61 499	70 076	71 315	60 473	64 490	63 002	77 926
HDV Diesel Articulated 34 - 40 t	Euro II	-	-	-	-	-	-	-	-	41 752	72 943	83 116	84 586	71 726	76 490	74 726	92 426
HDV Diesel Articulated 34 - 40 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	86 599	92 351	90 220	111 591
HDV Diesel Articulated 34 - 40 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 34 - 40 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 34 - 40 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 40 - 50 t	Conventional	137 541	127 815	70 465	48 412	33 756	30 534	19 051	18 413	31 612	55 228	62 929	64 042	54 306	57 913	56 577	69 979
HDV Diesel Articulated 40 - 50 t	Euro I	-	-	-	-	41 407	37 454	23 368	22 586	38 776	67 745	77 192	78 557	66 614	71 039	69 400	85 839
HDV Diesel Articulated 40 - 50 t	Euro II	-	-	-	-	-	-	-	-	47 713	83 357	94 982	96 661	81 966	87 411	85 394	105 622
HDV Diesel Articulated 40 - 50 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	97 884	104 386	101 978	126 133
HDV Diesel Articulated 40 - 50 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 40 - 50 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 40 - 50 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 50 - 60 t	Conventional	126 487	117 543	64 802	44 521	31 043	28 080	17 520	16 933	29 071	50 789	57 872	58 895	49 942	53 259	52 030	64 355
HDV Diesel Articulated 50 - 60 t	Euro I	-	-	-	-	36 870	33 350	20 808	20 111	34 527	60 322	68 734	69 949	59 315	63 255	61 796	76 433
HDV Diesel Articulated 50 - 60 t	Euro II	-	-	-	-	-	-	-	-	41 806	73 037	83 223	84 694	71 819	76 589	74 822	92 545
HDV Diesel Articulated 50 - 60 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	87 507	93 320	91 167	112 762
HDV Diesel Articulated 50 - 60 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 50 - 60 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Articulated 50 - 60 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15 t	Conventional	127 587	118 565	65 366	44 908	31 313	28 324	17 672	17 080	29 324	51 231	58 375	59 407	50 376	53 722	52 483	64 914
BUS Diesel Urban Midi <=15 t	Euro I	-	-	-	-	38 553	34 873	21 758	21 030	36 104	63 076	71 872	73 143	62 023	66 143	64 617	79 923
BUS Diesel Urban Midi <=15 t	Euro II	-	-	-	-	-	-	-	-	38 535	67 324	76 713	78 070	66 201	70 598	68 970	85 306
BUS Diesel Urban Midi <=15 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	70 617	75 308	73 571	90 997
BUS Diesel Urban Midi <=15 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Standard 15 - 18 t	Conventional	135 097	125 544	69 213	47 551	33 157	29 991	18 712	18 086	31 050	54 246	61 811	62 904	53 341	56 884	55 572	68 735
BUS Diesel Urban Standard 15 - 18 t	Euro I	-	-	-	-	40 297	36 450	22 742	21 981	37 737	65 929	75 123	76 452	64 829	69 135	67 540	83 538
BUS Diesel Urban Standard 15 - 18 t	Euro II	-	-	-	-	-	-	-	-	42 063	73 487	83 735	85 215	72 260	77 060	75 282	93 114
BUS Diesel Urban Standard 15 - 18 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	77 058	82 176	80 280	99 296
BUS Diesel Urban Standard 15 - 18 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Standard 15 - 18 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Standard 15 - 18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Articulated >18 t	Conventional	129 421	120 270	66 306	45 554	31 764	28 731	17 926	17 326	29 745	51 967	59 214	60 262	51 100	54 494	53 237	65 848
BUS Diesel Urban Articulated >18 t	Euro I	-	-	-	-	40 523	36 654	22 869	22 104	37 948	66 298	75 544	76 880	65 192	69 522	67 919	84 006

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
BUS Diesel Urban Articulated >18 t	Euro II	-	-	-	-	-	-	-	-	42 744	74 677	85 091	86 596	73 431	78 308	76 502	94 623
BUS Diesel Urban Articulated >18 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	77 935	83 111	81 194	100 426
BUS Diesel Urban Articulated >18 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Articulated >18 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Articulated >18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Standard <=18 t	Conventional	130 179	120 974	66 694	45 820	31 950	28 899	18 031	17 428	29 920	52 272	59 561	60 614	51 399	54 813	53 549	66 233
BUS Diesel Coach Standard <=18 t	Euro I	-	-	-	-	37 357	33 790	21 082	20 377	34 983	61 118	69 641	70 873	60 098	64 090	62 612	77 442
BUS Diesel Coach Standard <=18 t	Euro II	-	-	-	-	-	-	-	-	38 568	67 380	76 777	78 135	66 256	70 657	69 027	85 377
BUS Diesel Coach Standard <=18 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	71 719	76 483	74 719	92 418
BUS Diesel Coach Standard <=18 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Standard <=18 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Standard <=18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Articulated >18 t	Conventional	128 836	119 726	66 006	45 348	31 620	28 601	17 845	17 248	29 611	51 732	58 947	59 989	50 869	54 248	52 997	65 550
BUS Diesel Coach Articulated >18 t	Euro I	-	-	-	-	38 120	34 481	21 513	20 793	35 698	62 367	71 064	72 321	61 326	65 400	63 891	79 025
BUS Diesel Coach Articulated >18 t	Euro II	-	-	-	-	-	-	-	-	40 777	71 240	81 175	82 610	70 051	74 704	72 981	90 268
BUS Diesel Coach Articulated >18 t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	74 250	79 182	77 355	95 678
BUS Diesel Coach Articulated >18 t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Articulated >18 t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coach Articulated >18 t	Euro VI A/B/C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	Euro I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	Euro II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	EEV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOP Gasoline 2-stroke <50 cm³	Conventional	3 728	3 985	3 485	1 564	1 895	2 070	1 974	2 073	1 696	1 083	1 357	1 258	984	794	812	718
MOP Gasoline 2-stroke <50 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	1 177	949	971	858
MOP Gasoline 2-stroke <50 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 097
MOP Gasoline 2-stroke <50 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOP Gasoline 2-stroke <50 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 2-stroke >50 cm³	Conventional	8 475	9 059	7 923	3 556	4 308	4 706	4 487	4 713	3 854	2 462	3 084	2 860	2 238	1 805	1 847	1 632
MOT Gasoline 2-stroke >50 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	2 334	1 882	1 926	1 702
MOT Gasoline 2-stroke >50 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 928
MOT Gasoline 2-stroke >50 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 2-stroke >50 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke <250 cm³	Conventional	10 979	11 735	10 263	4 607	5 581	6 097	5 812	6 105	4 993	3 189	3 995	3 705	2 899	2 338	2 392	2 114
MOT Gasoline 4-stroke <250 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	3 224	2 600	2 660	2 351
MOT Gasoline 4-stroke <250 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 083
MOT Gasoline 4-stroke <250 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke <250 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke 250 - 750 cm³	Conventional	11 297	12 075	10 560	4 740	5 742	6 273	5 981	6 282	5 138	3 282	4 111	3 812	2 983	2 406	2 461	2 175
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	3 356	2 707	2 769	2 447

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 193
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke >750 cm³	Conventional	11 468	12 258	10 720	4 812	5 829	6 368	6 071	6 377	5 216	3 331	4 173	3 870	3 028	2 442	2 499	2 208
MOT Gasoline 4-stroke >750 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	3 451	2 784	2 848	2 517
MOT Gasoline 4-stroke >750 cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 250
MOT Gasoline 4-stroke >750 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT Gasoline 4-stroke >750 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 294 Mileage data for Road transport (average km/year/vehicle) 2004-2019

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PC Gasoline Small	PRE ECE	1714	1541	3034	2634	2369	2336	2142	1926	1805	1479	1701	1747	1726	2007	1945	1938
PC Gasoline Small	ECE 15/00-01	2064	1856	3654	3173	2853	2814	2580	-	-	-	-	-	-	-	-	-
PC Gasoline Small	ECE 15/02	2090	1879	3700	3213	2890	2850	2612	2349	2202	1804	2075	-	-	-	-	-
PC Gasoline Small	ECE 15/03	2463	2215	4360	3787	3405	3358	3079	2769	2595	2126	2446	2511	2480	2886	2795	-
PC Gasoline Small	ECE 15/04	3309	2975	5858	5087	4575	4511	4136	3719	3486	2856	3285	3374	3332	3876	3755	3743
PC Gasoline Small	Euro 1	3983	3581	7052	6124	5507	5431	4979	4478	4197	3438	3955	4061	4011	4666	4521	4506
PC Gasoline Small	Euro 2	4615	4150	8171	7096	6381	6293	5769	5188	4863	3984	4583	4706	4648	5407	5238	5221
PC Gasoline Small	Euro 3	5325	4788	9428	8187	7363	7261	6656	5986	5611	4597	5288	5430	5363	6239	6044	6024
PC Gasoline Small	Euro 4	-	5072	9988	8673	7800	7692	7052	6342	5944	4870	5602	5752	5681	6609	6403	6382
PC Gasoline Small	Euro 5	-	-	-	-	-	-	7674	6901	6469	5299	6096	6260	6182	7193	6968	6945
PC Gasoline Small	Euro 6	-	-	-	-	-	-	-	-	-	-	-	6805	6721	7819	7574	7550
PC Gasoline Medium	PRE ECE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8181	8154
PC Gasoline Medium	ECE 15/00-01	1836	1651	3251	2823	2539	2504	2295	2064	1935	1585	1823	1872	1849	2151	2084	2077
PC Gasoline Medium	ECE 15/02	2199	1977	3892	3380	3040	2998	2748	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	ECE 15/03	2307	2074	4084	3546	3189	3145	2883	2593	2430	1991	2290	-	-	-	-	-
PC Gasoline Medium	ECE 15/04	2644	2377	4681	4065	3655	3605	3305	2972	2786	2282	2625	2696	2662	3097	3001	-
PC Gasoline Medium	Euro 1	3556	3197	6295	5467	4916	4848	4444	3997	3746	3069	3531	3625	3581	4166	4035	4022
PC Gasoline Medium	Euro 2	4400	3956	7790	6765	6083	5999	5500	4946	4636	3798	4369	4486	4431	5155	4994	4978
PC Gasoline Medium	Euro 3	4962	4461	8785	7629	6860	6765	6202	5578	5228	4283	4927	5059	4997	5813	5632	5613
PC Gasoline Medium	Euro 4	5726	5148	10137	8803	7916	7807	7157	6436	6033	4942	5685	5838	5766	6708	6498	6477
PC Gasoline Medium	Euro 5	-	5428	10689	9282	8347	8232	7547	6787	6361	5212	5995	6156	6080	7073	6852	6830
PC Gasoline Medium	Euro 6	-	-	-	-	-	-	8264	7432	6966	5707	6565	6741	6658	7746	7504	7480
PC Gasoline Large	PRE ECE	-	-	-	-	-	-	-	-	-	-	-	7327	7236	8419	8156	8129
PC Gasoline Large	ECE 15/00-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8807	8779
PC Gasoline Large	ECE 15/02	1931	1736	3419	2969	2670	2633	2414	2171	2035	1667	1918	1969	1945	2263	2192	2185
PC Gasoline Large	ECE 15/03	2310	2077	4090	3552	3194	3150	2888	-	-	-	-	-	-	-	-	-
PC Gasoline Large	ECE 15/04	2351	2114	4162	3614	3250	3205	2938	2642	2477	2029	2334	-	-	-	-	-
PC Gasoline Large	Euro 1	2788	2507	4936	4287	3855	3801	3485	3134	2938	2407	2768	2843	2808	3266	3164	-
PC Gasoline Large	Euro 2	3699	3326	6549	5687	5114	5043	4624	4158	3897	3193	3673	3772	3725	4334	4198	4184

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PC Gasoline Large	Euro 3	4508	4053	7981	6931	6233	6146	5635	5068	4750	3891	4476	4596	4540	5281	5116	5100
PC Gasoline Large	Euro 4	5296	4762	9376	8142	7322	7221	6620	5953	5580	4571	5259	5400	5333	6204	6011	5991
PC Gasoline Large	Euro 5	5896	5301	10439	9065	8152	8039	7370	6628	6212	5089	5855	6012	5937	6908	6692	6670
PC Gasoline Large	Euro 6	-	5960	11735	10191	9164	9037	8285	7451	6984	5722	6582	6758	6675	7765	7523	7498
PC Diesel Small	Conventional	-	-	-	-	-	-	8788	7903	7408	6069	6981	7168	7080	8237	7979	7953
PC Diesel Small	Euro 1	-	-	-	-	-	-	-	-	-	-	-	7800	7703	8962	8682	8654
PC Diesel Small	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9385	9354
PC Diesel Small	Euro 3	-	-	-	-	-	9437	8651	7780	7292	5974	6872	7057	6970	8108	7855	7830
PC Diesel Small	Euro 4	-	-	-	-	-	-	8808	7921	7424	6082	6997	7185	7096	8255	7997	7971
PC Diesel Small	Euro 5	-	-	-	-	-	-	-	-	-	-	-	8374	8270	9622	9321	9291
PC Diesel Small	Euro 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9857	9825
PC Diesel Medium	Conventional	31885	33866	23192	17011	15438	13387	12198	11846	12171	9811	10277	10683	10180	10749	10980	11130
PC Diesel Medium	Euro 1	35921	38152	26127	19164	17392	15082	13742	13345	13712	11053	11578	12035	11469	12110	12370	12538
PC Diesel Medium	Euro 2	42309	44938	30774	22572	20485	17764	16186	15719	16150	13018	13637	14176	13509	14264	14569	14768
PC Diesel Medium	Euro 3	48008	50991	34919	25612	23244	20157	18366	17836	18326	14772	15474	16085	15328	16185	16532	16758
PC Diesel Medium	Euro 4	-	51440	35227	25838	23449	20334	18528	17993	18487	14902	15610	16227	15463	16327	16678	16905
PC Diesel Medium	Euro 5	-	-	-	-	-	-	20989	20383	20943	16882	17684	18382	17517	18496	18893	19151
PC Diesel Medium	Euro 6	-	-	-	-	-	-	-	-	-	-	-	19896	18960	20020	20449	20728
PC Diesel Large	Conventional	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22005	22305
PC Diesel Large	Euro 1	31885	33866	23192	17011	15438	13387	12198	11846	12171	9811	10277	10683	10180	10749	10980	11130
PC Diesel Large	Euro 2	35921	38152	26127	19164	17392	15082	13742	13345	13712	11053	11578	12035	11469	12110	12370	12538
PC Diesel Large	Euro 3	42309	44938	30774	22572	20485	17764	16186	15719	16150	13018	13637	14176	13509	14264	14569	14768
PC Diesel Large	Euro 4	48008	50991	34919	25612	23244	20157	18366	17836	18326	14772	15474	16085	15328	16185	16532	16758
PC Diesel Large	Euro 5	-	51440	35227	25838	23449	20334	18528	17993	18487	14902	15610	16227	15463	16327	16678	16905
PC Diesel Large	Euro 6	-	-	-	-	-	-	20989	20383	20943	16882	17684	18382	17517	18496	18893	19151
PC Gasoline Hybrid Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	19896	18960	20020	20449	20728
PC Gasoline Hybrid Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22005	22305
PC Gasoline Hybrid Medium	Euro 6	35211	37399	25611	18785	17048	14784	13470	13082	13441	10834	11349	11797	11242	11871	12125	12291
PC LPG Medium	Conventional	39892	42371	29016	21282	19315	16749	15261	14821	15228	12275	12858	13366	12737	13449	13737	13925
PC LPG Medium	Euro 1	44847	47634	32620	23926	21714	18830	17157	16662	17119	13799	14455	15026	14319	15119	15443	15654
PC LPG Medium	Euro 2	52427	55684	38133	27970	25384	22012	20056	19478	20013	16132	16898	17566	16739	17675	18054	18300
PC LPG Medium	Euro 3	-	57615	39455	28940	26264	22775	20752	20153	20707	16691	17484	18175	17319	18287	18680	18935
PC LPG Medium	Euro 4	-	-	-	-	-	-	23147	22479	23096	18617	19502	20272	19318	20398	20835	21120
PC LPG Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	21968	20934	22104	22578	22886
PC LPG Medium	Euro 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24320	24652
PC CNG Medium	Euro 4	57975	65849	67509	62900	58358	60481	56825	51332	46969	44440	38288	36311	37334	38898	34993	31531
PC CNG Medium	Euro 5	65806	74742	76627	71395	66240	68649	64500	58265	53313	50442	43460	41215	42376	44151	39719	35790
PC CNG Medium	Euro 6	69867	79355	81356	75802	70328	72887	68481	61861	56603	53556	46142	43758	44992	46876	42170	37999
LCV Gasoline <3,5 t	Conventional	73237	83183	85281	79458	73721	76402	71784	64846	59334	56139	48368	45869	47162	49138	44205	39832
LCV Gasoline <3,5 t	Euro 1	-	81318	83368	77677	72067	74689	70175	63391	58003	54880	47283	44841	46104	48036	43213	38938

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
LCV Gasoline <3,5 t	Euro 2	-	-	-	-	-	-	76548	69149	63271	59865	51577	48913	50292	52398	47138	42475
LCV Gasoline <3,5 t	Euro 3	-	-	-	-	-	-	-	-	-	-	-	51085	52524	54725	49231	44361
LCV Gasoline <3,5 t	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	51323	46246
LCV Gasoline <3,5 t	Euro 5	25655	42029	37384	41017	31016	36180	41597	39014	40530	43166	44303	39882	37983	38699	36088	36400
LCV Gasoline <3,5 t	Euro 6	-	-	-	-	-	-	45374	42558	44211	47087	48326	43504	41432	42213	39366	39706
LCV Diesel <3,5 t	Conventional	-	-	-	-	-	-	-	-	-	-	-	45435	43272	44087	41114	41469
LCV Diesel <3,5 t	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	42861	43232
LCV Diesel <3,5 t	Euro 2	4701	4227	8323	7228	6500	6410	5876	5285	4953	4058	4668	4794	4734	5508	5336	5318
LCV Diesel <3,5 t	Euro 3	5411	4865	9580	8319	7481	7378	6763	6083	5701	4671	5373	5517	5449	6339	6141	6121
LCV Diesel <3,5 t	Euro 4	6053	5442	10716	9306	8368	8253	7566	6804	6378	5225	6010	6172	6095	7091	6870	6847
LCV Diesel <3,5 t	Euro 5	6867	6174	12156	10557	9493	9362	8583	7719	7235	5927	6818	7001	6915	8044	7793	7768
LCV Diesel <3,5 t	Euro 6	-	6981	13746	11937	10734	10586	9705	8728	8181	6702	7710	7917	7819	9096	8812	8783
HDV Gasoline >3,5 t	Conventional	-	-	-	-	11660	11499	10542	9480	8886	7280	8374	8599	8493	9880	9572	9540
HDV Diesel Rigid <=7,5 t	Conventional	-	-	-	-	-	-	-	-	-	-	9127	9372	9256	10768	10432	10398
HDV Diesel Rigid <=7,5 t	Euro I	32837	34877	23884	17518	15899	13787	12562	12200	12535	10104	10584	11002	10484	11070	11308	11462
HDV Diesel Rigid <=7,5 t	Euro II	38094	40461	27708	20323	18444	15994	14573	14153	14542	11722	12278	12763	12163	12843	13118	13297
HDV Diesel Rigid <=7,5 t	Euro III	41906	44510	30481	22357	20290	17595	16031	15569	15997	12894	13507	14041	13380	14128	14431	14628
HDV Diesel Rigid <=7,5 t	Euro IV	45722	48563	33256	24393	22138	19197	17491	16987	17453	14069	14737	15319	14598	15414	15745	15960
HDV Diesel Rigid <=7,5 t	Euro V	-	55995	38346	28126	25525	22135	20168	19586	20124	16222	16992	17664	16832	17773	18154	18402
HDV Diesel Rigid <=7,5 t	Euro VI	-	-	-	-	27343	23711	21604	20981	21557	17377	18202	18921	18031	19039	19447	19713
HDV Diesel Rigid 7,5 - 12 t	Conventional	-	-	-	-	-	-	-	-	-	-	19730	20509	19544	20636	21079	21367
HDV Diesel Rigid 7,5 - 12 t	Euro I	6185	5561	10950	9509	8551	8433	7731	6953	6517	5339	6142	6306	6228	7246	7020	6997
HDV Diesel Rigid 7,5 - 12 t	Euro II	47538	50491	34577	25361	23017	19959	18186	17661	18146	14627	15322	15927	15178	16026	16370	16593
HDV Diesel Rigid 7,5 - 12 t	Euro III	55738	59201	40541	29736	26987	23402	21323	20708	21276	17150	17965	18675	17796	18791	19194	19456
HDV Diesel Rigid 7,5 - 12 t	Euro IV	65668	69748	47764	35034	31795	27572	25122	24397	25067	20206	21166	22002	20967	22139	22613	22922
HDV Diesel Rigid 7,5 - 12 t	Euro V	76844	81618	55893	40996	37206	32264	29397	28549	29333	23645	24768	25746	24535	25906	26462	26823
HDV Diesel Rigid 7,5 - 12 t	Euro VI	-	88258	60440	44331	40233	34889	31789	30872	31720	25568	26783	27841	26531	28014	28614	29005
HDV Diesel Rigid 12 - 14 t	Conventional	-	-	-	-	45243	39233	35747	34716	35669	28752	30118	31308	29835	31502	32178	32617
HDV Diesel Rigid 12 - 14 t	Euro I	-	-	-	-	-	-	-	-	-	-	33090	34398	32779	34611	35353	35836
HDV Diesel Rigid 12 - 14 t	Euro II	48903	51941	35570	26089	23678	20532	18708	18168	18667	15047	15762	16385	15614	16486	16840	17070
HDV Diesel Rigid 12 - 14 t	Euro III	61411	65227	44668	32763	29734	25784	23493	22815	23442	18896	19794	20576	19608	20703	21147	21436
HDV Diesel Rigid 12 - 14 t	Euro IV	72125	76607	52461	38479	34922	30283	27592	26796	27532	22193	23247	24166	23028	24315	24837	25176
HDV Diesel Rigid 12 - 14 t	Euro V	85297	90597	62042	45506	41299	35813	32631	31690	32560	26246	27492	28579	27234	28756	29373	29774
HDV Diesel Rigid 12 - 14 t	Euro VI	-	98901	67728	49677	45085	39096	35622	34594	35545	28652	30013	31198	29730	31392	32065	32503
HDV Diesel Rigid 14 - 20 t	Conventional	-	-	-	-	51257	44448	40499	39331	40411	32574	34121	35470	33801	35690	36455	36953
HDV Diesel Rigid 14 - 20 t	Euro I	-	-	-	-	-	-	-	-	-	-	37741	39233	37386	39476	40323	40873
HDV Diesel Rigid 14 - 20 t	Euro II	42646	45296	31019	22752	20648	17906	16315	15844	16279	13122	13745	14289	13616	14377	14686	14886
HDV Diesel Rigid 14 - 20 t	Euro III	55702	59163	40515	29717	26970	23387	21309	20694	21263	17139	17954	18663	17785	18779	19181	19443
HDV Diesel Rigid 14 - 20 t	Euro IV	66590	70727	48435	35525	32241	27959	25474	24739	25419	20490	21463	22311	21261	22449	22931	23244
HDV Diesel Rigid 14 - 20 t	Euro V	83080	88241	60429	44323	40225	34882	31783	30866	31714	25563	26778	27836	26526	28008	28609	29000

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
HDV Diesel Rigid 14 - 20 t	Euro VI	-	91004	62320	45710	41484	35974	32777	31832	32706	26364	27616	28707	27356	28885	29505	29907
HDV Diesel Rigid 20 - 26 t	Conventional	-	-	-	-	48792	42311	38551	37439	38468	31008	32481	33764	32175	33973	34702	35176
HDV Diesel Rigid 20 - 26 t	Euro I	-	-	-	-	-	-	-	-	-	-	36137	37565	35797	37798	38609	39136
HDV Diesel Rigid 20 - 26 t	Euro II	53673	57008	39039	28634	25987	22535	20533	19941	20488	16515	17300	17983	17137	18095	18483	18735
HDV Diesel Rigid 20 - 26 t	Euro III	67303	71484	48953	35906	32586	28258	25747	25004	25691	20709	21693	22550	21489	22690	23176	23493
HDV Diesel Rigid 20 - 26 t	Euro IV	77560	82379	56414	41378	37553	32565	29671	28815	29607	23865	24999	25986	24764	26148	26708	27073
HDV Diesel Rigid 20 - 26 t	Euro V	89924	95511	65407	47974	43539	37756	34401	33409	34326	27669	28984	30129	28711	30316	30966	31389
HDV Diesel Rigid 20 - 26 t	Euro VI	-	97604	66840	49025	44493	38583	35155	34141	35078	28276	29619	30789	29340	30980	31645	32077
HDV Diesel Rigid 26 - 28 t	Conventional	-	-	-	-	51221	44417	40471	39303	40383	32551	34098	35445	33777	35665	36430	36927
HDV Diesel Rigid 26 - 28 t	Euro I	-	-	-	-	-	-	-	-	-	-	37291	38764	36940	39004	39841	40385
HDV Diesel Rigid 26 - 28 t	Euro II	53752	57092	39097	28677	26026	22569	20563	19970	20519	16540	17325	18010	17162	18121	18510	18763
HDV Diesel Rigid 26 - 28 t	Euro III	68199	72437	49605	36384	33021	28634	26090	25337	26033	20985	21982	22850	21775	22992	23485	23806
HDV Diesel Rigid 26 - 28 t	Euro IV	78205	83064	56883	41722	37865	32835	29918	29055	29853	24063	25206	26202	24969	26365	26930	27298
HDV Diesel Rigid 26 - 28 t	Euro V	92881	98652	67558	49552	44971	38997	35532	34507	35455	28579	29937	31120	29655	31313	31984	32421
HDV Diesel Rigid 26 - 28 t	Euro VI	-	89877	61549	45144	40971	35529	32372	31438	32301	26037	27274	28352	27018	28528	29139	29537
HDV Diesel Rigid 28 - 32 t	Conventional	-	-	-	-	49123	42598	38813	37693	38728	31218	32701	33993	32393	34204	34937	35414
HDV Diesel Rigid 28 - 32 t	Euro I	-	-	-	-	-	-	-	-	-	-	35486	36888	35152	37117	37913	38431
HDV Diesel Rigid 28 - 32 t	Euro II	53538	56865	38941	28562	25922	22479	20481	19890	20437	16474	17256	17938	17094	18049	18436	18688
HDV Diesel Rigid 28 - 32 t	Euro III	65897	69992	47931	35156	31906	27668	25209	24482	25155	20277	21240	22079	21040	22216	22692	23002
HDV Diesel Rigid 28 - 32 t	Euro IV	75756	80462	55101	40415	36679	31807	28981	28145	28918	23310	24417	25382	24187	25539	26087	26443
HDV Diesel Rigid 28 - 32 t	Euro V	89018	94549	64748	47491	43100	37375	34054	33072	33980	27391	28692	29825	28422	30010	30654	31072
HDV Diesel Rigid 28 - 32 t	Euro VI	-	97109	66501	48777	44268	38388	34976	33968	34901	28132	29469	30633	29192	30823	31484	31914
HDV Diesel Rigid >32 t	Conventional	-	-	-	-	50741	44001	40091	38934	40004	32246	33778	35112	33460	35330	36088	36581
HDV Diesel Rigid >32 t	Euro I	-	-	-	-	-	-	-	-	-	-	36966	38426	36618	38664	39494	40033
HDV Diesel Rigid >32 t	Euro II	53660	56994	39030	28628	25981	22530	20528	19936	20483	16511	17295	17979	17133	18090	18478	18731
HDV Diesel Rigid >32 t	Euro III	66759	70907	48557	35616	32323	28030	25539	24802	25484	20542	21517	22367	21315	22506	22989	23303
HDV Diesel Rigid >32 t	Euro IV	76813	81586	55871	40980	37191	32251	29385	28538	29322	23635	24758	25736	24525	25896	26451	26812
HDV Diesel Rigid >32 t	Euro V	91208	96875	66341	48659	44161	38295	34892	33886	34817	28065	29398	30559	29121	30749	31408	31837
HDV Diesel Rigid >32 t	Euro VI	-	91316	62534	45867	41627	36097	32890	31941	32819	26454	27711	28806	27450	28984	29606	30010
HDV Diesel Articulated 14 - 20 t	Conventional	-	-	-	-	49195	42661	38870	37749	38786	31264	32749	34043	32441	34254	34989	35467
HDV Diesel Articulated 14 - 20 t	Euro I	-	-	-	-	-	-	-	-	-	-	35620	37028	35285	37257	38056	38576
HDV Diesel Articulated 14 - 20 t	Euro II	66113	70221	48088	35271	32010	27758	25292	24562	25237	20343	21309	22151	21109	22289	22767	23077
HDV Diesel Articulated 14 - 20 t	Euro III	72950	77482	53061	38919	35321	30629	27907	27102	27847	22447	23513	24442	23292	24593	25121	25464
HDV Diesel Articulated 14 - 20 t	Euro IV	89514	95076	65109	47755	43341	37584	34244	33256	34170	27543	28852	29992	28580	30178	30825	31246
HDV Diesel Articulated 14 - 20 t	Euro V	103100	109506	74990	55003	49919	43288	39441	38304	39356	31724	33231	34543	32918	34758	35503	35988
HDV Diesel Articulated 14 - 20 t	Euro VI	-	100314	68696	50386	45728	39654	36131	35088	36052	29061	30441	31644	30155	31840	32523	32967
HDV Diesel Articulated 20 - 28 t	Conventional	-	-	-	-	53874	46718	42567	41339	42474	34237	35864	37280	35526	37512	38316	38839
HDV Diesel Articulated 20 - 28 t	Euro I	-	-	-	-	-	-	-	-	-	-	38662	40189	38298	40439	41306	41870
HDV Diesel Articulated 20 - 28 t	Euro II	69909	74253	50849	37296	33849	29352	26744	25973	26686	21511	22533	23423	22321	23568	24074	24402
HDV Diesel Articulated 20 - 28 t	Euro III	84480	89728	61447	45070	40903	35470	32318	31386	32248	25994	27229	28305	26973	28480	29091	29488

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
HDV Diesel Articulated 20 - 28 t	Euro IV	101076	107356	73519	53924	48939	42438	38667	37552	38583	31101	32578	33865	32272	34076	34806	35282
HDV Diesel Articulated 20 - 28 t	Euro V	126024	133854	91664	67233	61018	52913	48211	46820	48106	38777	40619	42224	40237	42486	43397	43990
HDV Diesel Articulated 20 - 28 t	Euro VI	-	142085	97301	71368	64770	56166	51176	49699	51065	41162	43117	44820	42711	45099	46066	46695
HDV Diesel Articulated 28 - 34 t	Conventional	-	-	-	-	74483	64589	58850	57152	58722	47334	49583	51542	49116	51862	52974	53697
HDV Diesel Articulated 28 - 34 t	Euro I	-	-	-	-	-	-	-	-	-	-	55039	57213	54521	57568	58803	59606
HDV Diesel Articulated 28 - 34 t	Euro II	77515	82332	56381	41354	37531	32546	29654	28799	29590	23851	24984	25971	24749	26133	26693	27057
HDV Diesel Articulated 28 - 34 t	Euro III	92086	97807	66979	49127	44586	38663	35228	34212	35151	28335	29681	30853	29401	31045	31710	32143
HDV Diesel Articulated 28 - 34 t	Euro IV	110265	117116	80202	58826	53388	46296	42183	40966	42091	33928	35540	36944	35206	37173	37971	38489
HDV Diesel Articulated 28 - 34 t	Euro V	133630	141932	97197	71291	64700	56106	51121	49646	51010	41118	43071	44772	42666	45050	46016	46645
HDV Diesel Articulated 28 - 34 t	Euro VI	-	142085	97301	71368	64770	56166	51176	49699	51065	41162	43117	44820	42711	45099	46066	46695
HDV Diesel Articulated 34 - 40 t	Conventional	-	-	-	-	75373	65361	59553	57835	59424	47900	50175	52158	49703	52481	53607	54339
HDV Diesel Articulated 34 - 40 t	Euro I	-	-	-	-	-	-	-	-	-	-	55141	57319	54622	57675	58912	59716
HDV Diesel Articulated 34 - 40 t	Euro II	83220	88391	60531	44398	40293	34941	31836	30918	31767	25607	26823	27883	26571	28056	28657	29049
HDV Diesel Articulated 34 - 40 t	Euro III	97652	103719	71028	52097	47281	41000	37357	36280	37276	30047	31475	32718	31179	32921	33627	34086
HDV Diesel Articulated 34 - 40 t	Euro IV	116794	124051	84951	62309	56549	49038	44680	43391	44583	35937	37644	39132	37290	39375	40219	40768
HDV Diesel Articulated 34 - 40 t	Euro V	140857	149608	102453	75147	68200	59141	53886	52331	53769	43341	45400	47194	44973	47487	48505	49167
HDV Diesel Articulated 34 - 40 t	Euro VI	-	162886	111546	81816	74252	64389	58668	56975	58541	47188	49429	51382	48964	51701	52810	53531
HDV Diesel Articulated 40 - 50 t	Conventional	-	-	-	-	83966	72813	66343	64429	66199	53361	55896	58104	55370	58465	59719	60534
HDV Diesel Articulated 40 - 50 t	Euro I	-	-	-	-	-	-	-	-	-	-	61810	64252	61228	64650	66037	66938
HDV Diesel Articulated 40 - 50 t	Euro II	79360	84291	57723	42338	38424	33320	30359	29484	30294	24419	25579	26589	25338	26754	27328	27701
HDV Diesel Articulated 40 - 50 t	Euro III	102024	108363	74208	54430	49398	42836	39030	37904	38945	31393	32884	34183	32575	34395	35133	35612
HDV Diesel Articulated 40 - 50 t	Euro IV	121009	128528	88017	64558	58590	50807	46293	44957	46192	37234	39003	40544	38636	40796	41671	42239
HDV Diesel Articulated 40 - 50 t	Euro V	146100	155178	106267	77944	70739	61342	55892	54279	55770	44955	47090	48951	46647	49254	50311	50998
HDV Diesel Articulated 40 - 50 t	Euro VI	-	164499	112651	82626	74988	65027	59249	57540	59120	47655	49919	51891	49449	52213	53333	54061
HDV Diesel Articulated 50 - 60 t	Conventional	-	-	-	-	86768	75242	68557	66579	68408	55142	57761	60043	57218	60416	61711	62554
HDV Diesel Articulated 50 - 60 t	Euro I	-	-	-	-	-	-	-	-	-	-	64050	66580	63447	66993	68430	69364
HDV Diesel Articulated 50 - 60 t	Euro II	91620	97312	66640	48879	44360	38468	35050	34039	34974	28191	29530	30697	29253	30888	31550	31981
HDV Diesel Articulated 50 - 60 t	Euro III	112385	119368	81744	59957	54414	47186	42993	41753	42900	34581	36223	37654	35882	37888	38701	39229
HDV Diesel Articulated 50 - 60 t	Euro IV	138285	146877	100583	73775	66955	58061	52902	51376	52787	42550	44571	46332	44152	46620	47620	48270
HDV Diesel Articulated 50 - 60 t	Euro V	165141	175401	120116	88102	79957	69336	63175	61353	63038	50813	53227	55330	52726	55673	56867	57644
HDV Diesel Articulated 50 - 60 t	Euro VI	-	164499	112651	82626	74988	65027	59249	57540	59120	47655	49919	51891	49449	52213	53333	54061
BUS Diesel Urban Midi <=15 t	Conventional	-	-	-	-	90174	78196	71248	69193	71093	57306	60028	62400	59464	62787	64134	65009
BUS Diesel Urban Midi <=15 t	Euro I	-	-	-	-	-	-	-	-	-	-	65807	68407	65188	68831	70307	71267
BUS Diesel Urban Midi <=15 t	Euro II	84257	89492	61285	44951	40795	35376	32233	31303	32163	25926	27157	28230	26902	28405	29014	29411
BUS Diesel Urban Midi <=15 t	Euro III	100070	106288	72787	53387	48452	42016	38282	37178	38199	30791	32254	33528	31951	33736	34460	34930
BUS Diesel Urban Midi <=15 t	Euro IV	121165	128693	88130	64641	58665	50873	46352	45015	46252	37282	39053	40596	38686	40848	41724	42294
BUS Diesel Urban Midi <=15 t	Euro V	147634	156806	107382	78762	71481	61986	56478	54849	56355	45427	47584	49464	47137	49771	50839	51533
BUS Diesel Urban Midi <=15 t	Euro VI	-	164499	112651	82626	74988	65027	59249	57540	59120	47655	49919	51891	49449	52213	53333	54061
BUS Diesel Urban Standard 15 - 18 t	Conventional	-	-	-	-	86300	74837	68187	66220	68039	54845	57450	59719	56909	60090	61379	62217
BUS Diesel Urban Standard 15 - 18 t	Euro I	-	-	-	-	-	-	-	-	-	-	63535	66045	62937	66455	67880	68807

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BUS Diesel Urban Standard 15 - 18 t	Euro II	84989	90269	61817	45341	41150	35684	32513	31575	32442	26151	27393	28475	27135	28652	29267	29666
BUS Diesel Urban Standard 15 - 18 t	Euro III	104640	111141	76111	55825	50664	43934	40031	38876	39944	32197	33727	35059	33410	35277	36033	36525
BUS Diesel Urban Standard 15 - 18 t	Euro IV	111687	118627	81237	59585	54077	46893	42727	41494	42634	34366	35998	37421	35660	37653	38460	38986
BUS Diesel Urban Standard 15 - 18 t	Euro V	119138	126541	86656	63560	57684	50022	45577	44262	45478	36659	38400	39917	38039	40165	41026	41586
BUS Diesel Urban Standard 15 - 18 t	Euro VI	-	119541	81863	60044	54493	47255	43056	41814	42962	34631	36276	37709	35935	37943	38757	39286
BUS Diesel Urban Articulated >18 t	Conventional	-	-	-	-	61726	53527	48770	47363	48664	39227	41090	42714	40704	42979	43901	44500
BUS Diesel Urban Articulated >18 t	Euro I	-	-	-	-	-	-	-	-	-	-	43334	45046	42927	45326	46298	46930
BUS Diesel Urban Articulated >18 t	Euro II	89992	95583	65456	48010	43572	37784	34427	33434	34352	27690	29006	30152	28733	30339	30989	31412
BUS Diesel Urban Articulated >18 t	Euro III	109373	116168	79553	58350	52956	45922	41841	40634	41750	33654	35252	36645	34921	36873	37663	38178
BUS Diesel Urban Articulated >18 t	Euro IV	121910	129485	88672	65039	59026	51186	46637	45292	46536	37512	39293	40846	38924	41099	41981	42554
BUS Diesel Urban Articulated >18 t	Euro V	130004	138081	94559	69357	62945	54584	49734	48299	49626	40002	41902	43558	41508	43828	44768	45379
BUS Diesel Urban Articulated >18 t	Euro VI	-	133692	91554	67152	60944	52849	48153	46764	48048	38730	40570	42173	40189	42435	43345	43937
BUS Diesel Coach Standard <=18 t	Conventional	-	-	-	-	69309	60102	54762	53182	54643	44046	46138	47961	45704	48259	49294	49967
BUS Diesel Coach Standard <=18 t	Euro I	-	-	-	-	-	-	-	-	-	-	49116	51057	48654	51374	52475	53192
BUS Diesel Coach Standard <=18 t	Euro II	86211	91568	62706	45993	41741	36197	32981	32029	32909	26527	27787	28885	27526	29064	29687	30093
BUS Diesel Coach Standard <=18 t	Euro III	109986	116819	79999	58677	53253	46179	42076	40862	41984	33842	35450	36850	35116	37079	37874	38391
BUS Diesel Coach Standard <=18 t	Euro IV	123885	131583	90109	66092	59982	52015	47393	46026	47290	38119	39930	41508	39554	41765	42661	43243
BUS Diesel Coach Standard <=18 t	Euro V	131484	139653	95635	70146	63661	55205	50300	48849	50191	40457	42379	44053	41980	44327	45277	45895
BUS Diesel Coach Standard <=18 t	Euro VI	-	132590	90798	66598	60442	52413	47756	46378	47652	38411	40236	41825	39857	42085	42987	43574
BUS Diesel Coach Articulated >18 t	Conventional	-	-	-	-	70159	60839	55433	53834	55313	44586	46704	48549	46265	48851	49898	50580
BUS Diesel Coach Articulated >18 t	Euro I	-	-	-	-	-	-	-	-	-	-	49887	51858	49417	52180	53299	54026
BUS Diesel Coach Articulated >18 t	Euro II	86716	92104	63074	46263	41986	36409	33174	32217	33102	26682	27950	29054	27687	29234	29861	30269
BUS Diesel Coach Articulated >18 t	Euro III	101392	107691	73748	54092	49092	42571	38788	37669	38704	31198	32680	33971	32373	34182	34915	35392
BUS Diesel Coach Articulated >18 t	Euro IV	111780	118726	81304	59635	54122	46933	42762	41529	42669	34395	36028	37452	35690	37684	38492	39018
BUS Diesel Coach Articulated >18 t	Euro V	120998	128516	88009	64552	58585	50803	46288	44953	46188	37231	38999	40540	38633	40792	41667	42235
BUS Diesel Coach Articulated >18 t	Euro VI	-	134440	92066	67528	61285	53145	48422	47025	48317	38947	40797	42409	40413	42672	43587	44182
BUS CNG Urban	Euro I	-	-	-	-	67441	58483	53286	51749	53171	42859	44895	46669	44473	46959	47966	48620
BUS CNG Urban	Euro II	-	-	-	-	-	-	-	-	-	-	48097	49997	47644	50307	51386	52088
BUS CNG Urban	Euro III	85821	91154	62423	45785	41553	36033	32831	31884	32760	26407	27661	28754	27401	28933	29553	29957
BUS CNG Urban	EEV	103464	109892	75255	55198	50095	43441	39581	38439	39495	31836	33348	34665	33034	34880	35629	36115
BUS CNG Urban	Euro VI	118184	125527	85962	63051	57222	49621	45212	43908	45114	36365	38092	39597	37734	39843	40697	41253
MOP Gasoline 2-stroke <50 cm³	Conventional	125267	133050	91114	66830	60652	52595	47922	46539	47818	38544	40375	41971	39996	42231	43137	43726
MOP Gasoline 2-stroke <50 cm³	Euro 1	-	132917	91023	66763	60591	52542	47874	46493	47770	38506	40335	41929	39956	42189	43093	43682
MOP Gasoline 2-stroke <50 cm³	Euro 2	-	-	-	-	68612	59498	54211	52648	54094	43604	45675	47479	45245	47774	48798	49465
MOP Gasoline 2-stroke <50 cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	48912	50845	48452	51160	52257	52971
MOT Gasoline 2-stroke >50 cm³	Conventional	44026	72123	64152	70388	53225	62087	71381	66950	69551	74075	76025	68439	65180	66408	61929	62464
MOT Gasoline 2-stroke >50 cm³	Euro 1	49072	80391	71506	78456	59327	69204	79564	74624	77524	82566	84740	76284	72651	74021	69028	69625
MOT Gasoline 2-stroke >50 cm³	Euro 2	52330	85728	76254	83665	63265	73798	84846	79579	82671	88048	90366	81348	77475	78935	73611	74247
MOT Gasoline 2-stroke >50 cm³	Euro 3	-	100487	89382	98069	74157	86504	99454	93279	96904	103207	105924	95354	90813	92525	86284	87030
MOT Gasoline 4-stroke <250 cm³	Conventional	652	586	1154	1003	902	889	815	733	687	563	647	665	657	764	740	738

Subsector	Technology	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
MOT Gasoline 4-stroke <250 cm³	Euro 1	780	701	1380	1199	1078	1063	974	876	821	673	774	795	785	913	885	882
MOT Gasoline 4-stroke <250 cm³	Euro 2	997	896	1765	1532	1378	1359	1246	1120	1050	860	990	1016	1004	1168	1131	1128
MOT Gasoline 4-stroke <250 cm³	Euro 3	-	-	1860	1615	1453	1433	1313	1181	1107	907	1043	1071	1058	1231	1192	1189
MOT Gasoline 4-stroke 250 - 750 cm³	Conventional	-	-	-	-	-	-	-	-	-	-	-	-	-	1433	1388	1383
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 1	1482	1333	2624	2279	2049	2021	1853	1666	1562	1280	1472	1511	1493	1737	1682	1677
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 2	1546	1390	2737	2377	2137	2108	1932	1738	1629	1335	1535	1576	1557	1811	1755	1749
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 3	1751	1575	3100	2693	2421	2388	2189	1969	1845	1512	1739	1786	1764	2052	1988	1981
MOT Gasoline 4-stroke >750 cm³	Conventional	-	-	3178	2760	2482	2447	2244	2018	1891	1549	1782	1830	1808	2103	2037	2031
MOT Gasoline 4-stroke >750 cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	-	2260	2190	2183
MOT Gasoline 4-stroke >750 cm³	Euro 2	1920	1726	3400	2952	2655	2618	2400	2159	2023	1658	1907	1958	1934	2250	2179	2172
MOT Gasoline 4-stroke >750 cm³	Euro 3	2136	1920	3781	3283	2953	2912	2669	2401	2250	1843	2121	2177	2150	2502	2424	2416
MOT Gasoline 4-stroke <250 cm³	Euro 2	1892	1701	3349	2908	2615	2579	2364	2126	1993	1633	1878	1929	1905	2216	2147	2140
MOT Gasoline 4-stroke <250 cm³	Euro 3	-	-	3576	3106	2793	2754	2525	2271	2129	1744	2006	2060	2034	2367	2293	2285
MOT Gasoline 4-stroke <250 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	2350	2276	2269
MOT Gasoline 4-stroke 250 - 750 cm³	Conventional	1976	1777	3498	3038	2732	2694	2470	2221	2082	1706	1962	2015	1990	2315	2242	2235
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 1	2223	1999	3935	3418	3073	3031	2778	2499	2342	1919	2207	2266	2238	2604	2523	2515
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 2	1992	1791	3526	3062	2754	2716	2490	2239	2099	1719	1978	2031	2006	2334	2261	2253
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 3	-	-	3576	3106	2793	2754	2525	2271	2129	1744	2006	2060	2034	2367	2293	2285
MOT Gasoline 4-stroke 250 - 750 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	2376	2302	2294
MOT Gasoline 4-stroke >750 cm³	Conventional	2006	1803	3551	3084	2773	2735	2507	2255	2113	1731	1992	2045	2020	2350	2276	2269
MOT Gasoline 4-stroke >750 cm³	Euro 1	2286	2055	4047	3515	3161	3117	2857	2570	2409	1973	2270	2331	2302	2678	2594	2586
MOT Gasoline 4-stroke >750 cm³	Euro 2	2044	1838	3619	3142	2826	2787	2555	2298	2154	1764	2030	2084	2058	2395	2320	2312
MOT Gasoline 4-stroke >750 cm³	Euro 3	-	-	3576	3106	2793	2754	2525	2271	2129	1744	2006	2060	2034	2367	2293	2285
MOT Gasoline 4-stroke >750 cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	2389	2314	2307