REPUBLIC OF BULGARIA
MINISTRY OF ENVIRONMENT AND WATER

EXECUTIVE ENVIRONMENT AGENCY

NATIONAL INVENTORY DOCUMENT 2025

GREENHOUSE GAS EMISSIONS IN BULGARIA 1988-2023

April, 2025

Reporting Entity
Executive Environmental Agency at the Ministry of Environment and Water
136 "Tzar Boris III" Blvd.
Sofia 1618

Table of Contents

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 the human activity. Greenhouse gases prevent the radiation of heat back to space and cause warming of the climate. According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (AR5) (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

[1] Fifth Assessment Report of the Intergovernmental Panel on Climate Change (AR5) (IPCC 2014): 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

The annual inventory and reporting of greenhouse gas emissions and removals provide an information base for the planning and monitoring of climate policy. 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 P 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 obligations for 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 Document (NID) of Bulgaria for the 2025 submission to the EU, the UNFCCC and the Paris agreement 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 global warming potential. 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 (28), nitrous oxide (265) 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 accept values, over a time horizon of 100 years, as mentioned in the IPCC Fifth Assessment Report of 2014[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 NID 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.

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 NID 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 2023. Full time series of the emissions and removals (with exception of F-gases) from 1988 to 2023 are included in the submission.

The structure of this NID was reelaborated in order to follow the Outlines of the biennial transparency report, national inventory document and technical expert review report pursuant to the modalities, procedures and guidelines for the transparency framework for action and support. The annotated outline of the NID'[9]. 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

[6] Regulation EU 2018/1999

[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/ar5/wg1/en/ch2s2-10-2.html#table-2-14

[9] https://unfccc.int/sites/default/files/resource/Transparency%20outlines.pdf

from the year 1988 to the year 2023. In Chapters 3 to 9 more detailed information of GHG emission estimates are given for the seven sectors:

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

In Chapter 10 improvements and recalculations. Chapter 11 information on changes in national system. 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 CRT tables).

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.

The inventories are prepared according to the UNFCCC Guidelines[10] and establishing the NID 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 2023. 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 1988-2023 in the Common reporting tables (CRT) for annual GHG inventories are submitted together with the Report.

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

In 2023 Bulgaria's greenhouse gas emissions are totall 45 365 Gg CO_2 eq. without reporting of sequestration from LULUCF sector. The emissions decreased by 60.07 % compared with the base year. Emissions in 2023 were 22.32% decreased in comparison with the emissions of the previous year.

The net emissions including reporting of sequestration from LULUCF sector were 36 764 Gg CO_2 eq. The emissions decreased by 61.89% 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 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 1988-2023, which resulted in the reduction of population by 28.28%.

ES 4 Background information of the Kyoto Protocol

[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

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.

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006 GL)[12]
- 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 2023 is submitted to the European Commission by Bulgarian Ministry of Environment and Water in fulfilment of Bulgaria’s obligation regarding Regulation EC 2018/1999 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.

[12] 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".

The purpose of Regulation 841/2018 sets out the commitments of Member States for the land use, land use change and forestry ('LULUCF') sector that contribute to achieving the objectives of the Paris Agreement and meeting the greenhouse gas emission reduction target of the Union for the period from 2021 to 2030. This Regulation also lays down the rules for the accounting of emissions and removals from LULUCF and for checking the compliance of Member States with those commitments.

The Paris Agreement, inter alia, sets out a long-term goal in line with the objective to keep the global temperature increase well below 2 °C above pre-industrial levels and to pursue efforts to keep it to 1,5 °C above pre-industrial levels. Forests, agricultural land and wetlands will play a central role in achieving this goal. In the Paris Agreement, the Parties also recognise the fundamental priority of safeguarding food security and ending hunger, in the context of sustainable development and efforts to eradicate poverty, and the particular vulnerabilities of food production systems to the adverse impacts of climate

change, thereby fostering climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production. In order to achieve the objectives of the Paris Agreement, the Parties should increase their collective efforts. The Parties should prepare, communicate and maintain successive nationally determined contributions. The Paris Agreement replaces the approach taken under the 1997 Kyoto Protocol, which will not be continued beyond 2020. The Paris Agreement also calls for a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, and invites Parties to take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases, including forests.
The inventory of the anthropogenic emissions by sources and removals by sinks is prepared in accordance with the methodologies accepted by the IPCC and agreed upon by the UNFCCC:

- 2006 IPCC guidelines for national greenhouse gas inventory (2006 IPCC GLs).

1.1.2 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES

The annual inventory and reporting of greenhouse gas emissions and removals provides an information base for the planning and monitoring of climate policy. The Kyoto Protocol has obliged the 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 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 National Inventory Document (NID) of Bulgaria for the 2025 submission to the EU and the UNFCCC 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 NID 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.
The emission estimates and removals are presented by gas and by source category and refer to the year 2023. Full time series of the emissions and removals (with exception of F-gases) from 1988 to 2023 are included in this inventory submission.
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 CRT 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.
As a Party to the Convention Bulgaria reports annually its GHG inventory/emissions from the base year to the year proceeding the year of reporting.
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 – Global Warming Potential(GWP), in some cases over one hundred times, compared to methane (28), nitrous oxide (265) and carbon dioxide (1). A common assessment criteria for the effect of each GHG on the atmosphere warming should be introduced. This criteria 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 accept values, over a time horizon of 100 years, as mentioned in the IPCC Fifth Assessment Report of 2014.
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 NID 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 NID 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 2023. 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 1988-2023 in the Common reporting tables (CRT) 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 INSTITUTIONAL, LEGAL AND PROCEDURAL ARRANGEMENTS

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:

BGNIS until 2007 (submission 2007)	**Present BGNIS (submission 2008-2023)**	**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 NID 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 Environmental 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 national inventory. This is outlined in the national inventory preparation cycle.
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.

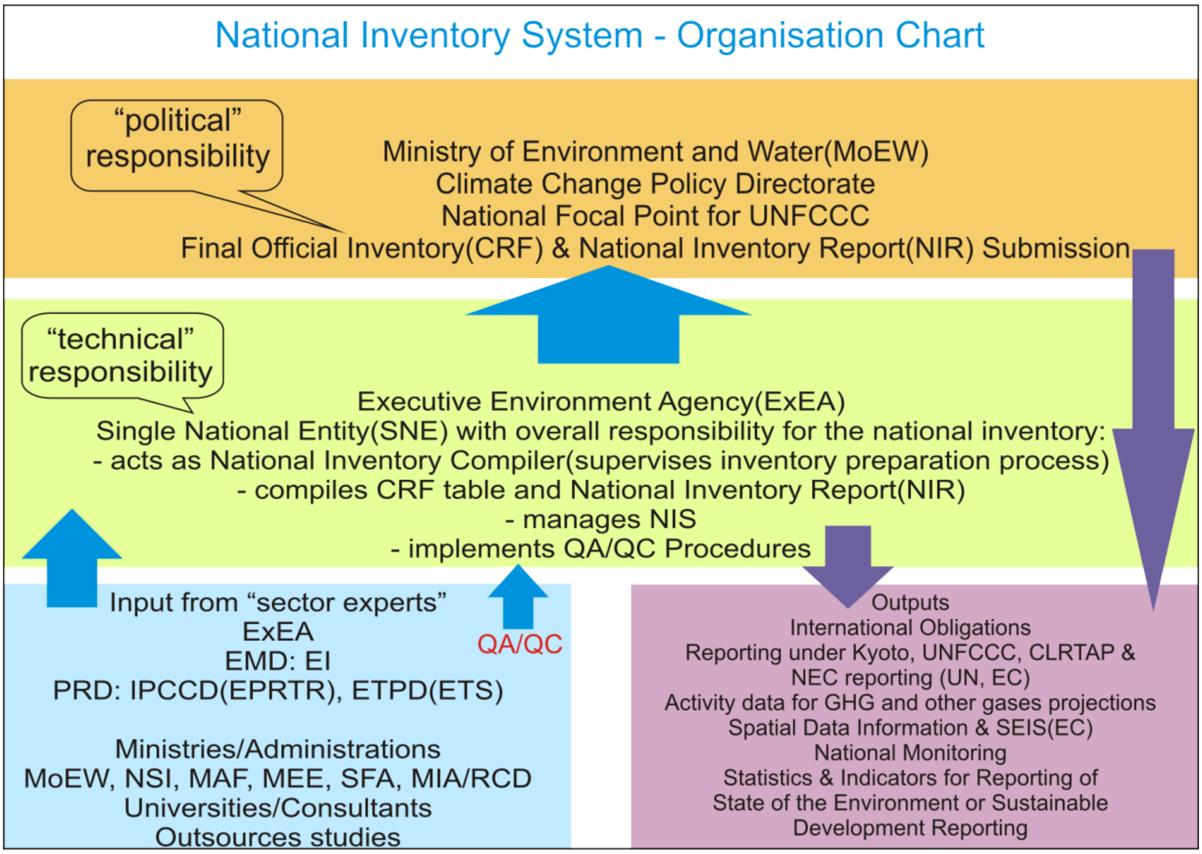


Figure 1 Organizational Chart of the Bulgarian National Inventory System

The Bulgarian Government by MoEW (Climate Change Policy Directorate) has the political responsibility for compliance with commitments under the UNFCCC and Paris agreement. In order to meet all challenges in this sphere, the Climate Change Policy has been transformed in a separate directorate.
The following strategic goals in climate change area were achieved by the Ministry of Environment and Water so far:

Climate change mitigation law

Climate change mitigation law adopted on first reading in the National Assembly on 23.10.2013. 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 Paris agreement 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 is 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 Paris agreement 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).

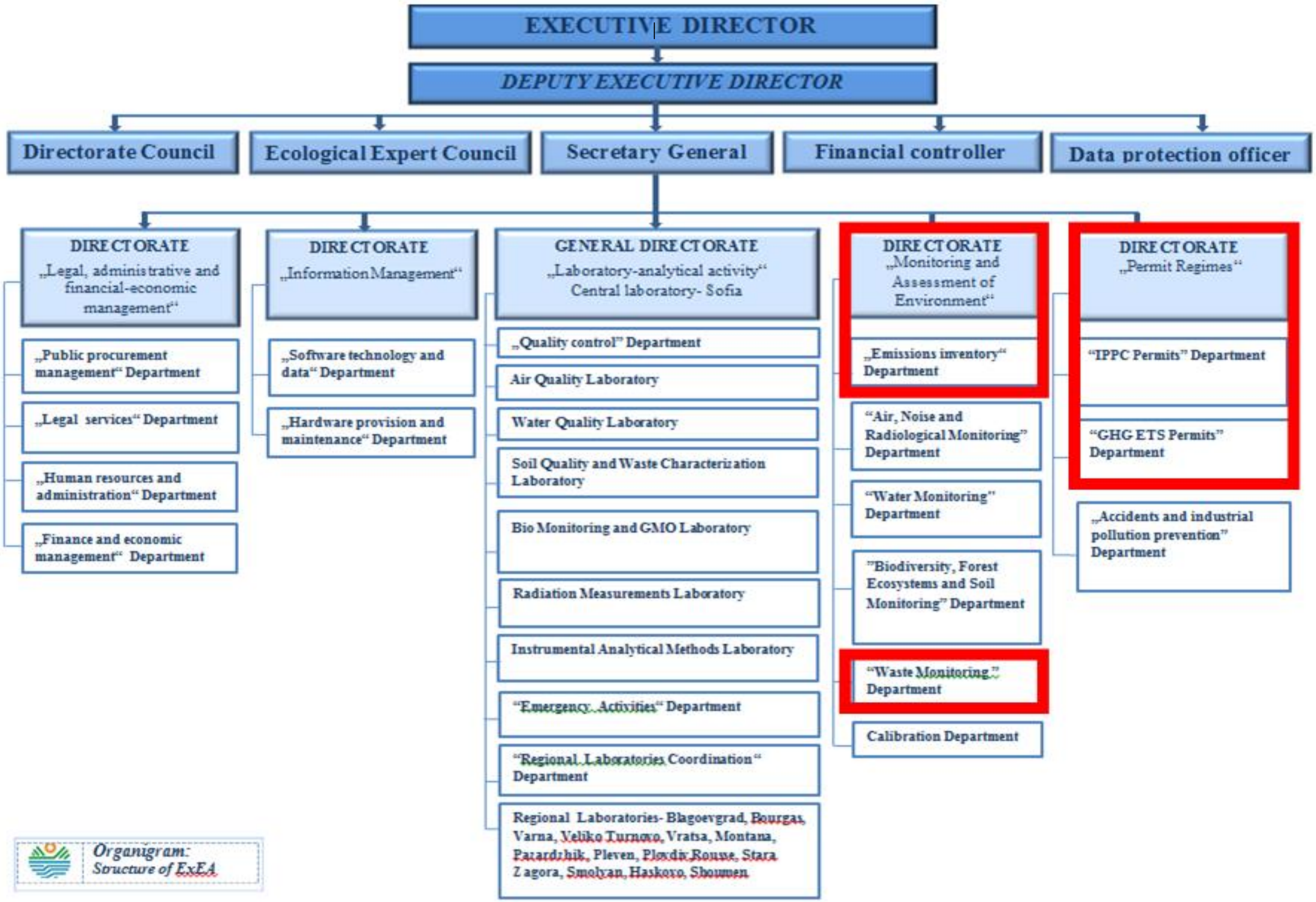


Figure 2 Organizational Chart of the Executive Environmental Agency (ExEA)

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 overall objective of the BGNIS is annually to produce a high quality inventory (National CRT and NID, and NID)
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)

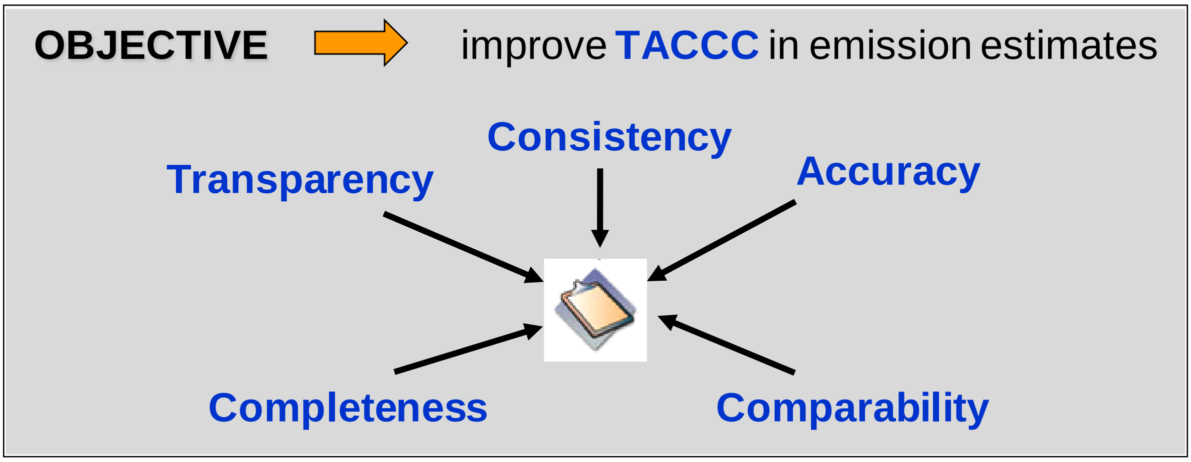


Figure 3 Objectives of the Bulgarian National Inventory System

1.1.4 OVERVIEW OF INVENTORY PLAN, 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 Paris agreement.

The ExEA has been identified as the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Paris agreement 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 CRT tables and NID;
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 March 2021);
Statute on the organization and structure of ExEA (Decision of Council of ministers 162/03.08.2010 – 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 261/05.09.2014 SG 76/2014 on the way and order of organization of the National Inventories of hazardous substances and greenhouse gases in the ambient air (last update 227/16.10.2017 SG 84/2017)

Add 1.

EPA establishes the national Executive Environmental Agency (ExEA) according to **Regulation on the organization and structure of ExEA** (Decision of Council of ministers 162/03.08.2010 - 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 2.

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 3.

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 4.

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. 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 and Forestry (MAF) 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 Environmental 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 CRT tables and NID, 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

In order 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[13]. 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

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)[14].

Basic Course[15]

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.

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

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

Executive Environmental Agency at the Ministry of Environment and Water
136 "Tzar Boris III" Blvd
Sofia 1618, Bulgaria
P.O.Box 251
Tel.:+359 2 9559011
Fax: +359 2 9559015
E-mail: iaos@eea.government.bg
http://eea.government.bg/en

ETF Focal Point : Detelina Petrova
Organization: Ministry of Environment and Water
Address: 22 "Maria Luiza" blvd., 1202 Sofia, Bulgaria
E-mail: dpetrova@moew.government.bg

[13] 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."

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

[15] 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

Tel.: +359 2 940 61 44

ETF Focal point (Alternate) Violeta Stoeva **Head of Emission Inventory Department & National Inventory**
Organization: Executive Environmental Agency
Address: 136, "Tsar Boris III" blvd., 1618 Sofia, Bulgaria
e-mail: v.stoeva@eea.government.bg
Tel.: +359 2 940 64 66
Fax: +359 2 955 90 15

National Inventory Focal Point (NIFP): Magdalina Kushleva-Zarkova
Organization: Ministry of Environment and Water
Address: 136, "Tsar Boris III" blvd., 1618 Sofia, Bulgaria
e-mail: v.stoeva@eea.government.bg
Tel.: +359 2 940 64 66
Fax: +359 2 955 90 15

An overview of the general responsibilities in the inventory development and reporting process is given. 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).

1.2 INVENTORY PREPARATION, DATA COLLECTION, PROCESSING AND STORAGE

Collection of activity data by ExEA

The information is being collected on 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, MAF, 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 261/05.09.2014 (SG 76/2014)).
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

Sectors	Data Source of Activity Data	Activity Data supplier	
	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 Environmental Agency
	National studies	MoEW/ExEA	Ministry of Environment and Water/ Executive Environmental Agency
	National VOC register	ExEA	Executive Environmental Agency
3. Agriculture	National agriculture statistics	MAF	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	MAF	Ministry of Agriculture and Forestry
5. Waste	National statistics	NSI	National Statistical Institute
	National database	ExEA	Executive Environmental Agency/ Waste Monitoring Department

Inventory preparation

The inventory preparation process covers:

- Identification key source categories[16];
- Prepare estimates[17] 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[18] for each source category and for the inventory in total recalculations[19] 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;

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

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

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

[19] prepared in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories 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[20] (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.

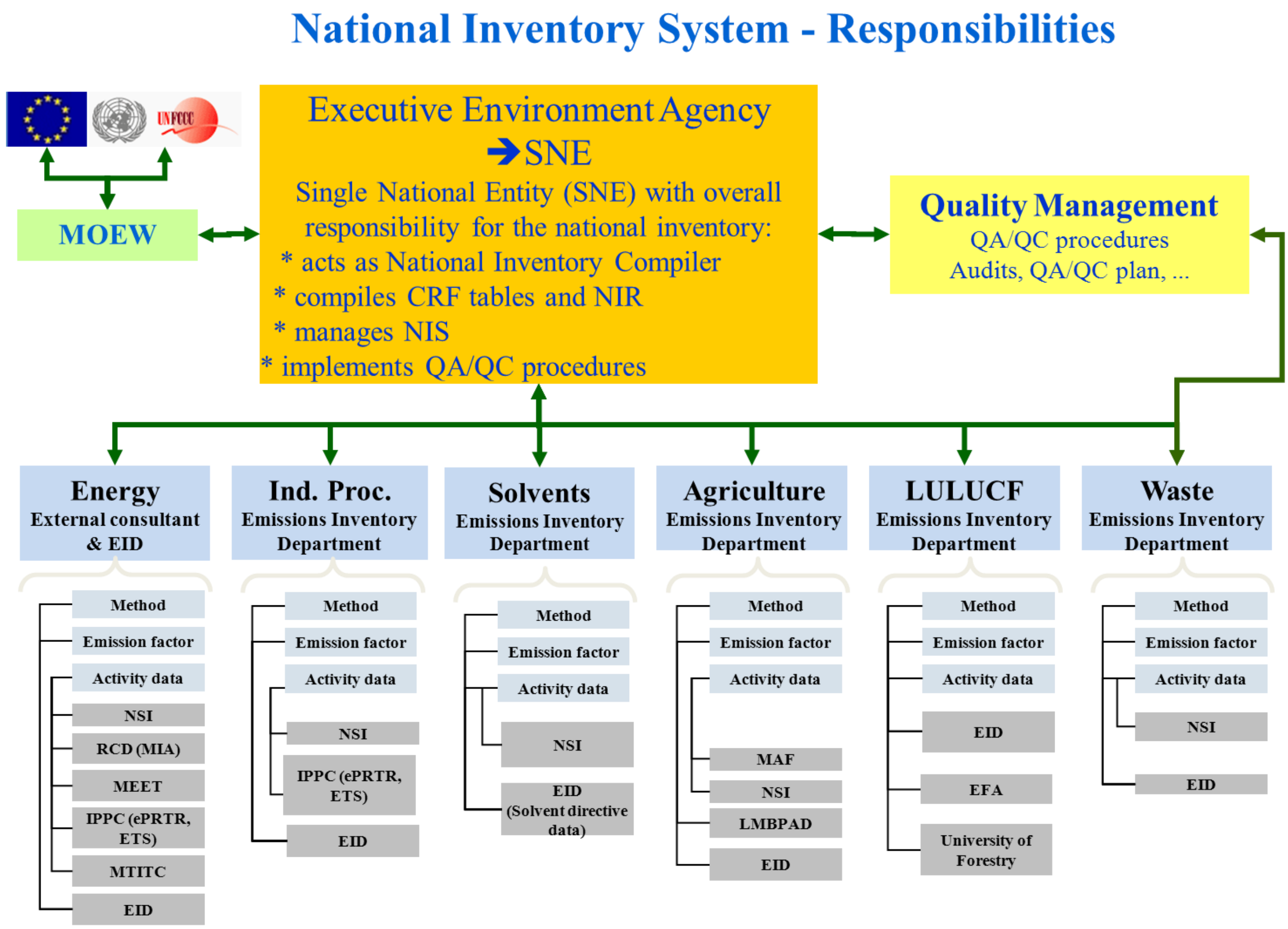


Figure 4 Bulgarian National Inventory System – Responsibilities

The following table presents the responsibilities of all engaged institutions for preparation of GHGs emission inventory for 2025 submission.

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

Table 2 Preparation of GHGs emission inventory for 2025 submission

Sector CRT	Activity data	Methodology and selection of emission factors	Preparation of Sector inventories
Energy CRT1A1 CRT1A2 CRT1A4	NSI	ExEA, NSI	Sector expert ExEA External consultants
Energy/Transport CRT1A3	NSI MI MTITC	ExEA, NSI MI, MTITC	Sector expert ExEA External consultants
Energy CRT1B	NSI ME	ExEA, NSI, ME	Sector expert ExEA External consultants
Industry processes and product use CRT2	NSI ExEA MOEW NSI ExEA	ExEA, NSI, Installations operators	Sector expert ExEA
Agriculture CRT3	MAFF NSPP	ExEA, MAFF	Sector expert ExEA
LULUCF CRT4	EAF MAF	ExEA, EAF	Sector expert ExEA External consultants
Waste CRT5	NSI ExEA	ExEA, NSI	Sector expert ExEA

The National Inventory Compiler compiles the national GHGs inventory (CRT-tables and NID) 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.

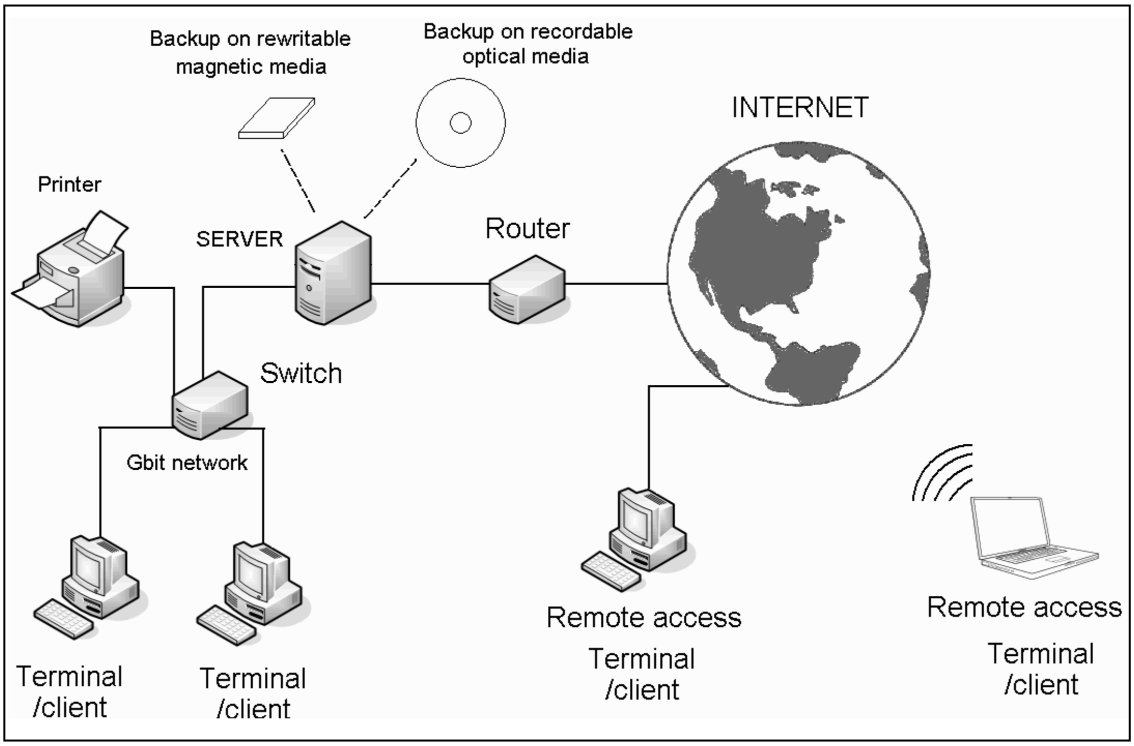


Figure 5 Documentation and data archiving in ExEA

1.2.1 QUALITY ASSURANCE, QUALITY CONTROL AND VERIFICATION

As it is written above the Executive Environmental Agency is responsible for the preparation of the GHGs Emission Inventory and the relevant National inventory documents 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.

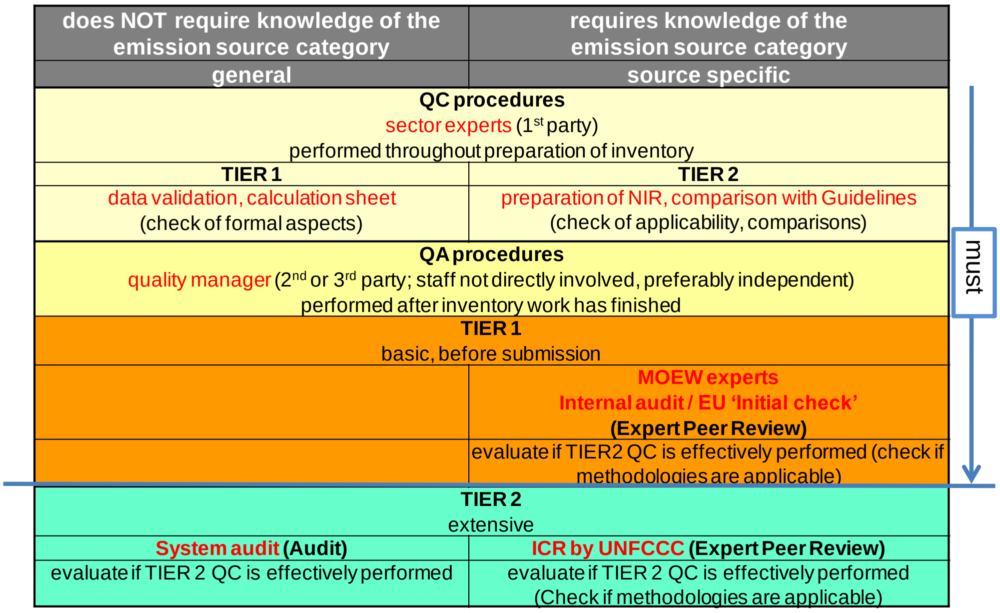


Figure 6 National quality assurance and quality control program

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	MAF, MI, MTITC, ME, NSI, EAF, ExEA, MOEW
Methodology and selection of emission factors	ExEA, MAF, 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 tables (CRT) tables and the preparation of a structured national inventory document (NID) 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 CRT 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 2023 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 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 document 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	✓	✓

	2006 IPCC GL	ISO 9001
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 CRT tables and respective chapters from NID;
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 (CRT and NID);
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 (CRT).
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 2025 submission

Sector CRT	Activity data		Methodology/ emission factors		Emission calculations	
	Check	Correction	Check	Correction	Check	Correction
Energy CRT1	ExEA NSI ME external consultant	NSI ME	ExEA NSI ME	external consultant	ExEA NSI ME	external consultant
Transport CRT1A3	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 CRT2	NSI ExEA	NSI ExEA	NSI ExEA	ExEA	NSI ExEA	Sector expert ExEA
Agriculture CRT3	ExEA MAF	MAF	ExEA MAF	ExEA	ExEA MAF	Sector expert ExEA
LULUCF CRT4	ExEA EAF	EAF	ExEA EAF	ExEA	ExEA EAF	Sector expert ExEA and external consultant
Waste CRT5	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 2023 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 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 (CRT).
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 2025 submission

Sector - CRT	Reporting Tables - CRT		National Report - NID	
	Check	Correction	Check	Correction
Energy CRT1	MOEW ExEA	External consultant	MOEW ExEA	External consultant
IPPU CRT2	MOEW ExEA	Sector expert ExEA	MOEW ExEA	Sector expert ExEA
Agriculture CRT3	MOEW ExEA	Sector expert ExEA	MOEW ExEA	Sector expert ExEA

Sector - CRT	Reporting Tables - CRT		National Report - NID	
LULUCF CRT4	MOEW ExEA	External consultant	MOEW ExEA	External consultant
Waste CRT5	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, MAF, 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.

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

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[21] 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

[21] 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.

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 2026

The next table presents the responsibilities of all engaged institutions for preparation of GHGs emission inventory for 2026 submission.

Table 7 Preparation of GHGs emission inventory for 2025 submission

Sector CRT	Activity data	Methodology and selection of emission factors	Preparation of Sector inventories
Energy CRT1A1 CRT1A2 CRT1A4	NSI	ExEA, NSI	Sector expert ExEA External consultant
Energy/Transport CRT1A3	NSI MI MTITC	ExEA, NSI MI, MTITC	Sector expert ExEA External consultant
Energy CRT1B	NSI MEE	ExEA, NSI, ME	Sector expert ExEA External consultant
Industry processes and product use CRT2	NSI ExEA MOEW ExEA	ExEA, NSI, Installations operators	Sector expert ExEA
Agriculture CRT3	MAF NSPP	ExEA, MAF	Sector expert ExEA
LULUCF CRT4	EAF MAF	ExEA, EAF	Sector expert ExEA External consultant
Waste CRT5	NSI ExEA	ExEA, NSI	Sector expert ExEA

The Work plan for preparation and submission of National GHGs inventory in 2026 is presented in the next table.

Table 8 Work plan for GHGs inventory preparation and submission 2026

Action	Responsible organization	Initial Deadline	Final Deadline	Comment
Sending of statistic questionnaire to all enterprises in the country	NSI with its regional inspectorates	31.03.25	15.06.25	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	31.03.25	15.06.25	
QA/QC Procedures - Implementation of the requirements of National QA/QC Plan.	NSI MAF, ME, MEW, SFA, RCD	15.06.25	30.09.25	National QA/QC Plan
Provision of all collected activity data by questionnaires and other sources of information to ExEA	NSI MAF, ME, MEW, EFA, MIA	30.09.25	30.10.25	
QA/QC Procedures - Implementation of the requirements of National QA/QC Plan	ExEA	30.10.25	15.11.25	QA/QC expert, responsible for implementation of all procedures laid down in the National QA/QC Plan
Provision of annual national energy and material balances to ExEA	NSI		30.11.25	
Preliminary estimation of emissions	ExEA, external consultants		15.12.25	
Provision of corrected activity data as a result of QA/QC procedures to ExEA	NSI MAF, ME, MEW, EFA, MIA		20.12.25	
Recalculation of emissions, based on the corrected activity data of inventory in the required format for reporting	ExEA and external consultant		31.12.25	
Preparation of Preliminary National inventory document (NID) to the EC.	ExEA		10.01.26	
Submission of national GHG inventory under the RMM with the short NID.	ExEA		15.01.26	Delivered to Eionet Central Data Repository
Submission of final national GHG inventory and NID.	ExEA		15.03.26	Delivered to Eionet Central Data Repository
Submission of the final GHG inventory and NID after the European Commission comments	MEW ExEA		15.04.26	Official submission to UNFCCC Delivered to Eionet Central Data Repository
Documentation and archiving of inventory. Preparation of inventory management report	ExEA		15.05.26	
Preparation of QA/QC plan for the next inventory.	ExEA		15.06.26	

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.
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 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 above and periodic internal evaluations of the inventory preparation process, re-evaluate the inventory planning process in order to meet the established quality objectives.

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.

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

The most recent greenhouse gas inventory for the period 1988 to 2023 (NID 2025) was compiled according to the recommendations for inventories set out in the UNFCCC reporting guidelines according to Decision 24/CP.19, the Common reporting tables (CRT) 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 CRT 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 CRT 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 NID 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 2023, submission 2025.

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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
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								

<table>
<tr><td colspan="3">The following notation keys were used to specify the method applied:</td></tr>
<tr><td>D (IPCC default)</td><td>T1a, T1b, T1c (IPCC Tier 1a, Tier 1b and Tier 1c, respectively)</td><td>CR (CORINAIR)</td></tr>
<tr><td>RA (Reference Approach)</td><td>T2 (IPCC Tier 2)</td><td>CS (Country Specific)</td></tr>
<tr><td>T1 (IPCC Tier 1)</td><td>T3 (IPCC Tier 3)</td><td>OTH (Other)</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="3">Use the following notation keys to specify the emission factor used:</td></tr>
<tr><td>D (IPCC default)</td><td>CS (Country Specific)</td><td>OTH (Other)</td></tr>
<tr><td>CR (CORINAIR)</td><td>PS (Plant Specific)</td><td></td></tr>
</table>

1.4 BRIEF DESCRIPTION OF KEY CATEGORIES

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.

Table 11 Methods and the emission factors applied submission 2024: HFCs, PFCs, SF_6

Source	Fuel/Cat.	GHG	excl. LULUCF	Icl. LULUCF
1	2	3	4	5
1A1	Liquid fuels	CO2	LA TA	LA TA
1A1	Solid fuels	CO2	LA TA	LA TA
1A1	Gaseous fuels	CO2	LA TA	LA TA
1A1	All fuel	CH4	LA TA	LA TA
1A1	All fuel	N2O	LA TA	LA TA
1A2	Liquid fuels	CO2	LA TA	LA TA
1A2	Solid fuels	CO2	LA TA	LA TA
1A2	Gaseous fuels	CO2	LA TA	LA TA
1A2	Other fossil fuels	CO2	LA TA	LA TA
1A2	All fuel	CH4	LA TA	LA TA
1A2	All fuel	N2O	LA TA	LA TA
1A3a	Liquid fuel	CO2	LA TA	LA TA
1A3a	Liquid fuel	CH4	LA TA	LA TA
1A3a	Liquid fuel	N2O	LA TA	LA TA
1A3b	Gasoline	CO2	LA TA	LA TA
1A3b	Diesel Oil	CO2	LA	LA
1A3b	All fuel	CH4	LA TA	LA TA
1A3b	All fuel	N2O	LA TA	LA TA
1A3b	LPG	CO2	LA	LA TA
1A3b	Gaseous fuel	CO2	LA TA	LA TA
1A3b	Other liquid fuels	CO2	LA TA	LA TA
1A3b	Other fossil fuels	CO2	LA TA	LA TA
1A3c	Liquid fuel	CO2	LA TA	LA TA
1A3c	Liquid fuel	CH4	LA TA	LA TA
1A3c	Liquid fuel	N2O	LA TA	LA TA
1A3d	Gas/diesel oil	CO2	LA TA	LA TA
1A3d	Gas/diesel oil	CH4	LA TA	LA TA
1A3d	Gas/diesel oil	N2O	LA TA	LA TA
1A3e	Gaseous fuel	CO2	LA TA	LA TA
1A3e	Gaseous fuel	CH4	LA TA	LA TA
1A3e	Gaseous fuel	N2O	LA TA	LA TA
1A4	Liquid fuel	CO2	LA	LA
1A4	Solid fuel	CO2	LA	LA

1A4	Gaseous fuel	CO2	LA	LA TA
1A4	All fuel	CH4	LA	LA
1A4	All fuel	N2O	LA TA	LA TA
1A5	Stationary - Fossil fuels	CO2	LA	LA
1A5	Stationary - Fossil fuels	CH4	LA TA	LA TA
1A5	Stationary - Fossil fuels	N2O	LA TA	LA TA
1B1	Solid fuel	CO2	LA	LA
1B1	Solid fuel	CH4	LA	LA
1B2	Oil and Natural Gas	CO2	LA	LA
1B2	Oil and Natural Gas	CH4	LA	LA
1B2	Oil and Natural Gas	N2O	LA TA	LA TA
2A1	Cement Production	CO2	LA TA	LA TA
2A2	Lime Production	CO2	LA TA	LA TA
2A3	Glass production	CO2	LA TA	LA TA
2A4a	Ceramics - Bricks and Tails	CO2	LA TA	LA TA
2A4b	Soda ash uses	CO2	LA TA	LA TA
2A4d	DeSOx - instalations	CO2	LA	LA TA
2B1	Ammonia Production	CO2	LA	LA
2B2	Nitric Acid Production	N2O	LA	LA
2B5b	Calcium Carbide	CO2	LA TA	LA TA
2B7	Soda ash production	CO2	LA	LA TA
2B8	Petrochemical and carbon black production	CH4	LA TA	LA TA
2B8b	Ethylene	CO2	LA TA	LA TA
2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	LA TA	LA TA
2C1	Iron and Steel Production	CO2	LA	LA
2C1	Iron and Steel Production	CH4	LA TA	LA TA
2C2	Ferroalloys Production	CO2	LA TA	LA TA
2C2	Ferroalloys Production	CH4	LA TA	LA TA
2C2	Lead production	CO2	LA	LA
2C2	Zinc production	CO2	LA	LA
2D	Non-energy products from fuels and solvent use	CO2	LA	LA
2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	LA	LA
2G	Other product manufacture and use	N2O	LA TA	LA TA
2G	Other product manufacture and use	CO2	LA	LA TA
2G1	Electrical equipment - SF6	CO2eq	LA	LA
2H	Other	CO2	TA	TA
3A1	Cattle	CH4	LA	LA
3A2	Sheep	CH4	LA	LA
3A3	Swine	CH4	LA	LA
3A4	Other livestock	CH4	LA	LA
3B	N2O em. from Manure Management	N2O	LA	LA
3B1	Cattle	CH4	LA	LA
3B2	Sheep	CH4	LA	LA
3B3	Swine	CH4	LA	LA
3B4	Other livestock	CH4	LA	LA
3C	Rice Cultivation	CH4	LA	LA
3Da	Direct N2O emissions from managed soils	N2O	LA	LA
3Db	Indirect N2O Emissions from managed soils	N2O	LA	LA
3F	Field burning of agricultural residues	CH4	LA	LA
3F	Field burning of agricultural residues	N2O	LA	LA TA
3G	Liming	CO2	LA	LA
3H	Urea application	CO2		LA
4A1	Forest Land remaining Forest Land	CO2		LA
4A2	Land converted to Forest Land	CO2		LA
4B1	Cropland remainig Cropland	CO2		LA

4B2	Land converted to Cropland	CO2		LA
4C1	Grassland remaining grassland	CO2		LA
4C2	Land converted to Grassland	CO2		LA
4D2	Land converted to Wetlands	CO2		LA
4E2	Land converted to Settlements	CO2		LA
4F	Other Land	CO2		LA TA
4A2	Land converted to Forest Land	N2O		LA
4B2	Land converted to Cropland	N2O		LA
4C1	Grassland remaining grassland	N2O		LA
4D2	Land converted to Wetlands	N2O	LA	LA
4E2	Land converted to Settlements	N2O	LA	LA
4(IV)A1	Forest Land remaining Forest Land - biomass burning	CH4	LA	LA
4(IV)A2	Land converted to Forest Land - biomass burning	CH4	LA	LA
4(IV)A1	Forest Land remaining Forest Land - biomass burning	N2O	LA	LA
4(IV)A2	Land converted to Forest Land - biomass burning	N2O	LA	LA
4G	Harvested wood products	CO2	LA	LA
5A	Solid waste disposal	CH4	LA	LA

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

1.5 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 12.

Combined uncertainty as a part of overall emissions for 2023 for every source has been calculated as following equation:

MCUi =(EMi/EMtotal)x CUi

where MCUi – measured combined uncertainty,
EM_i - source emissions for 2023,
EM_{total} – total country emissions for 2023,
CN_i – combined uncertainty of the i-th source.
Uncertainty of the overall emissions trend for 2023 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 2022 (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 2023 (row 7, column M in Table 6.1.) are given in Table 12. The relevant data for the previous inventory for 2022 are given for comparison (NID 2024 and NID 2025).

Table 12 Uncertainty in total GHG emissions, %

Uncertainty	Uncertainty NID 2024	Uncertainty NID 2025
Uncertainty in total GHG emissions	12.42%	15.71%
Overall uncertainty into the trend in total GHG emissions	1.94	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.

1.6 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 CRT 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.
CRT - 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 CRT 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 CRT. Notation keys used in the NID are consistent

with those reported in the CRT. 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 CRT 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 NID and the CRT 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 NID 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 CRT 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.

2 TRENDS IN GREENHOUSE GAS EMISSIONS

Description and interpretation of emission trends for aggregated greenhouse gas emissions

In 2023 Bulgaria's greenhouse gas emissions totalled 45 365 Gg CO_2 eq. without reporting of sequestration from LULUCF sector. The emissions decreased by 60.07% compared with the base year. Emissions in 2023 were 22,32% decreased in comparison with the emissions of the previous year.

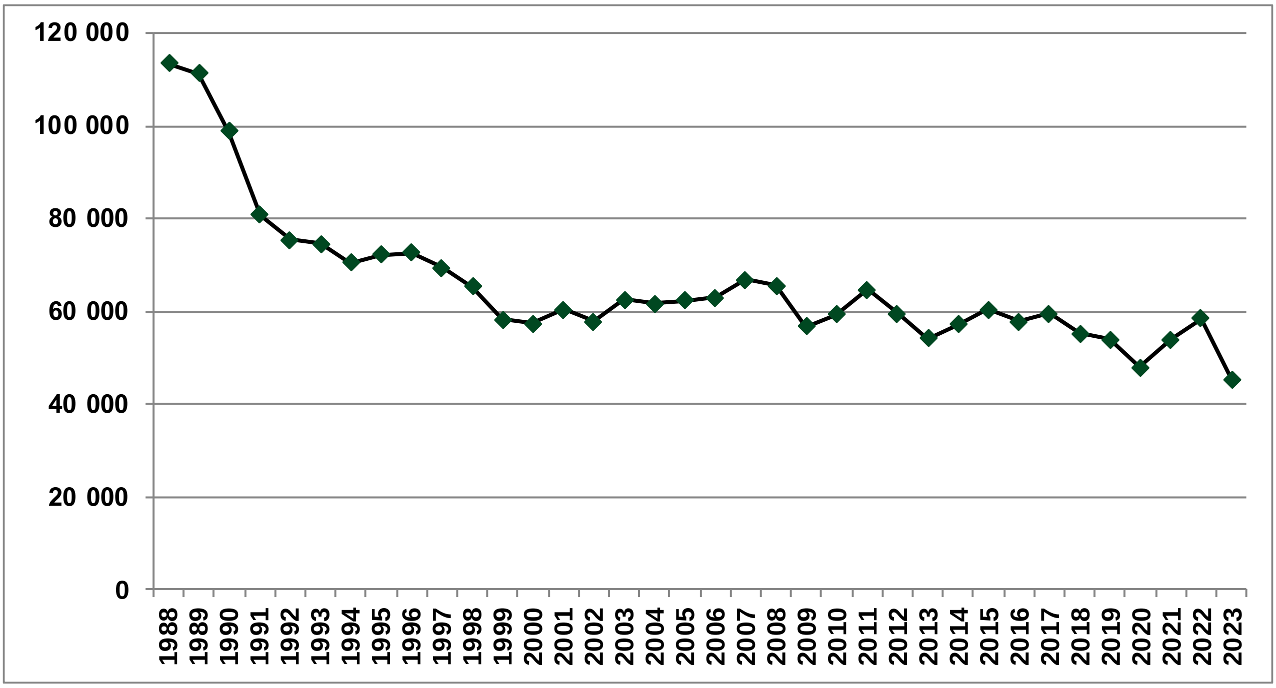


Figure 7 Total GHG emissions (without LULUCF) for 1988 – 2023, Gg CO_2 eq.

The net emissions including reporting of sequestration from LULUCF sector were 36 764Gg CO_2 eq. The emissions decreased by 61.89 % compared with the base year.

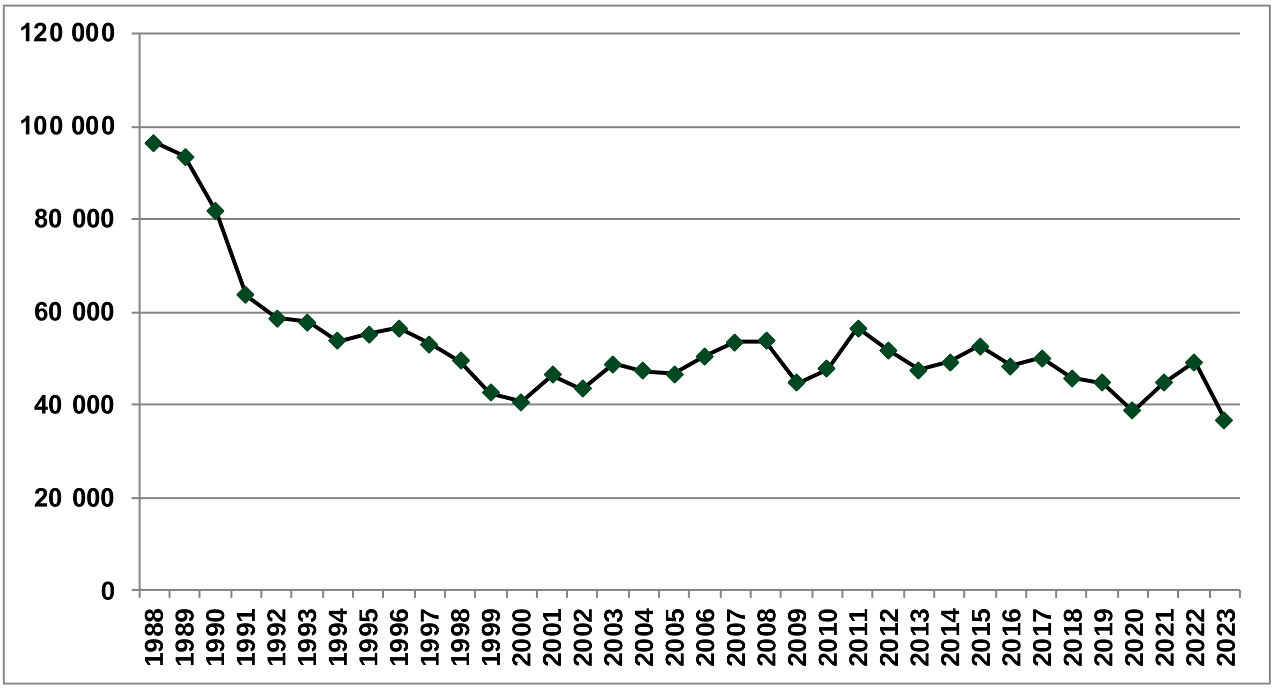


Figure 8 Total GHG emissions (with LULUCF) for 1988 – 2023, Gg CO_2 eq.

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 decreasing population trend during the period 1988-2023, which resulted in the reduction of population by 28.28 %.

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 76.05% excluding LULUCF and 70.07% including LULUCF. In absolute terms CO_2 emissions have decreased 61.47% since 1988. Around 72.42% 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 60.42% 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 51.49%.

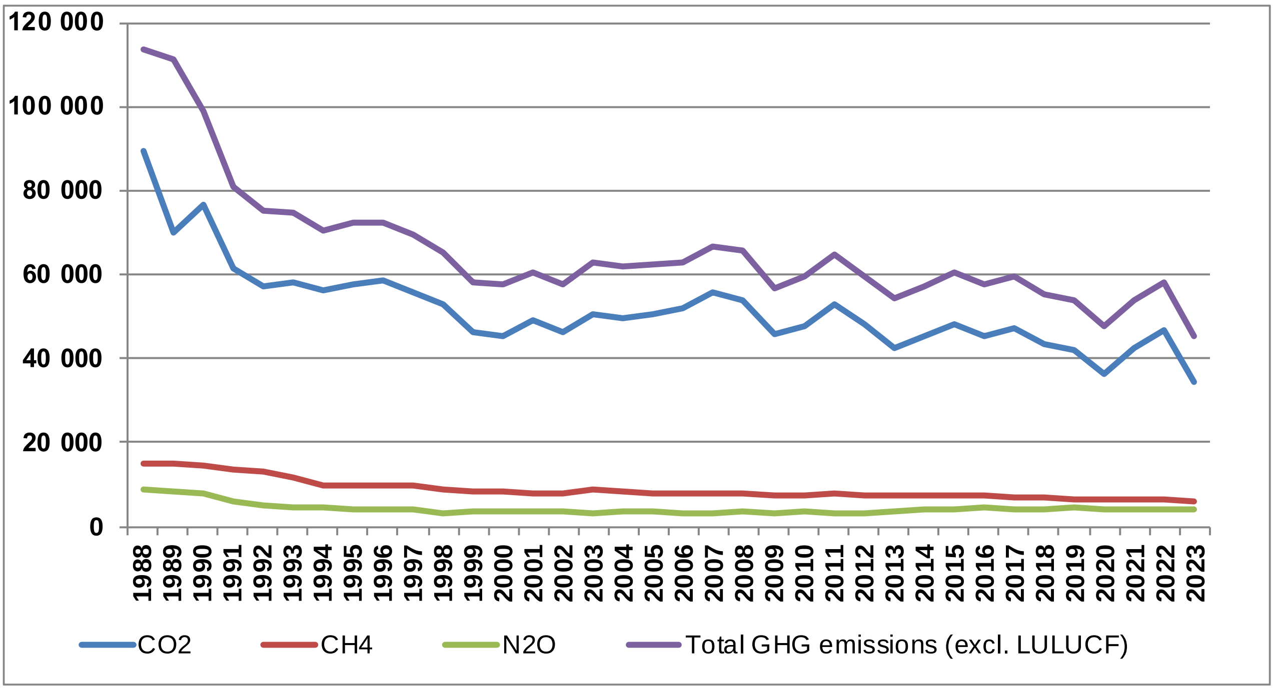


Figure 9 Total GHG emissions in Gg CO_2 eq. for 1988 – 2023

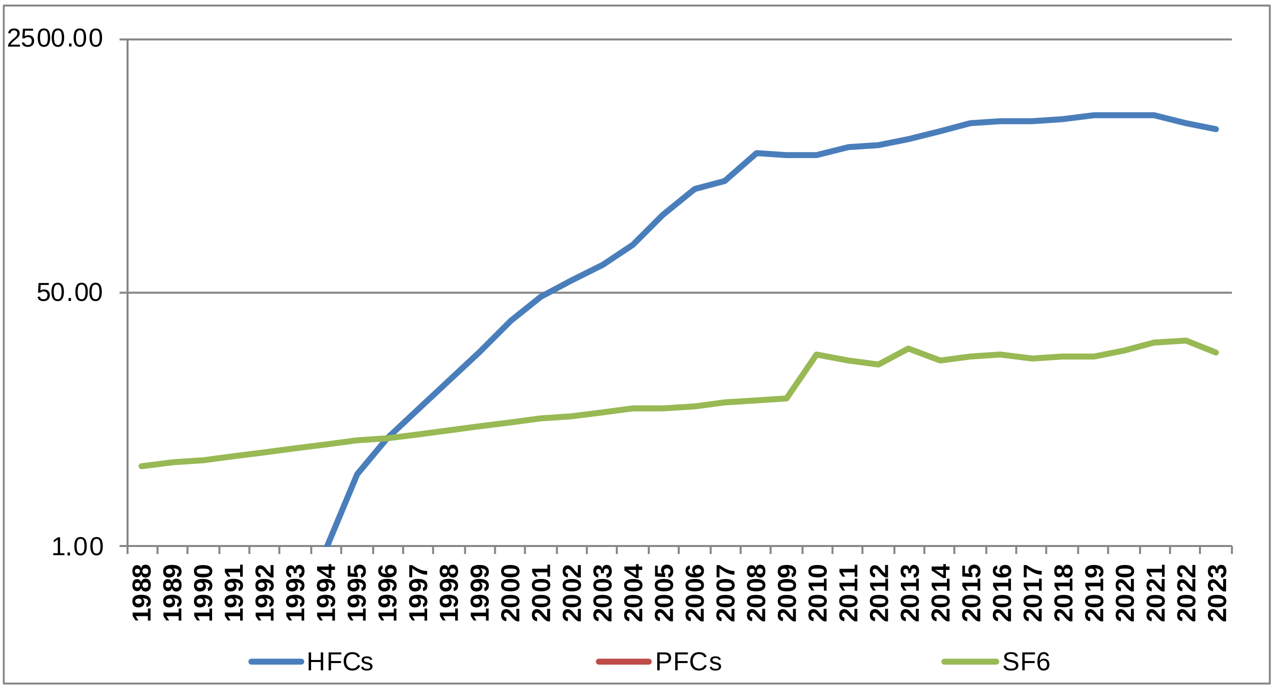


Figure 10 Actual emissions of HFCs, PFCs and SF_6 for 1988 – 2023, Gg CO_2 eq.

The emissions of F-gases have increased during 1995-2023. A key driver behind the trend has been the substitution of ozone depleting substances (ODS) by F-gases in many applications. The scale of the Chart is logarithmic, so that the trend can be clear. The slight decrease in the end of the period occurs mainly because of the implied policy in the field of F-gases sphere.

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 2023 with the biggest share – 72.42%. Sector Agriculture ranked the second place with 13.10% , followed by IPPU ranked the third place with 8.50% and sector Waste with 5.98%.

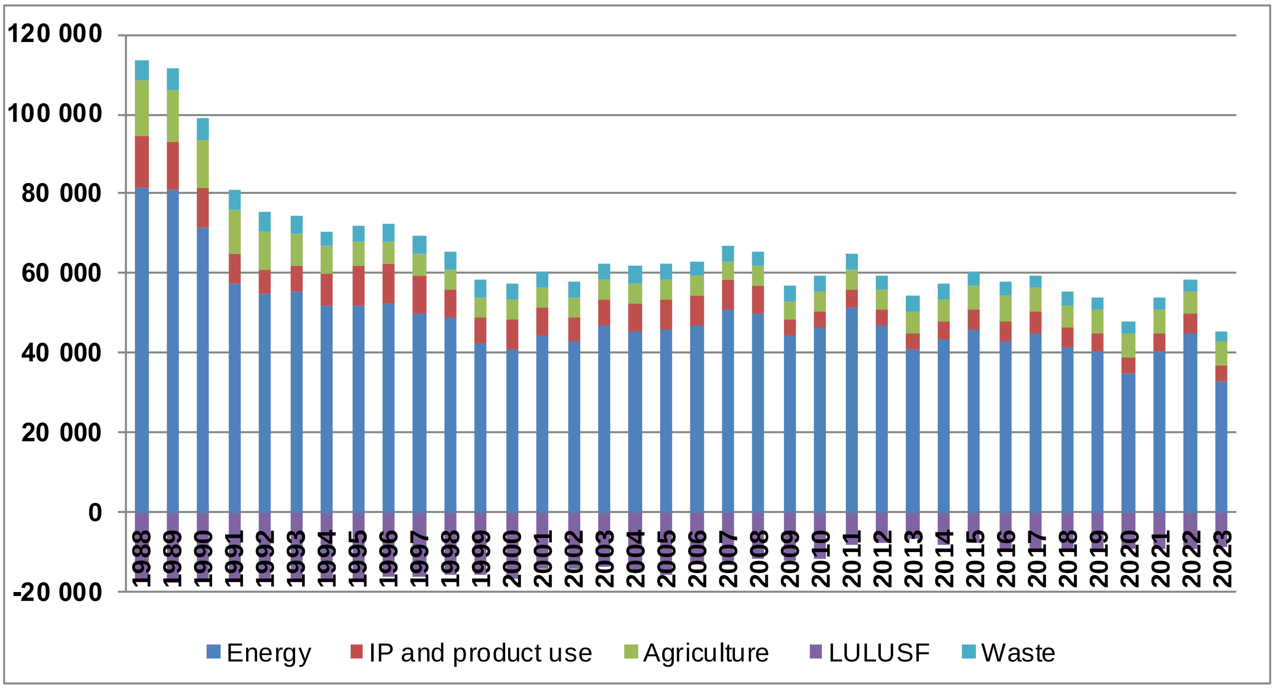


Figure 11 Total greenhouse gas emissions in CO_2-eq. per IPCC sector 1988-2023

Table 13 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	-59.72%
2. Industrial Processes and product use	-70.69%
3. Agriculture	-56.34%
4. Land Use, Land-Use Change and Forestry(5)	-49.81%
5. Waste	-48.64%
6. Other	0.00
Total (including LULUCF)	-61.89%

Energy

Emissions from the energy sector in 2023 decreased by 59.72% compared to the base year (32 853 Gg CO_2eq in 2023 compared to 81 562 Gg CO2eq in 1988). Compared to previous year, the emissions in 2023 decreased with 27.2%.

The main source of emissions in the energy sector is combustion of solid fuels, which is responsible for 68.70% of the emissions from fuel combustion in 2023.

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 2023 was defined by a substantial fluctuation of emissions from fuel combustion in energy industries.Fuel combustion decreased by 62.6% compared to the base year. The energy use in manufacturing industry and construction decreased by 78.12% compared to the base year and in other sectors (commercial, residential, agriculture and forestry) (80.5%), as well as a clear increase in GHG emissions from transport (43.7%).

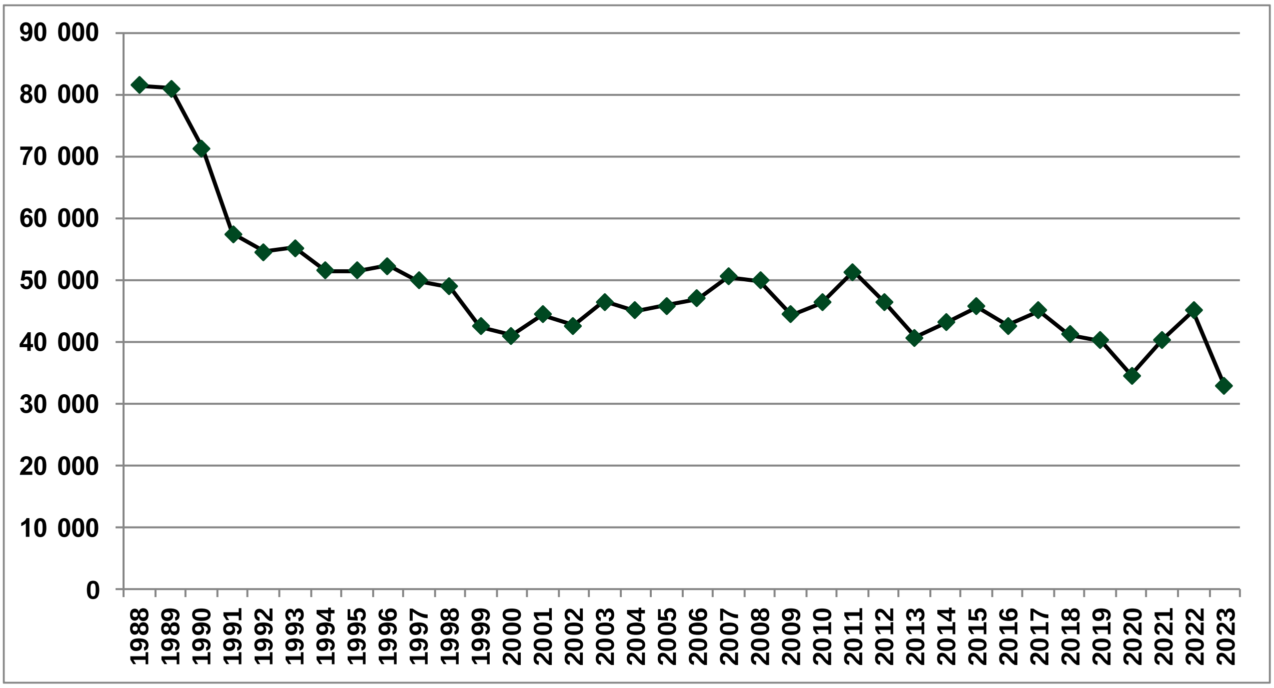


Figure 12 GHG emissions from Energy sector for 1988 – 2023, Gg CO_2 eq.

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

Industrial Processes and Product use

A non – steady trend with some fluctuations towards emission reduction in this sector is observed since 1988. The emissions in 2023 decreased with 70.69% compared to the base year.

In the year 2023 – 8.50% of national total greenhouse gas emissions (without LULUCF) originated from industrial processes and product use, compared to 11.6% in the base year 1988. In 2023, greenhouse gas emissions from Industrial Processes and Product Use are 3855.65 CO_2 equivalent compared to 13 155.10 Gg CO_2 in the base year.

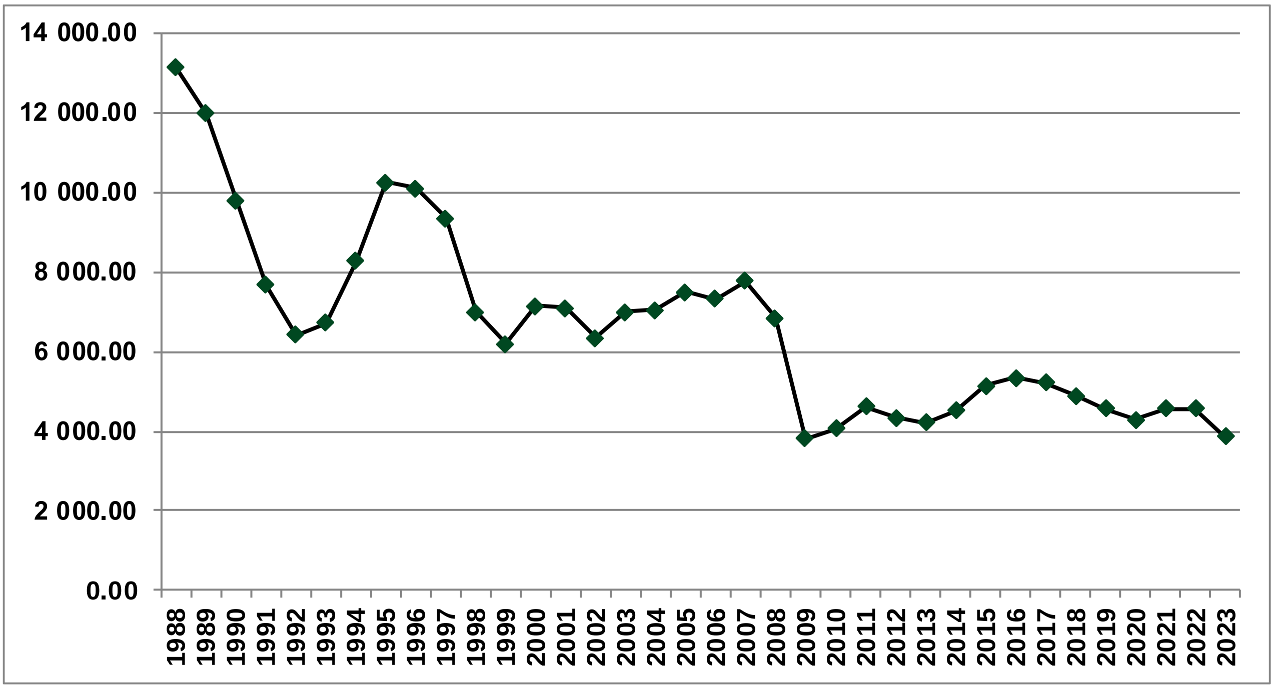


Figure 13 GHG emissions from Industrial processes sector for 1988 – 2023, Gg CO_2 eq.

In 2023 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 51.04%. The second category by share is Chemical Industry (ammonia and nitric acid production) with 26.81% share, followed by Product uses as ODS substitutes (Consumption of Halocarbons) with 16.38% and finally Metal Production (steel) with 4.1%.

Greenhouse gas emissions from the Industrial Processes and Product Use sector fluctuate during the period and reach a minimum in 2009. The reduction in 2023 for the whole sector is 70.69% while the biggest reduction (compared to the base year) can be seen in Metal Production category – 96.1%.

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.

Chapter 4 of this Report contains a more detailed analysis of GHG emissions in the sector.

Agriculture

The overall emission reduction in the sector has amounted to 56.34% since 1988. In the year 2023 the sector agriculture contributed 13.1% to the total of Bulgaria's greenhouse gas emissions (without LULUCF).

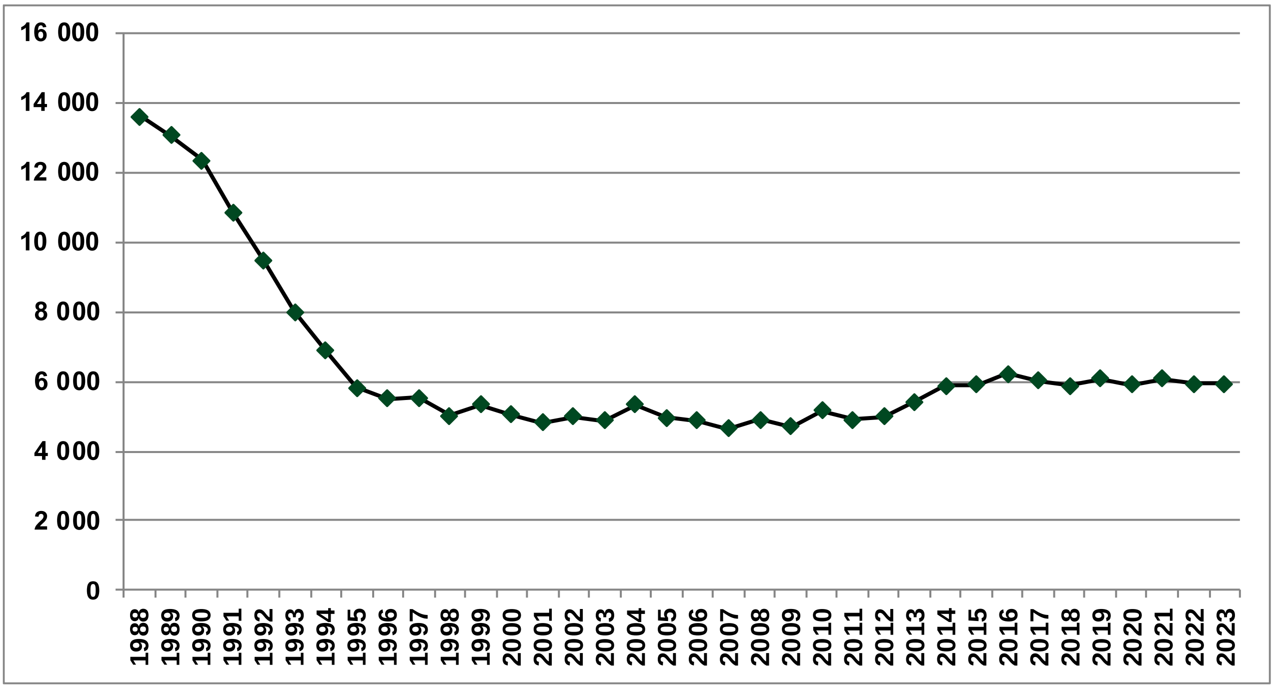


Figure 14 GHG emissions from Agriculture sector for 1988 – 2023, Gg CO_2 eq.

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.

Chapter 5 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 49.81% 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. For the current inventoried year the share is – 19.0%.

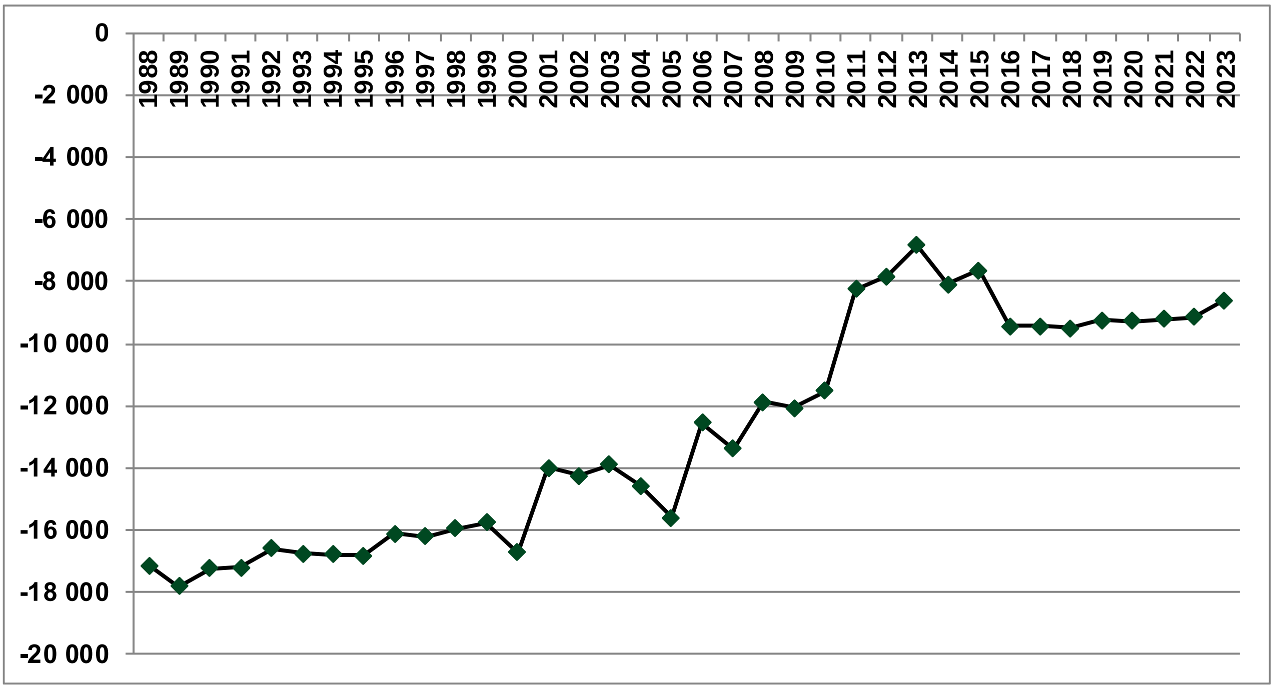


Figure 15 LULUCF emissions and removals for 1988 – 2023 CO2 eq.

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 6 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 48.64 %. The decline was mainly driven by a steady population decrease over the past 25 – 30 years.

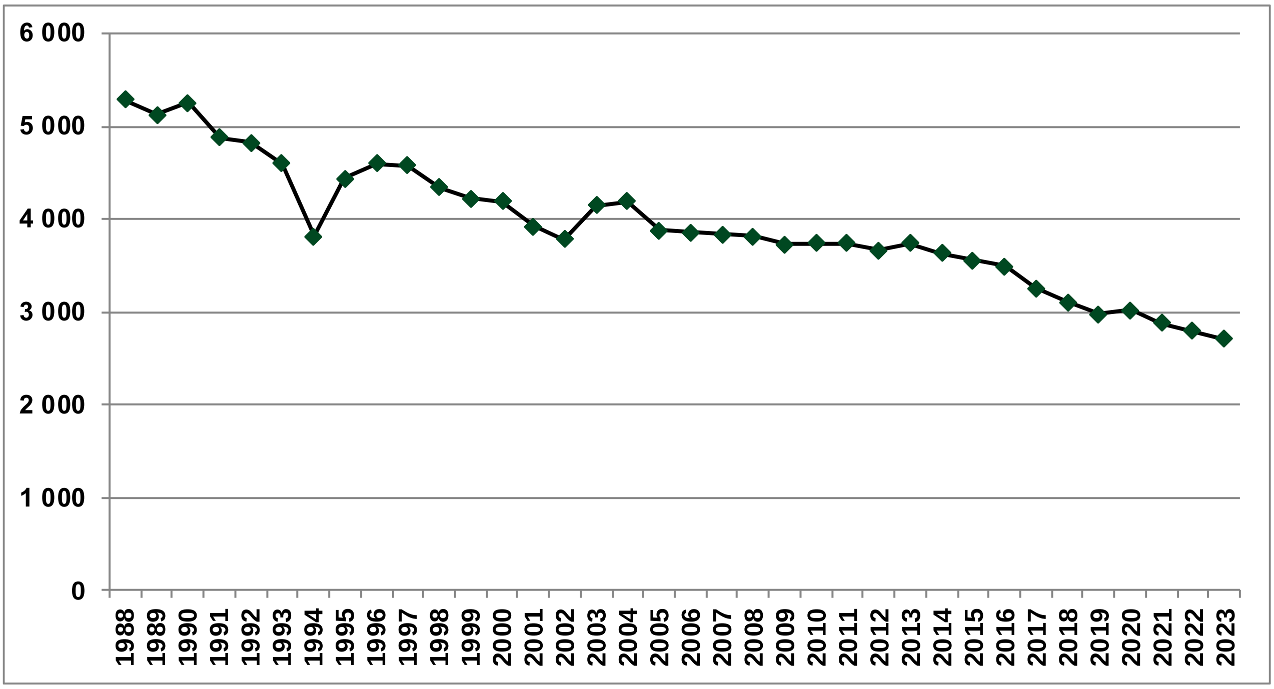


Figure 16 GHG emissions from Waste sector for 1988 – 2023, Gg CO2 eq.

Chapter 7 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 51.49%
- CO with 90.02%
- SO_x with 60.68%
- NMVOC with 60.169%

3 ENERGY (CRT 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 (CRT category 1A), as well as fugitive emissions from fuels (CRT 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 2023 the sector is responsible for 72.4% of national total GHG emissions (32 853 Gg CO_2e from sector 1A of the total 45 365 Gg CO_2e excl. LULUCF).

3.2 EMISSION TREND

Emissions from the energy sector in 2023 decreased by 59.7% compared to the base year (32 853 Gg CO_2eq in 2023 compared to 81 563 Gg CO_2e in 1988). Compared to the year before, emissions in 2023 decreased by 27.2% mostly due to the decrease of electricity production from fossil fuels in the energy industries sector.

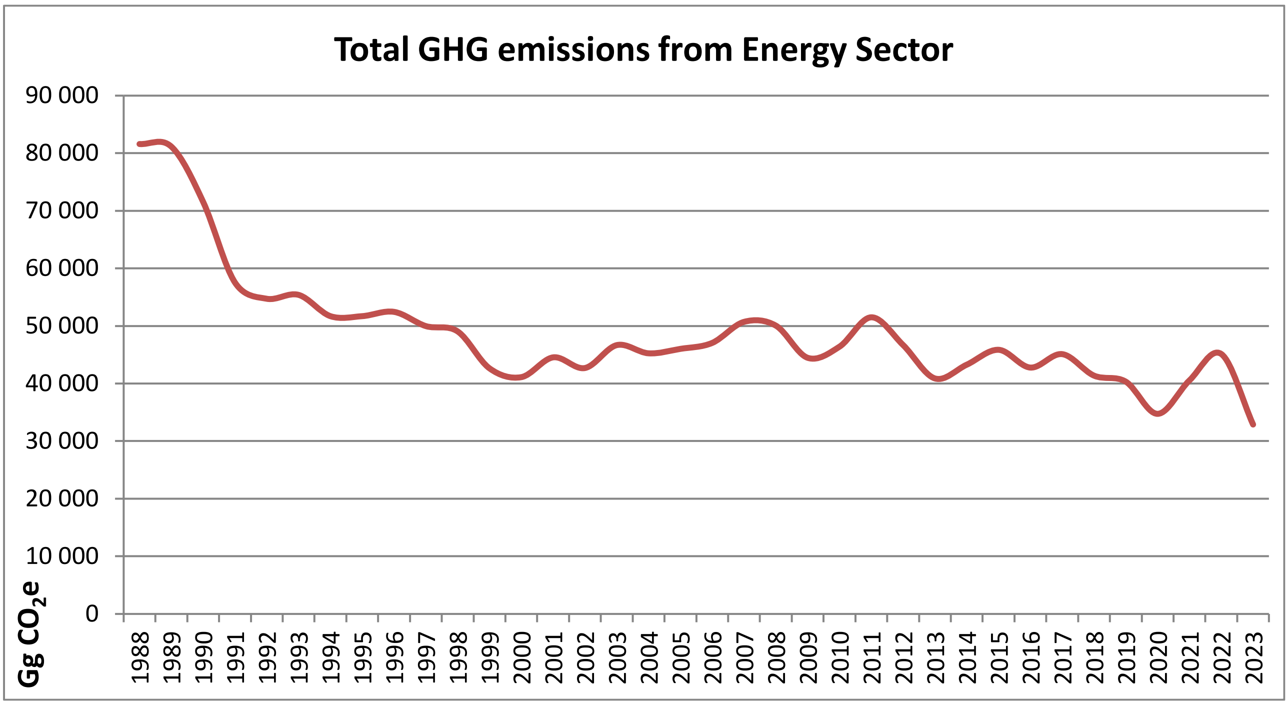


Figure 17 Total GHG emissions from Energy Sector

The main source of emissions in the energy sector is combustion of solid fuels, which is responsible for 44.0% of the emissions from fuel combustion in 2023, followed by liquid fuels with 41.1% and gaseous fuels with 12.7%.

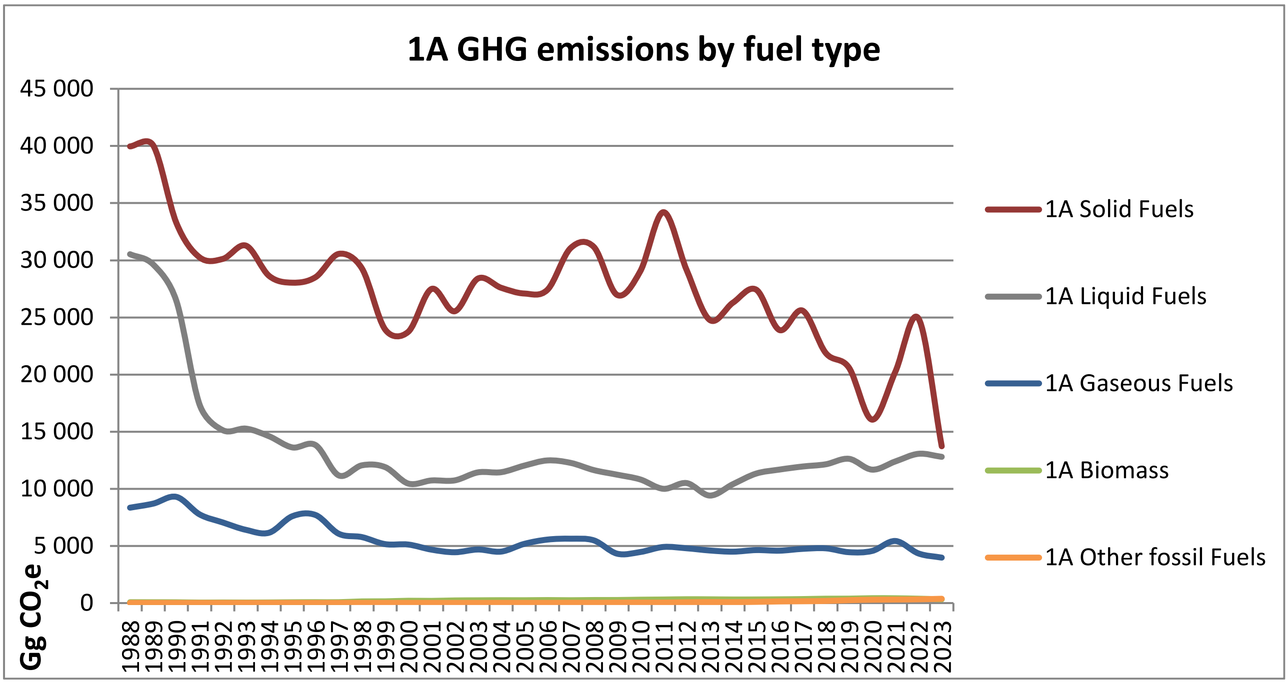


Figure 18 GHG emissions from fuel combustions by fuel type

On a subcategory level, the energy industries sector is the major source of emissions, responsible for 50.6% of the emissions from fuel combustion, followed by transport with 32.6% and manufacturing industries and construction with 12.3%.

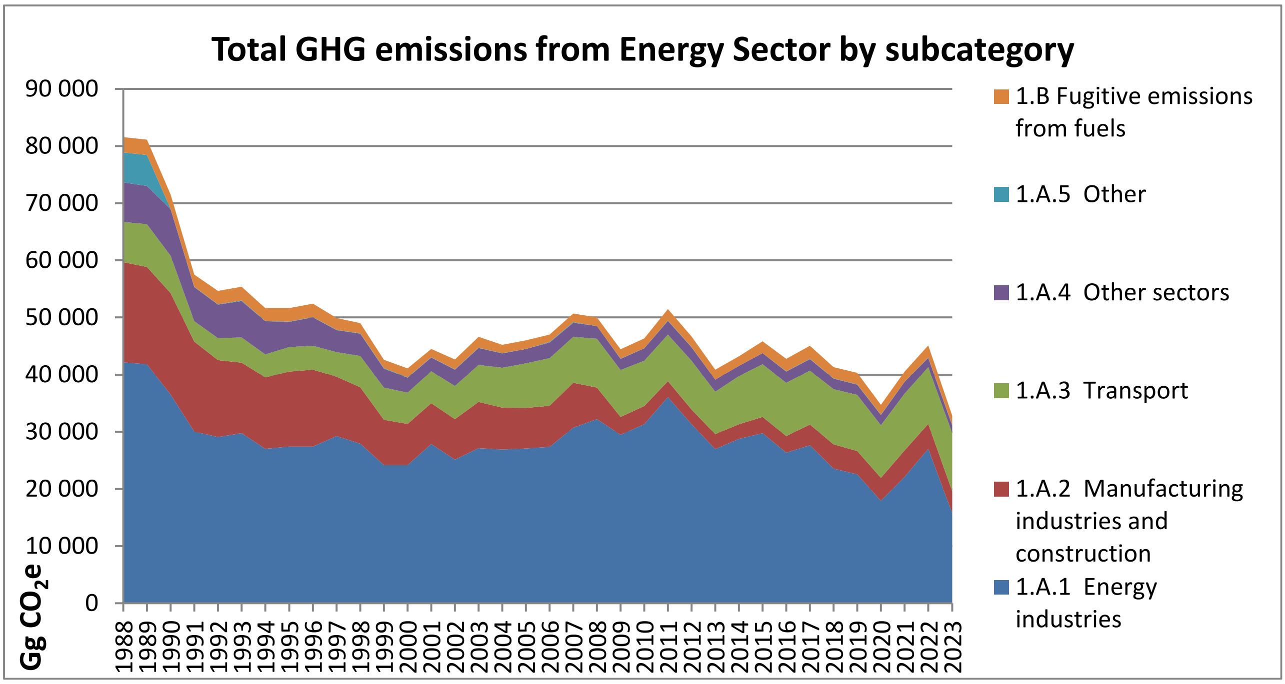


Figure 19 Total GHG emissions from Energy Sector by subcategory

Total emissions from the energy sector mainly consist of CO_2; with a total amount of 31 284 Gg for 2023, followed by CH_4 and N_2O, which only make up about 46.47 Gg and 1.01 Gg, respectively.

Table 14 Emissions of GHG and their trends for the years 1988 – 2023

Year	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1988	78 087.39	107.48	1.76	81 562.81
1990	68 272.69	99.71	1.69	71 512.07
1995	48 872.04	89.74	1.07	51 667.70
2000	39 049.81	63.40	0.97	41 082.13
2005	44 012.11	60.56	1.07	45 992.28

Year	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
2010	44 354.06	62.53	1.01	46 371.91
2011	49 143.70	72.89	1.10	51 475.44
2012	44 500.56	67.07	1.05	46 655.60
2013	38 932.50	59.65	0.96	40 856.04
2014	41 317.79	59.42	1.00	43 245.70
2015	43 744.03	64.51	1.06	45 831.50
2016	40 769.15	61.07	1.01	42 746.99
2017	42 963.48	65.69	1.05	45 080.84
2018	39 381.32	59.80	1.09	41 344.67
2019	38 427.48	56.25	1.10	40 294.85
2020	32 958.78	52.78	1.03	34 709.86
2021	38 590.07	57.81	1.16	40 515.46
2022	43 071.54	61.19	1.21	45 105.68
2023	31 284.45	46.47	1.01	32 853.46

3.3 FUEL COMBUSTION (CRT 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

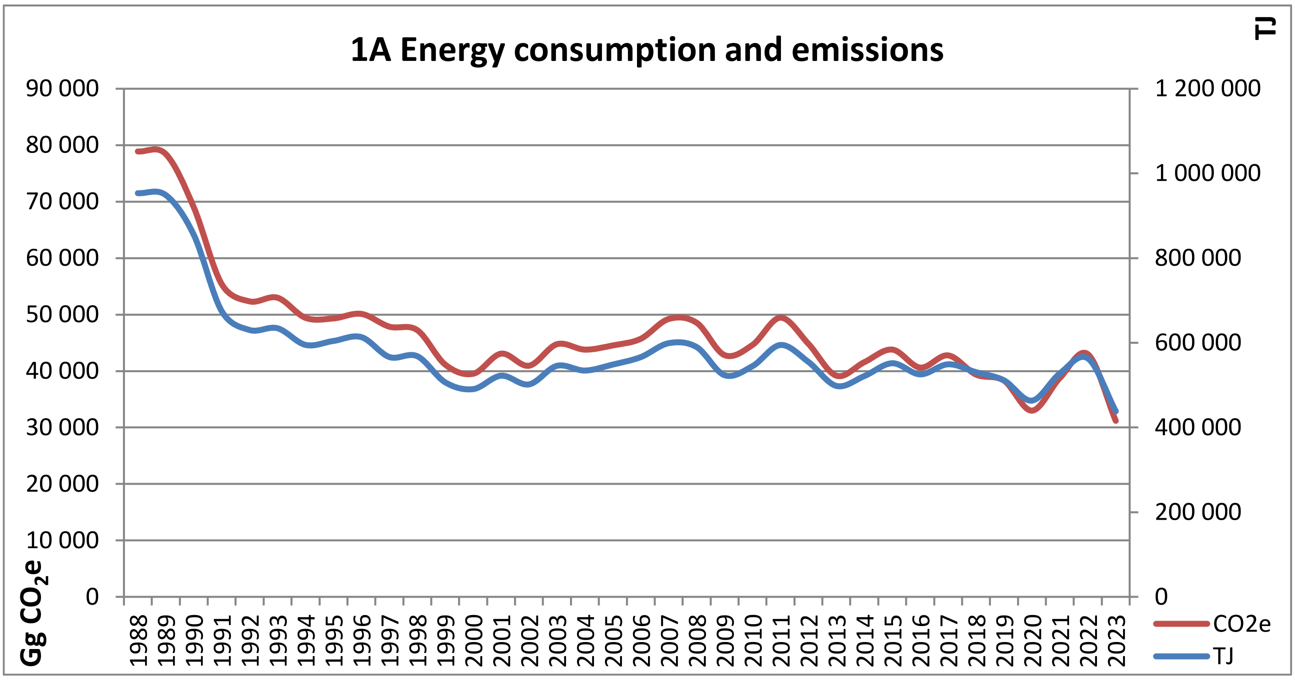


Figure 20 Comparison of the sectoral approach with the reference approach

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

Table 15 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	1 015.04	945.55	7.35%	84 470.30	77 924.27	8.40%
1990	894.21	848.21	5.42%	73 953.79	68 148.11	8.52%
1995	680.22	596.15	14.10%	56 821.81	48 705.13	16.66%
2000	502.90	467.82	7.50%	43 453.18	38 925.36	11.63%
2005	557.98	519.76	7.35%	48 202.23	43 887.99	9.83%
2010	518.26	506.58	2.31%	45 869.80	43 979.70	4.30%
2011	567.70	554.31	2.41%	50 818.08	48 749.22	4.24%
2012	523.19	508.43	2.90%	46 132.23	44 117.53	4.57%
2013	465.74	449.58	3.59%	40 597.34	38 520.49	5.39%
2014	493.71	475.25	3.88%	43 323.20	40 933.82	5.84%
2015	518.27	501.64	3.32%	45 463.81	43 143.66	5.38%
2016	483.93	471.62	2.61%	41 915.53	39 956.24	4.90%
2017	513.24	495.70	3.54%	44 600.78	42 086.02	5.98%
2018	486.36	468.00	3.92%	41 008.66	38 669.87	6.05%
2019	470.61	451.82	4.16%	40 075.31	37 600.48	6.58%
2020	420.97	401.58	4.83%	34 601.56	32 274.40	7.21%
2021	491.23	466.85	5.22%	40 997.65	38 027.55	7.81%
2022	526.86	503.13	4.72%	45 280.69	42 290.75	7.07%
2023	406.61	386.79	5.12%	32 955.90	30 591.52	7.73%

Table 16 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	463.40	402.95	15.00%	34 192.20	30 120.58	13.52%
1990	362.76	353.01	2.76%	26 872.35	26 010.44	3.31%
1995	224.06	182.93	22.48%	16 447.84	13 385.57	22.88%
2000	145.58	142.45	2.20%	10 706.34	10 270.36	4.25%

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
2005	176.99	160.81	10.06%	13 070.22	11 844.05	10.35%
2010	152.70	144.56	5.63%	11 312.63	10 677.53	5.95%
2011	143.87	135.22	6.39%	10 528.00	9 857.88	6.80%
2012	150.97	141.29	6.86%	11 103.36	10 358.90	7.19%
2013	138.11	126.62	9.08%	10 190.73	9 281.43	9.80%
2014	150.58	139.04	8.30%	11 103.55	10 270.72	8.11%
2015	163.95	153.30	6.95%	12 054.74	11 186.87	7.76%
2016	168.18	158.10	6.38%	12 463.38	11 539.74	8.00%
2017	174.94	161.38	8.40%	13 081.27	11 808.01	10.78%
2018	173.79	163.45	6.32%	12 921.11	11 998.25	7.69%
2019	179.65	170.60	5.30%	13 453.35	12 473.89	7.85%
2020	164.22	158.15	3.83%	12 207.00	11 533.72	5.84%
2021	171.35	167.13	2.52%	12 702.02	12 241.55	3.76%
2022	184.71	177.19	4.24%	13 712.41	12 906.73	6.24%
2023	178.12	174.37	2.15%	13 118.08	12 642.56	3.76%

Table 17 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	280.05	1.48%	30 155.55	28 930.94	4.23%
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	249.78	247.29	1.01%	26 581.28	25 414.03	4.59%
2018	222.75	216.37	2.95%	23 068.20	21 735.52	6.13%
2019	205.75	198.45	3.67%	21 833.39	20 466.05	6.68%
2020	167.53	158.59	5.64%	17 350.00	15 931.36	8.90%
2021	215.29	198.88	8.25%	22 401.09	20 090.76	11.50%
2022	258.21	244.89	5.44%	26 789.07	24 759.17	8.20%
2023	149.80	136.84	9.47%	15 364.69	13 640.58	12.64%

Table 18 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	85.08	2.12%	4 820.15	4 721.93	2.08%
2018	87.81	85.85	2.27%	4 876.63	4 769.87	2.24%
2019	82.48	79.69	3.50%	4 582.96	4 429.67	3.46%
2020	86.46	81.74	5.77%	4 799.27	4 539.12	5.73%

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
2021	101.59	97.50	4.19%	5 635.94	5 410.88	4.16%
2022	80.72	77.44	4.23%	4 501.69	4 319.16	4.23%
2023	74.87	71.41	4.85%	4 147.76	3 956.39	4.84%

3.3.1.3 Explanation of differences

A comparison between the Reference Approach (RA) and the Sectoral Approach (RA) indicates a difference of 5.1% in terms of energy consumption and 7.7% in terms of CO_2 emissions for 2023.
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 4.2% for the period 1990-2022 and 4.9% for 2023 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 CO_2 emissions from the biofuel 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 2023 the difference due to statistical differences and distribution losses for gaseous fuels is equal to 3 441 TJ, which is 3.9% of the total consumption of gaseous fuels. In terms of emissions, this is equivalent to 190.6 Gg CO_2. For liquid fuels, in 2023 the refinery losses are 4.9% of the refinery intake, which is equal to 13 071 TJ or 958.1 Gg CO_2.
If all those quantified differences are accounted for, the remaining difference between the reference and the sectoral approaches for 2023 is equal to 0.9% in terms of energy consumption and 4.0% 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 19 GHG Emissions from International bunker fuels

Year	Total [Gg CO_2e]	Aviation [Gg CO_2e]	Navigation [Gg CO_2e]
1988	2 069.80	1 111.46	958.33
1990	903.09	718.71	184.38

Year	Total [Gg CO_2e]	Aviation [Gg CO_2e]	Navigation [Gg CO_2e]
1995	1 773.58	911.67	861.91
2000	444.20	241.64	202.57
2005	870.79	522.62	348.17
2010	883.49	575.15	308.34
2011	812.15	572.76	239.39
2012	726.11	524.30	201.81
2013	805.10	519.55	285.55
2014	811.09	553.64	257.46
2015	848.90	575.68	273.22
2016	948.26	703.45	244.81
2017	1 029.44	776.78	252.65
2018	1 077.90	818.55	259.35
2019	1 009.53	773.12	236.42
2020	674.38	410.36	264.02
2021	762.47	495.38	267.09
2022	809.62	596.27	213.35
2023	872.76	664.70	208.06

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 8.1% of the total apparent energy consumption during the period 1988-2023 and 7.2% for 2023. The apparent consumption is calculated according to Equation 6.2 in Vol. 2, Ch. 6 of the 2006 IPCC Guidelines.

Table 20 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%

Year	Non-energy use, PJ	Apparent energy consumption incl. non-energy use, PJ	%
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%
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	523.74	7.1%
2019	36.20	506.81	7.1%
2020	35.15	456.13	7.7%
2021	36.09	527.32	6.8%
2022	30.84	557.71	5.5%
2023	31.51	438.12	7.2%

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

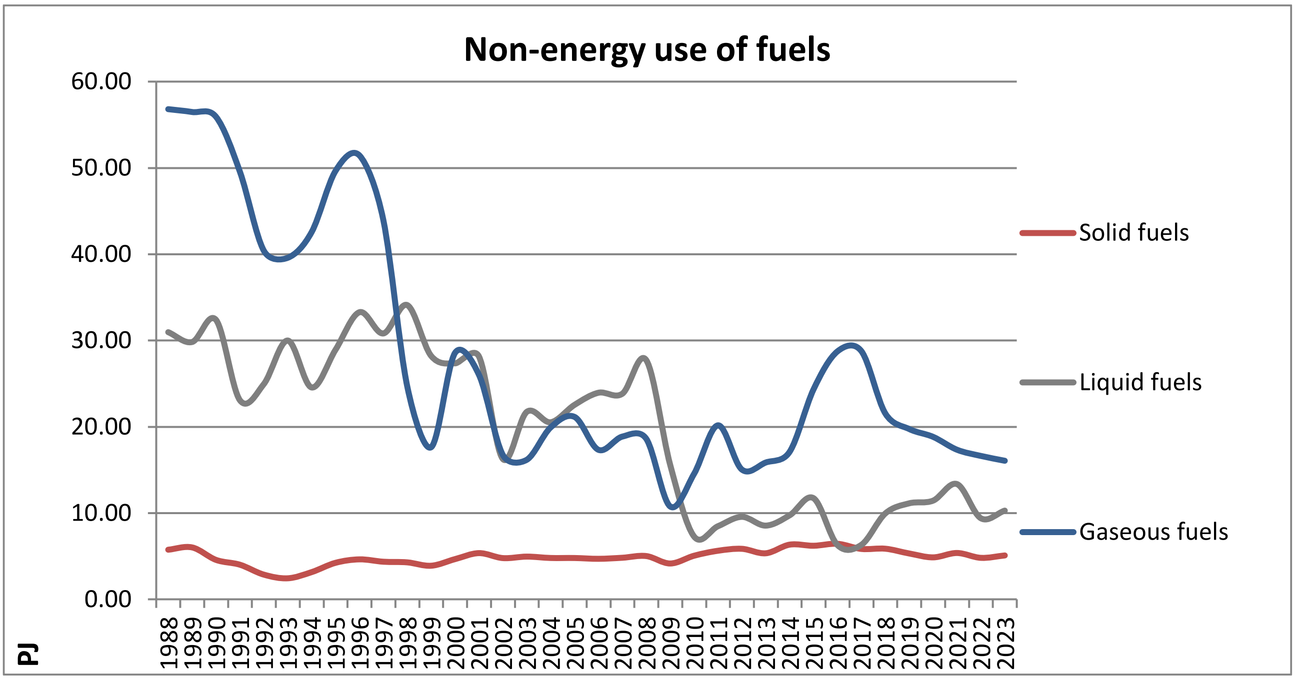


Figure 21 Non-energy use of fuels

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. This excludes emissions from lubricants used in 2-stroke engines, which are reported under the Energy sector (CRT 1.A.3.b.iv), which 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 21 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
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
2020	4.88	11.43	18.85
2021	5.38	13.35	17.35
2022	4.82	9.38	16.64
2023	5.10	10.34	16.08

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 1990-2023. 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 22 presents the key source categories of 1 A Fuel Combustion Activities.

Table 22 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

Category	Classification	Gas	Key Category Assessment*
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 CRT subcategories 1.A.1, 1.A.2., 1.A.4 and 1.A.5. The formula used in the calculations is the following:

$$\textit{Emissions}_{GHG} = \textit{Fuel Consumption} \bullet \textit{Emission Factor}_{GHG}$$

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 CRT 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 CRT 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:

$$C = \textit{Emission Factor} / (44/12)$$

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 23 Default Emission factors for CO_2 for different fuels

Fuel	EF C t/TJ	EF CO_2 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

Fuel	EF C t/TJ	EF CO_2 t/TJ (excl. oxidation factor)
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
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		

Fuel	EF C t/TJ	EF CO_2 t/TJ (excl. oxidation factor)
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 25 and Table 26.

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 183 operators have provided their verified CO_2 emission reports required under the EU ETS for the years 2007-2023. 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 105 operators reporting in 2023, only the 18 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 2018/2066 on the monitoring and reporting of greenhouse gas emissions) and which were within the default IPCC ranges for the respective fuel. 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 2023 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 24 Country-specific carbon content for solid fuels [t/TJ]

Fuel	Anthracite	Lignite	Other Bituminous Coal	Petroleum Coke	Refinery gas
1988-2006	28.1856	29.5664	26.7573	25.7857	15.6544
2007	27.4792	29.3911	27.3114	26.1149	15.6544
2008	28.8427	29.8238	26.9270	25.9131	15.6544
2009	28.6586	29.5021	26.7776	25.3961	15.6544
2010	27.9950	29.5215	26.3476	25.6574	15.6544
2011	27.7125	29.3377	26.5553	25.1971	15.6544
2012	27.2728	29.3820	26.8637	25.5126	15.6544
2013	27.2555	29.3129	26.5746	25.6736	15.6544
2014	27.4779	29.3766	26.1637	25.8451	17.1280
2015	27.5376	29.3360	25.9361	25.7868	15.3577
2016	29.3428	29.4636	26.0945	25.9060	15.3524
2017	29.5507	29.2726	25.4187	25.7673	15.4696
2018	29.9937	28.4366	24.9509	25.6125	15.2767
2019	29.0681	29.1563	24.9035	25.5579	15.7952
2020	29.3064	28.5466	23.6826	25.6505	15.5696

Fuel	Anthracite	Lignite	Other Bituminous Coal	Petroleum Coke	Refinery gas
2021	28.6252	28.6423	24.5867	25.6852	15.7336
2022	27.9661	28.3817	26.5904	25.9784	16.3265
2023	28.2369	28.1882	25.0424	25.9914	16.2155

The following emission factors excluding oxidation factor were calculated:

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

Fuel	Anthracite	Lignite	Other Bituminous Coal	Petroleum Coke	Refinery gas
1988-2006	103.3470	108.4102	98.1099	94.5477	57.3994
2007	100.7572	107.7673	100.1419	95.7545	57.3994
2008	105.7566	109.3540	98.7324	95.0147	57.3994
2009	105.0817	108.1742	98.1845	93.1192	57.3994
2010	102.6484	108.2456	96.6078	94.0772	57.3994
2011	101.6126	107.5715	97.3695	92.3894	57.3994
2012	100.0003	107.7340	98.5004	93.5463	57.3994
2013	99.9368	107.4805	97.4401	94.1364	57.3994
2014	100.7522	107.7140	95.9336	94.7654	62.8025
2015	100.9712	107.5652	95.0989	94.5517	56.3114
2016	107.5904	108.0331	95.6798	94.9888	56.2921
2017	108.3525	107.3327	93.2018	94.4801	56.7220
2018	109.9769	104.2675	91.4866	93.9125	56.0144
2019	106.5831	106.9063	91.3130	93.7125	57.9159
2020	107.4568	104.6709	86.8363	94.0517	57.0886
2021	104.9591	105.0219	90.1511	94.1791	57.6900
2022	102.5425	104.0662	97.4980	95.2541	59.8639
2023	103.5355	103.3566	91.8220	95.3019	59.4570

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

Table 26 Country-specific EFs incl. oxidation factor for CO_2 for solid fuels [t/TJ]

Fuel	Anthracite	Lignite	Other Bituminous Coal	Petroleum Coke	Refinery gas
1988-2006	98.4802	105.8747	95.6910	94.5161	57.3994
2007	97.5236	104.9506	98.3294	95.7225	57.3994
2008	100.7763	106.8890	96.2981	94.9830	57.3994
2009	99.6547	105.5404	95.1683	93.0881	57.3994
2010	97.3953	105.8315	93.4475	94.0458	57.3994
2011	96.6057	105.1891	95.0759	92.3586	57.3994
2012	96.3049	105.3618	96.4435	93.5150	57.3994
2013	95.8515	104.8037	95.3831	94.1049	57.3994
2014	96.6008	104.6660	94.1733	94.7434	62.8025
2015	98.2139	104.3856	93.4664	94.5258	56.3114
2016	104.9487	104.5859	93.8423	94.9704	56.2921
2017	105.5266	104.0991	90.1683	94.4578	56.7220
2018	105.1822	101.3470	88.5682	93.8869	56.0144
2019	102.9444	104.1995	88.1773	93.6844	57.9159
2020	103.6573	101.7753	83.4055	94.0091	57.0886
2021	101.7021	102.2390	86.2875	94.1418	57.6900
2022	101.3348	101.5074	93.6592	95.2272	59.8639
2023	101.2018	100.5369	88.4162	95.2257	59.4570

The national emission estimates were prepared using country-specific emission factors, including oxidation factor for anthracite, lignite, other bituminous coke petroleum coke, and refinery gas. 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 (EU) 2018/2066 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 25) or the default emission factors (Table 23). 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 2007-2023;
- Petroceltic Bulgaria EOOD and Oil and Gas Exploration and Production AD - the companies licensed for oil and gas extraction for the period 2004-2023 and 1999-2023 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 27 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
2020	15.1388	55.5090
2021	15.1299	55.4764
2022	15.2097	55.7689
2023	15.1085	55.3980

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 28 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
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

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
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 29 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

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
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
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

3.3.8.3 Choice of emission factors for mobile sources

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

3.3.8.4 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 1990-2023. 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 CRT 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].

3.3.8.4.1 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 30 Selected Net Calorific Values for 2022

Fuel	Public electricity and heat production [MJ/kg]	Industry [MJ/kg]
Liquid fuels		
Crude oil	42.538	
Gasoline	42.922	
Jet Kerosene	43.120	
Gas/Diesel Oil	41.974	
Residual Fuel Oil	40.000	
LPG	46.000	
Naphtha	43.961	
Bitumen	40.449	
Lubricants	40.200	
Petroleum Coke	32.590	
Refinery Feedstocks	41.946	
Refinery Gas	47.385	
White Spirit SBP	40.200	
Paraffin Wax	40.200	

Other Petroleum Products	40.200	
Solid fuels		
Anthracite	21.657	25.476
Coking Coal	-	-
Other Bituminous Coal	20.290	22.224
Lignite and Sub-bituminous Coal	6.911	7.015
BKB & Patent Fuel	10424	11.939
Coke Oven / Gas Coke	-	28.500
Gaseous fuels		
Natural Gas, 20°C [MJ/m3]	34.869	
Natural Gas, 15°C [MJ/m3]	35.462	

For all NCVs please consult Annex IV.

3.3.8.5 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 2006-2021 and for gaseous biofuels is reported for 2008-2021.

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.

3.3.8.6 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.

3.3.8.7 Uncertainties in CRT 1.A

<u>STATIONARY COMBUSTION</u>

3.3.8.7.1 Uncertainty of AD

Solid fuels
About 94% of solid fuels consumption is derived from indigenous lignite production, whereas around 3% of solid fuels (anthracite, other bituminous coal and coke oven coke) are imported, predominantly from Kazakhstan, South Africa, Mozambique, Colombia and Turkiye. 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 CRT categories 1.A.1 and 1.A.2: 1%
- For CRT 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 CRT categories 1.A.1 and 1.A.2: 1%
- For CRT 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 CRT categories 1.A.1 and 1.A.2: 3%
- For CRT category 1.A.4 and 1.A.5: 5%

3.3.8.7.2 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 CRT categories 1.A.1 and 1.A.2: 2%
- For solid fuels in CRT 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.

3.3.8.8 Source-specific QA/QC and verification

For the calculation of the emissions from CRT 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.

3.3.8.8.1 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.

3.3.8.8.2 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 CRT 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 CRT tables generated by the CRT Reporter software.

3.3.8.9 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 24.
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 2021 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.
For the 2023 submissions was identified and corrected an error in the calculations – the 2019 country-specific emission factors were erroneously applied for the 2020 calculations, which lead to the recalculation of the emissions in most subcategories. Additional recalculations were introduced due to

revisions in the national energy balances reflecting net calorific values, statistical differences and non-energy use of natural gas as well as for some liquid fuels (kerosene, gas-diesel oil and bitumen).

3.3.8.10 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

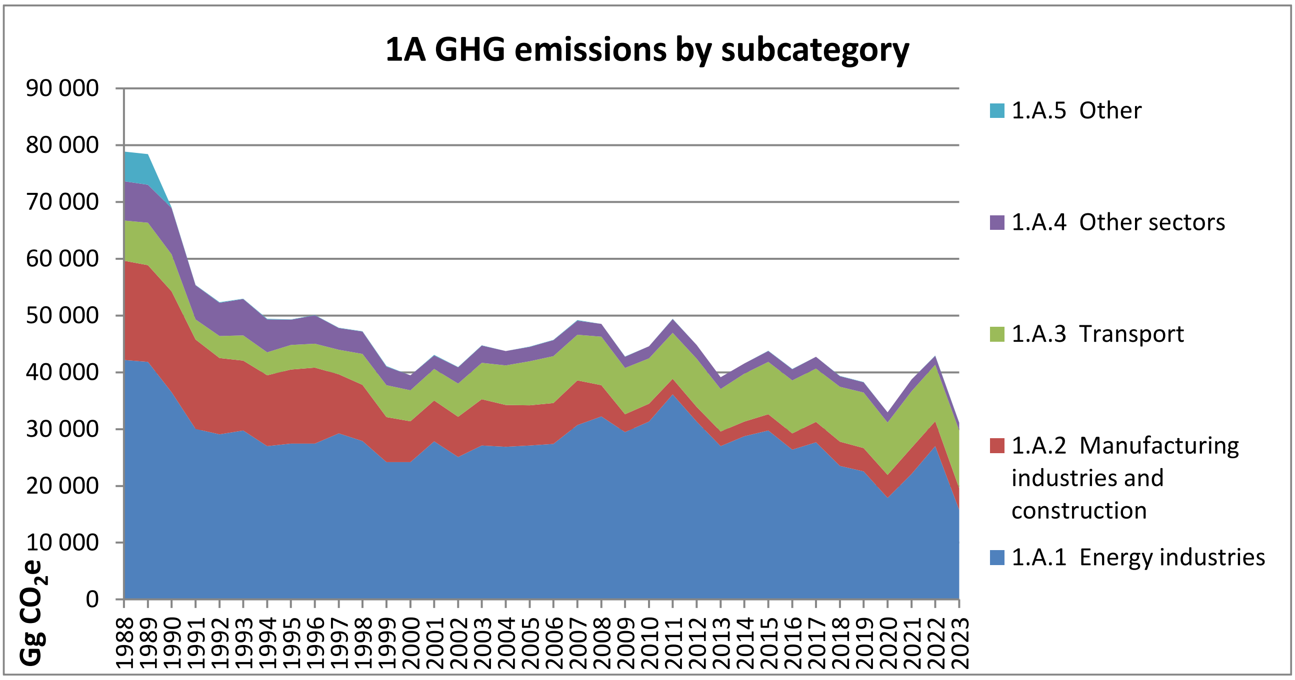


Figure 22 Total GHG emissions from Fuel combustion by subcategory

Energy Industries are the main source of GHG emissions from fuel combustion with 50.6% of the sector emissions for 2023. Transport is the second most important source with 32.6% of the sector emissions, followed by Manufacturing industries and construction with 12.3%.

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 2020 there is a decrease of the emissions from fuel combustion of 14.1% compared to 2019 due to the pandemic situation, which resulted in a decrease of electricity production and transport activities. In 2021 due to the recovery of the economy, the trend reversed, which lead to an increase of 17.5% compared to 2020. The upwards trend continued in 2022, in which a further 22.2% increase of emissions was observed. In 2023 the general downward trend continued with a major decline of 41.7% compared to previous year.

Manufacturing industry and construction is the sector, which changed drastically – compared to 1988 the emissions decreased by 78.1% in 2023. 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, significantly decreased the emissions from solid fuels and the emissions from the industry subcategory in general, even though since 2015 the emissions from gaseous fuels slightly increased. Since 2017 there is also 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. However, in 2023 there was a significant decrease of solid fuels used for electricity generation due to the rapid growth of renewable energy production and restructuring of the regional electricity market.

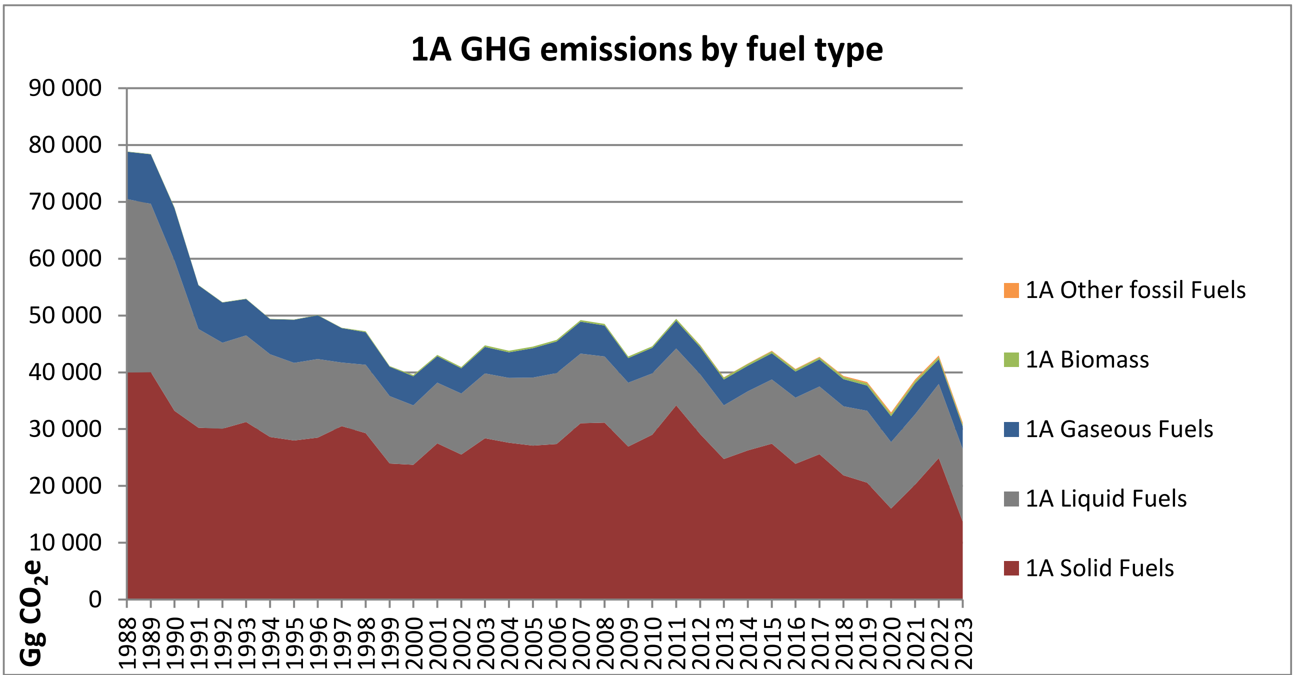


Figure 23 Total GHG emissions from Fuel combustion by fuel type

In 2023, 44.0% of the emissions from fuel combustion were from solid fuels, 41.1% were from liquid fuels, and 12.7% 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 fuels due to the increase of transport sector, and a slight increase of gaseous fuels due to the on-going gasification of industrial plants, residential sector and transport.

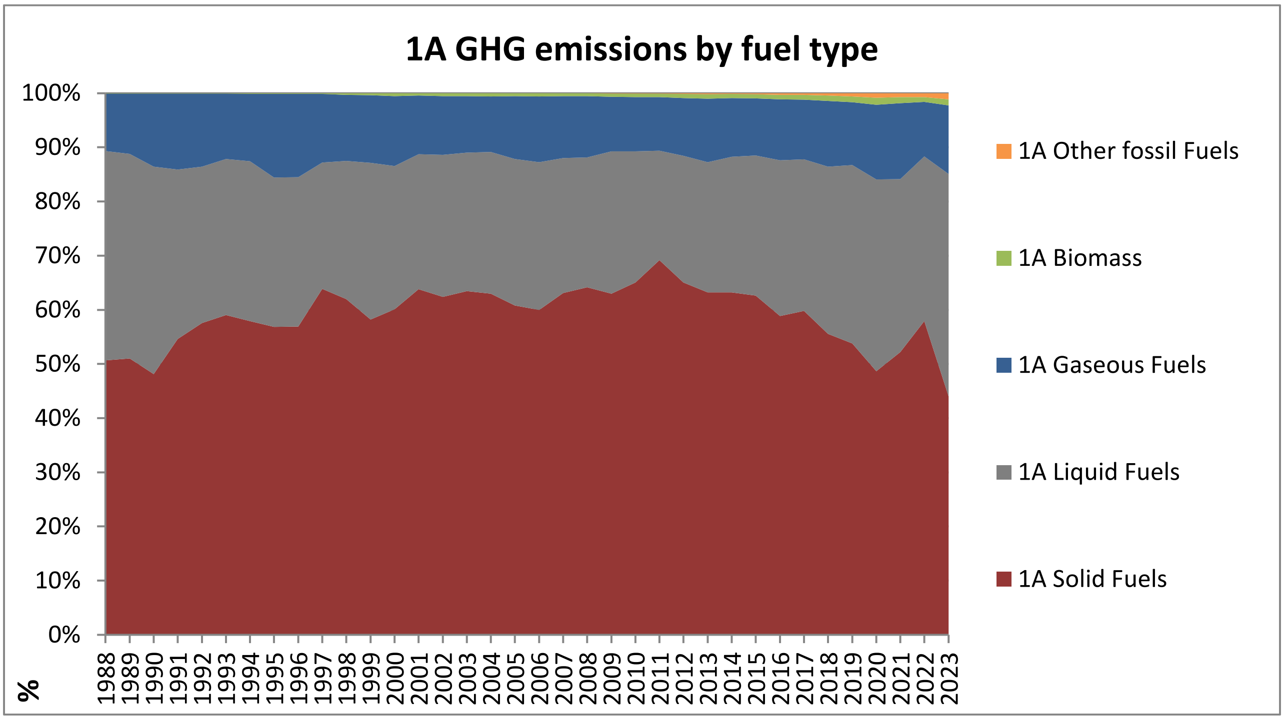


Figure 24 Total GHG emissions from Fuel combustion by fuel type

Table 31 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	77 924.27	30 120.58	39 467.58	8 336.10	889.3920	NO
1990	68 148.11	26 010.44	32 856.19	9 281.48	808.7520	NO
1995	48 705.13	13 385.57	27 731.81	7 587.76	945.9520	NO
2000	38 925.36	10 270.36	23 549.84	5 105.16	2 580.2560	NO
2005	43 887.99	11 844.05	26 878.52	5 162.62	3 262.2153	2.8073
2010	43 979.70	10 677.53	28 827.99	4 445.63	4 280.3962	28.5474
2011	48 749.22	9 857.88	33 972.88	4 889.51	4 542.8506	28.9425
2012	44 117.53	10 358.90	28 930.94	4 774.46	5 104.3794	53.2415
2013	38 520.49	9 281.43	24 589.36	4 578.78	5 288.7179	70.9248
2014	40 933.82	10 270.72	26 123.38	4 475.36	5 042.5419	64.3638
2015	43 143.66	11 186.87	27 254.76	4 614.34	5 398.5932	87.6851
2016	39 956.24	11 539.74	23 729.49	4 561.65	5 716.9467	125.3597
2017	42 086.02	11 808.01	25 414.03	4 721.93	5 798.1273	142.0447
2018	38 669.87	11 998.25	21 735.52	4 769.87	7 576.1075	166.2327
2019	37 600.48	12 473.89	20 466.05	4 429.67	8 151.6547	230.8571
2020	32 274.40	11 533.72	15 931.36	4 539.12	8 395.7834	270.2046
2021	38 027.55	12 241.55	20 090.76	5 410.88	9 278.1272	284.3508
2022	42 290.75	12 906.73	24 759.17	4 319.16	8 461.3024	305.7056
2023	30 591.52	12 642.56	13 640.58	3 956.39	7 293.8550	351.9915
Decrease 1988-2023	60.7%	58.0%	65.4%	52.5%	-720.1%	-
Decrease 1990-2023	55.1%	51.4%	58.5%	57.4%	-801.9%	-
Decrease 2022-2023	27.7%	2.0%	44.9%	8.4%	13.8%	-15.1%

Table 32 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	18.3819	3.8093	12.0393	0.1510	2.3823	NO
1990	15.5266	3.8013	9.3878	0.1712	2.1663	NO
1995	11.5051	2.4462	6.7247	0.1408	2.1933	NO
2000	11.4669	1.5082	3.3707	0.0967	6.4913	NO
2005	12.6689	1.2409	3.4212	0.1390	7.8668	0.0010
2010	13.3090	1.0040	2.7783	0.2007	9.3154	0.0105
2011	14.3618	0.9186	3.4149	0.2164	9.8027	0.0093
2012	14.8825	0.8980	3.2582	0.2271	10.4844	0.0148

CH_4 (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2013	13.8866	0.7281	2.7207	0.2385	10.1813	0.0180
2014	12.7965	0.7933	2.0056	0.2619	9.7179	0.0178
2015	12.9035	0.8113	2.0552	0.2663	9.7456	0.0251
2016	13.3753	0.7454	2.2399	0.2460	10.1024	0.0415
2017	14.1305	0.6945	2.3960	0.2450	10.7450	0.0501
2018	14.1695	0.6517	1.8221	0.2508	11.3836	0.0613
2019	14.0033	0.6303	1.6523	0.2543	11.3836	0.0829
2020	15.1528	0.5703	1.5702	0.2437	12.6850	0.0836
2021	15.2844	0.6159	2.1358	0.2663	12.1756	0.0908
2022	12.9406	0.6007	0.9715	0.1962	11.0748	0.0975
2023	10.8339	0.5524	0.4726	0.1683	9.5254	0.1152
Decrease 1988-2023	41.1%	85.5%	96.1%	-11.5%	-299.8%	-
Decrease 1990-2023	30.2%	85.5%	95.0%	1.7%	-339.7%	-
Decrease 2022-2023	16.3%	8.0%	51.4%	14.2%	14.0%	-18.2%

Table 33 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	1.7576	1.1370	0.5737	0.0151	0.0318	NO
1990	1.6876	1.1654	0.4765	0.0168	0.0289	NO
1995	1.0669	0.6188	0.4005	0.0137	0.0338	NO
2000	0.9699	0.5299	0.3386	0.0092	0.0922	NO
2005	1.0728	0.5551	0.3909	0.0102	0.1165	0.0001
2010	1.0056	0.4198	0.4218	0.0109	0.1517	0.0015
2011	1.0951	0.4252	0.4955	0.0118	0.1613	0.0013
2012	1.0435	0.4296	0.4201	0.0120	0.1795	0.0022
2013	0.9537	0.3936	0.3595	0.0122	0.1857	0.0028
2014	0.9951	0.4194	0.3825	0.0128	0.1777	0.0027
2015	1.0586	0.4546	0.3968	0.0132	0.1901	0.0038
2016	1.0076	0.4452	0.3454	0.0128	0.1982	0.0061
2017	1.0455	0.4512	0.3714	0.0133	0.2023	0.0073
2018	1.0872	0.4740	0.3250	0.0137	0.2656	0.0089
2019	1.0999	0.4895	0.2980	0.0138	0.2867	0.0118
2020	1.0286	0.4692	0.2382	0.0136	0.2955	0.0120
2021	1.1557	0.5016	0.2994	0.0153	0.3264	0.0129
2022	1.2070	0.5148	0.3684	0.0117	0.2982	0.0139
2023	1.0078	0.5183	0.2056	0.0105	0.2571	0.0163
Decrease 1988-2023	42.7%	54.4%	64.2%	30.4%	-709.5%	-
Decrease 1990-2023	40.3%	55.5%	56.8%	37.5%	-790.2%	-
Decrease 2022-2023	16.5%	-0.7%	44.2%	10.0%	13.8%	-16.9%

Table 34 GHG emissions in 1.A. Fuel Combustion

GHG (Gg)	TJ	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	953 492.74	78 904.72	30 528.56	39 956.71	8 344.33	75.1219	NO
1990	855 435.83	69 030.07	26 425.71	33 245.32	9 290.73	68.3107	NO
1995	604 598.48	49 310.00	13 618.05	28 026.24	7 595.34	70.3660	NO
2000	490 859.38	39 503.46	10 453.02	23 733.93	5 110.32	206.1761	NO
2005	548 883.05	44 527.01	12 025.89	27 077.90	5 169.20	251.1452	2.8714
2010	545 163.76	44 618.83	10 816.88	29 017.56	4 454.14	301.0268	29.2286
2011	595 021.04	49 441.55	9 996.28	34 199.80	4 898.70	317.2275	29.5410
2012	555 083.35	44 810.77	10 497.90	29 133.48	4 784.00	341.1361	54.2404
2013	498 388.45	39 162.05	9 406.12	24 760.80	4 588.69	334.2749	72.1633
2014	521 625.59	41 555.82	10 404.08	26 280.90	4 486.08	319.1891	65.5724
2015	551 947.91	43 785.48	11 330.06	27 417.47	4 625.29	323.2622	89.3905
2016	525 699.07	40 597.77	11 678.59	23 883.73	4 571.93	335.3880	128.1357
2017	549 413.79	42 758.73	11 947.02	25 579.55	4 732.31	354.4641	145.3935
2018	530 747.11	39 354.71	12 142.11	21 872.65	4 780.54	389.1134	170.3012
2019	511 490.05	38 284.05	12 621.26	20 591.29	4 440.46	394.7260	236.3163

GHG (Gg)	TJ	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2020	463 736.05	32 971.26	11 674.04	16 038.46	4 549.56	433.4905	275.7156
2021	528 031.68	38 761.78	12 391.72	20 229.92	5 422.40	427.4190	290.3231
2022	563 373.65	42 972.94	13 059.97	24 883.99	4 327.74	389.1099	312.1294
2023	438 566.57	31 161.95	12 795.38	13 708.29	3 963.89	334.8487	359.5358
Decrease 1988-2023	54.0%	60.5%	58.1%	65.7%	52.5%	-345.7%	-
Decrease 1990-2023	48.7%	54.9%	51.6%	58.8%	57.3%	-390.2%	-
Decrease 2022-2023	22.2%	27.5%	2.0%	44.9%	8.4%	13.9%	-15.2%

3.3.10 ENERGY INDUSTRIES (CRT 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.

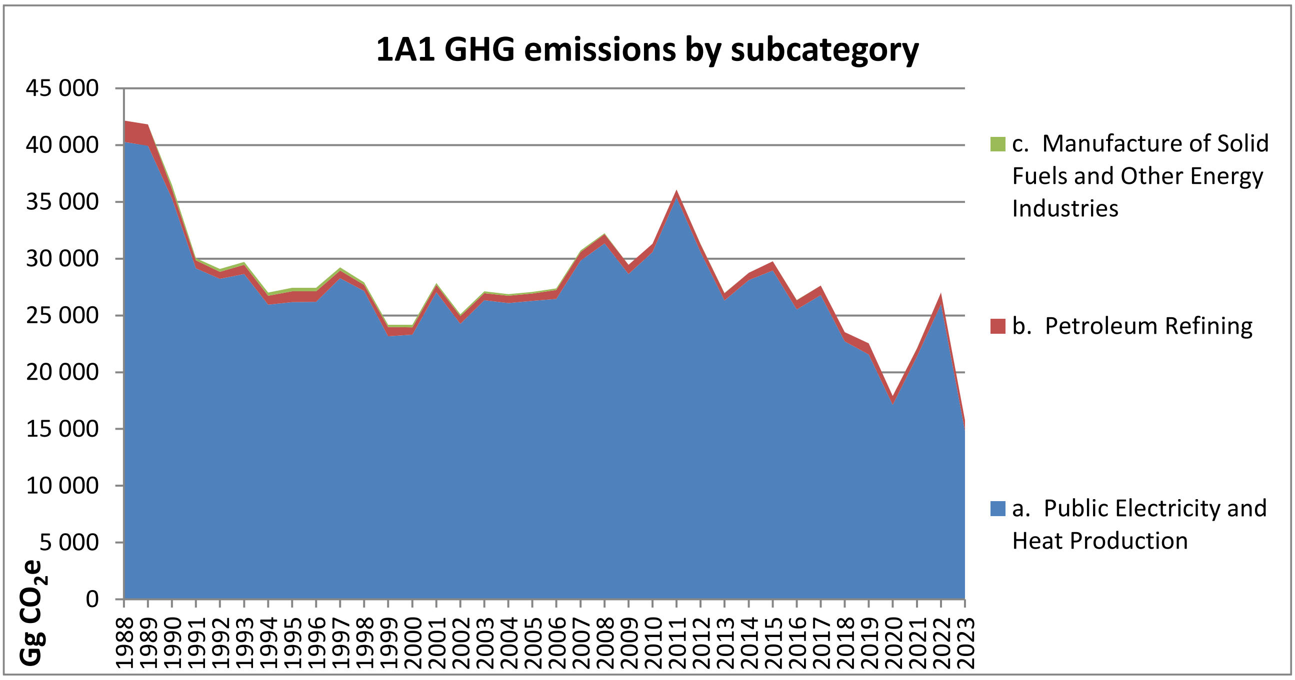


Figure 25 Total GHG emissions from 1.A.1 Energy industries by subcategory

For 2023 the general trend in CRT category 1.A.1 is a decrease in the emissions of 62.6% compared to base year and a decrease of 41.7% compared to last year.

3.3.10.1 Public Electricity and Heat Production (CRT 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.

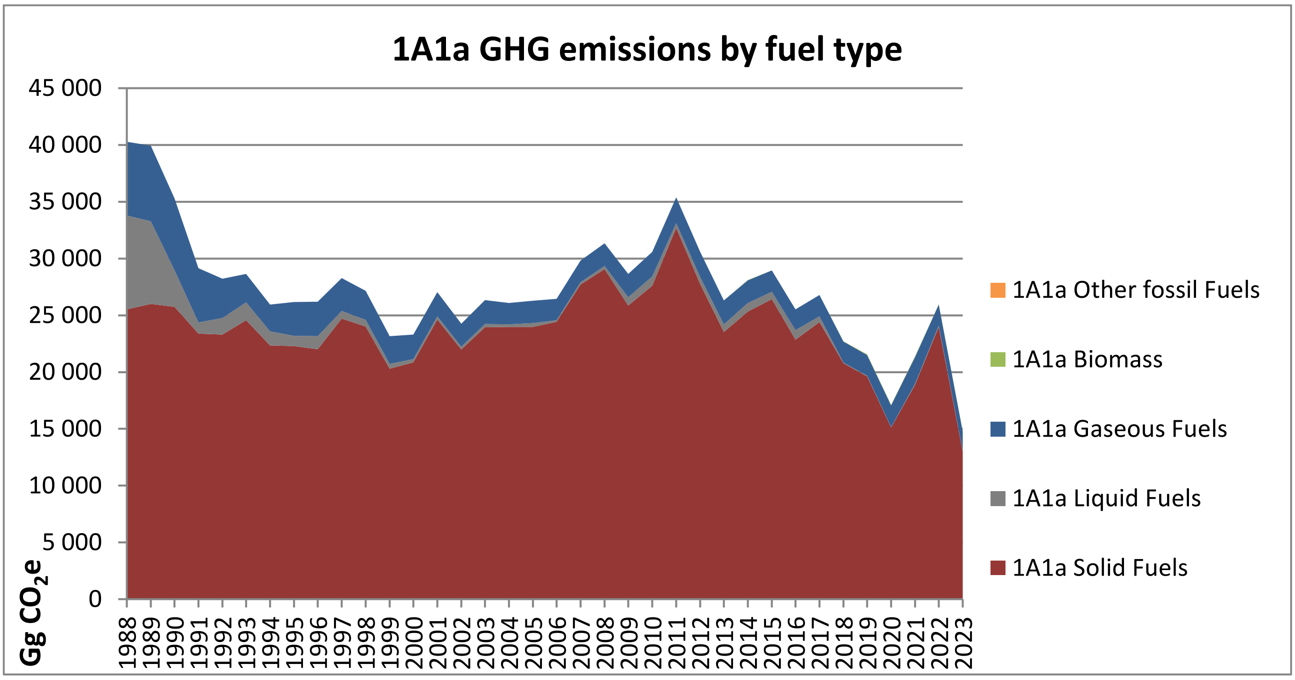


Figure 26 GHG emissions from 1.A.1.a Public Electricity and Heat Production

The share of CRT category 1.A.1.a from the total GHG emissions is 25.4% for the year 2023. The share of this subcategory from CRT category 1.A Fuel combustion is 47.5% for the year 2023. The decrease of the emissions from this subcategory is due to the decrease of electricity and heat production from combustible fuels caused by the increase of local renewable electricity generation and increase of electricity imports.

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

CO_2 (Gg)	CRT 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	30 479.68	839.55	27 482.65	2 157.47	9.0720	NO
2011	35 265.16	423.22	32 557.09	2 284.85	30.4640	NO
2012	30 482.08	625.82	27 634.52	2 221.74	17.6960	NO
2013	26 226.51	668.18	23 449.64	2 108.69	19.0036	NO
2014	27 992.52	744.56	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	22 590.28	59.70	20 683.98	1 846.59	1 845.4130	NO
2019	21 433.69	48.72	19 545.39	1 839.57	2 295.7260	NO
2020	17 012.04	38.50	15 052.38	1 921.16	2 063.5225	NO
2021	21 245.36	68.39	18 825.17	2 351.80	3 346.5239	NO
2022	25 838.11	109.11	23 893.64	1 835.37	2 711.0605	NO
2023	14 713.11	54.46	12 923.50	1 735.16	2 250.6253	NO
Decrease 1988-2023	63.4%	99.3%	49.2%	73.3%	-	-
Decrease 1990-2023	58.2%	98.3%	49.6%	72.4%	-	-

CO_2 (Gg)	CRT 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 2022-2023	43.1%	50.1%	45.9%	5.5%	17.0%	-

Table 36 CH_4 emissions in CRT 1.A.1.a. Public Electricity and Heat Production

CH_4 (Gg)	CRT 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
2020	0.7166	0.0015	0.1486	0.0346	0.5318	NO
2021	1.1051	0.0027	0.1849	0.0424	0.8751	NO
2022	0.9830	0.0042	0.2359	0.0329	0.7099	NO
2023	0.7519	0.0021	0.1290	0.0313	0.5894	NO
Decrease 1988-2023	-10.3%	99.3%	47.3%	73.4%	-	-
Decrease 1990-2023	-53.4%	98.3%	48.4%	72.5%	-	-
Decrease 2022-2023	23.5%	50.0%	45.3%	4.8%	17.0%	-

Table 37 N_2O emissions in 1.A.1.a. Public Electricity and Heat Production

N_2O (Gg)	CRT 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
2020	0.2975	0.0003	0.2229	0.0035	0.0709	NO
2021	0.3988	0.0005	0.2774	0.0042	0.1166	NO
2022	0.4527	0.0008	0.3539	0.0033	0.0946	NO
2023	0.2756	0.0004	0.1935	0.0031	0.0786	NO
Decrease 1988-2023	37.7%	99.3%	47.3%	73.4%	-	-
Decrease 1990-2023	33.1%	98.3%	48.4%	72.5%	-	-
Decrease 2022-2023	39.1%	50.0%	45.3%	4.8%	17.0%	-

Table 38 GHG emissions in 1.A.1.a. Public Electricity and Heat Production

GHG (Gg)	TJ	CRT 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	469 001.13	40 303.15	8 267.43	25 520.70	6 515.02	NO	NO
1990	406 137.77	35 301.53	3 255.54	25 744.33	6 301.67	NO	NO
1995	280 421.90	26 167.27	904.12	22 289.37	2 973.79	0.0019	NO

GHG (Gg)	TJ	CRT 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2000	243 184.91	23 316.60	292.09	20 857.88	2 166.62	NO	NO
2005	271 362.80	26 276.24	336.03	23 983.71	1 956.50	NO	NO
2010	316 032.41	30 597.87	841.79	27 596.32	2 159.60	0.1539	NO
2011	362 026.24	35 403.37	424.35	32 691.40	2 287.10	0.5168	NO
2012	314 344.18	30 599.69	627.42	27 748.04	2 223.93	0.3002	NO
2013	273 363.45	26 327.47	669.88	23 546.53	2 110.76	0.2997	NO
2014	290 518.57	28 102.00	746.46	25 337.56	2 016.85	1.1319	NO
2015	295 634.38	28 947.07	665.49	26 422.11	1 858.42	1.0570	NO
2016	263 865.22	25 523.89	839.30	22 855.69	1 825.82	3.0821	NO
2017	275 253.81	26 783.16	499.78	24 414.20	1 867.21	1.9679	NO
2018	247 713.71	22 709.51	59.89	20 771.14	1 848.41	30.0699	NO
2019	226 743.63	21 553.45	48.87	19 625.57	1 841.38	37.6317	NO
2020	186 642.19	17 110.95	38.62	15 115.62	1 923.05	33.6687	NO
2021	233 822.88	21 381.99	68.60	18 903.87	2 354.11	55.4063	NO
2022	276 138.67	25 985.59	109.45	23 994.04	1 837.16	44.9476	NO
2023	164 890.25	14 807.21	54.63	12 978.39	1 736.86	37.3230	NO
Decrease 1988-2023	64.8%	63.3%	99.3%	49.1%	73.3%	-	-
Decrease 1990-2023	59.4%	58.1%	98.3%	49.6%	72.4%	-	-
Decrease 2022-2023	40.3%	43.0%	50.1%	45.9%	5.5%	17.0%	-

3.3.10.2 Petroleum refining (CRT 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.

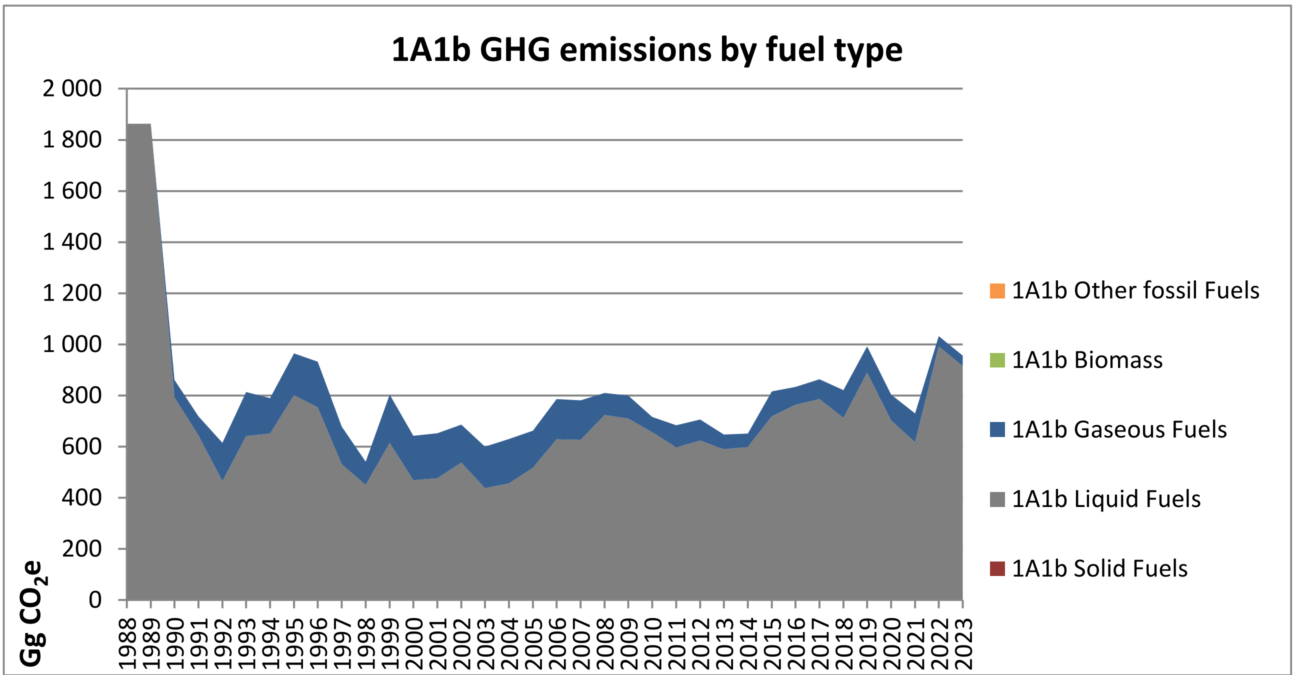


Figure 27 GHG emissions from CRT 1.A.1.b Petroleum refining

For the year 2023 the share of this subcategory from sector 1A Fuel Combustion is 2.9%, which is equivalent to 1.6% 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 decrease of emissions from fuels after 2020 is due mostly to the pandemic situation.

Table 39 CO_2 emissions in CRT 1.A.1.b Petroleum refining

CO_2 (Gg)	CRT 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	859.81	791.15	NO	68.66	NO	NO
1995	963.04	798.99	NO	164.06	NO	NO
2000	641.36	468.22	NO	173.15	NO	NO
2005	660.66	516.13	NO	144.53	NO	NO
2010	715.04	655.18	NO	59.86	NO	NO
2011	682.66	596.96	NO	85.70	NO	NO
2012	704.95	622.83	NO	82.12	NO	NO
2013	646.84	588.94	NO	57.90	NO	NO
2014	649.71	598.37	NO	51.34	NO	NO
2015	814.97	717.90	NO	97.08	NO	NO
2016	832.67	762.97	NO	69.70	NO	NO
2017	862.10	785.04	NO	77.06	NO	NO
2018	820.62	711.33	NO	109.29	NO	NO
2019	991.48	888.49	NO	102.99	NO	NO
2020	803.05	701.36	NO	101.69	NO	NO
2021	728.71	617.18	NO	111.53	NO	NO
2022	1 031.49	991.10	NO	40.39	NO	NO
2023	954.80	913.80	NO	40.99	NO	NO
Decrease 1988-2023	48.6%	50.8%	-	-	-	-
Decrease 1990-2023	-11.0%	-15.5%	-	40.3%	-	-
Decrease 2022-2023	7.4%	7.8%	-	-1.5%	-	-

Table 40 CH_4 emissions in CRT 1.A.1.b Petroleum refining

CH_4 (Gg)	CRT 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
2020	0.0143	0.0125	NO	0.0018	NO	NO
2021	0.0130	0.0109	NO	0.0020	NO	NO
2022	0.0176	0.0169	NO	0.0007	NO	NO
2023	0.0172	0.0165	NO	0.0007	NO	NO
Decrease 1988-2023	76.0%	77.1%	-	-	-	-
Decrease 1990-2023	22.6%	21.6%	-	40.5%	-	-
Decrease 2022-2023	2.2%	2.4%	-	-2.2%	-	-

Table 41 N_2O emissions in CRT 1.A.1.b Petroleum refining

N_2O (Gg)	CRT 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

N_2O (Gg)	CRT 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
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
2020	0.0015	0.0013	NO	0.0002	NO	NO
2021	0.0013	0.0011	NO	0.0002	NO	NO
2022	0.0018	0.0018	NO	0.0001	NO	NO
2023	0.0019	0.0019	NO	0.0001	NO	NO
Decrease 1988-2023	86.6%	87.1%	-	-	-	-
Decrease 1990-2023	45.8%	46.0%	-	40.5%	-	-
Decrease 2022-2023	-5.3%	-5.4%	-	-2.2%	-	-

Table 42 GHG emissions in CRT 1.A.1.b Petroleum refining

GHG (Gg)	TJ	CRT 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	24 000.00	1 863.43	1 863.43	NO	NO	NO	NO
1990	13 493.80	861.37	792.64	NO	68.73	NO	NO
1995	15 051.80	964.86	800.64	NO	164.22	NO	NO
2000	10 206.50	642.51	469.19	NO	173.32	NO	NO
2005	10 679.95	661.87	517.20	NO	144.67	NO	NO
2010	12 061.03	715.99	656.08	NO	59.92	NO	NO
2011	11 623.22	683.52	597.73	NO	85.78	NO	NO
2012	11 922.62	705.84	623.64	NO	82.20	NO	NO
2013	10 957.69	647.63	589.67	NO	57.96	NO	NO
2014	10 286.56	650.40	599.02	NO	51.39	NO	NO
2015	14 089.36	815.95	718.77	NO	97.17	NO	NO
2016	14 416.58	833.65	763.88	NO	69.77	NO	NO
2017	14 807.18	863.13	785.99	NO	77.14	NO	NO
2018	14 382.69	821.55	712.15	NO	109.40	NO	NO
2019	17 159.19	992.43	889.35	NO	103.09	NO	NO
2020	14 086.26	803.84	702.05	NO	101.79	NO	NO
2021	12 658.21	729.43	617.79	NO	111.64	NO	NO
2022	17 218.59	1 032.46	992.03	NO	40.43	NO	NO
2023	15 913.50	955.79	914.76	NO	41.03	NO	NO
Decrease 1988-2023	33.7%	48.7%	50.9%	-	-	-	-
Decrease 1990-2023	-17.9%	-11.0%	-15.4%	-	40.3%	-	-
Decrease 2022-2023	7.6%	7.4%	7.8%	-	-1.5%	-	-

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 CRT subcategory 1.A.1.b were reallocated under CRT subcategory 1.B.2.a.4. Similarly, the GHG emissions from hydrogen production, which were previously reported under CRT subcategory 1.A.1.b were reallocated under CRT subcategory 1.B.2.c.2.i.

3.3.10.3 Manufacture of Solid Fuels and Other Energy Industries (CRT 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).

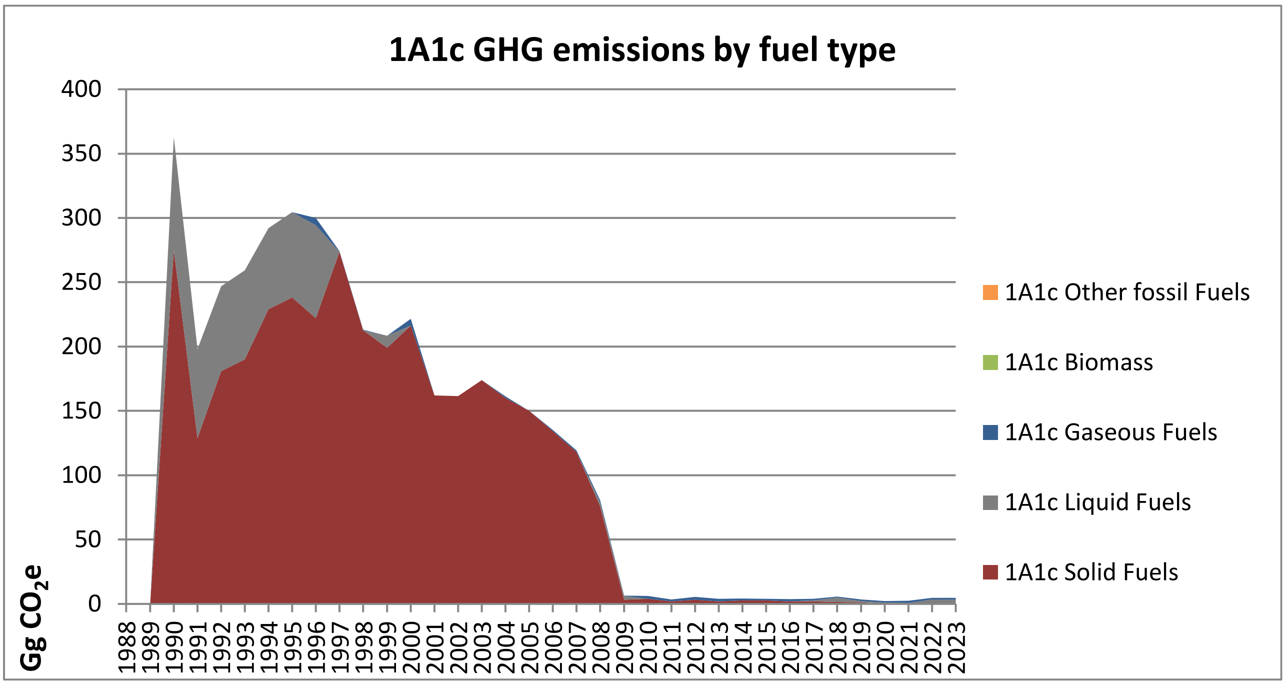


Figure 28 GHG emissions from 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

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 43 CO_2 emissions in CRT 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

CO_2 (Gg)	CRT 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
2020	2.16	0.70	0.16	1.30	NO	NO
2021	2.47	0.54	0.08	1.85	NO	NO
2022	4.66	3.28	0.06	1.33	NO	NO
2023	4.57	3.11	0.05	1.41	NO	NO
Decrease 1988-2023	-	-	-	-	-	-
Decrease 1990-2023	98.7%	96.5%	100.0%	-	-	-
Decrease 2022-2023	2.1%	5.2%	11.1%	-5.9%	-	-

Table 44 CH_4 emissions in CRT 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

CH_4 (Gg)	CRT 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
2020	0.0000	0.0000	0.0000	0.0000	NO	NO
2021	0.0000	0.0000	0.0000	0.0000	NO	NO
2022	0.0001	0.0001	0.0000	0.0000	NO	NO
2023	0.0002	0.0001	0.0000	0.0000	NO	NO
Decrease 1988-2023	-	-	-	-	-	-
Decrease 1990-2023	98.4%	96.5%	100.0%	-	-	-
Decrease 2022-2023	-1.9%	-1.0%	10.3%	-6.6%	-	-

Table 45 N_2O emissions in CRT 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

N_2O (Gg)	CRT 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
2020	0.0000	0.0000	0.0000	0.0000	NO	NO
2021	0.0000	0.0000	0.0000	0.0000	NO	NO
2022	0.0000	0.0000	0.0000	0.0000	NO	NO
2023	0.0000	0.0000	0.0000	0.0000	NO	NO
Decrease 1988-2023	-	-	-	-	-	-
Decrease 1990-2023	98.3%	96.5%	99.9%	-	-	-
Decrease 2022-2023	-3.1%	-3.3%	10.3%	-6.6%	-	-

Table 46 GHG emissions in 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

GHG (Gg)	TJ	CRT 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	362.93	88.05	274.87	NO	NO	NO

GHG (Gg)	TJ	CRT 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1995	5 928.39	304.36	66.04	238.32	NO	NO	NO
2000	4 549.15	221.69	NO	216.41	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	5.27	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	1.85	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
2020	35.77	2.17	0.71	0.16	1.30	NO	NO
2021	42.46	2.47	0.54	0.08	1.85	NO	NO
2022	69.54	4.67	3.29	0.06	1.33	NO	NO
2023	68.00	4.58	3.12	0.05	1.41	NO	NO
Decrease 1988-2023	-	-	-	-	-	-	-
Decrease 1990-2023	99.0%	98.7%	96.5%	100.0%	-	-	-
Decrease 2022-2023	2.2%	2.1%	5.2%	11.1%	-5.9%	-	-

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

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

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

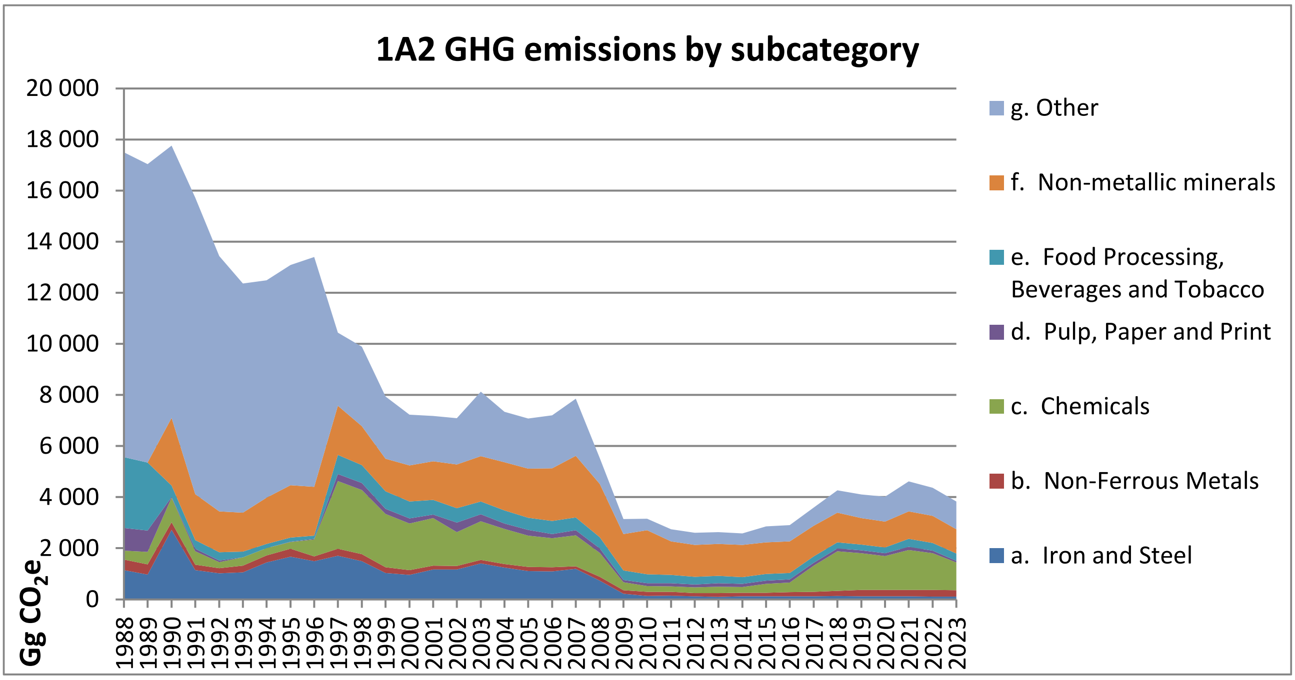


Figure 29 Total GHG emissions from 1.A.2 Manufacturing Industries and Construction by subcategory

Following the restructuring of the industry sector of the country, the general trend in CRT category 1.A.2 shows an emission decrease of 78.1% compared to base year and a decrease of 12.3% 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 increasing since 2015.

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

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

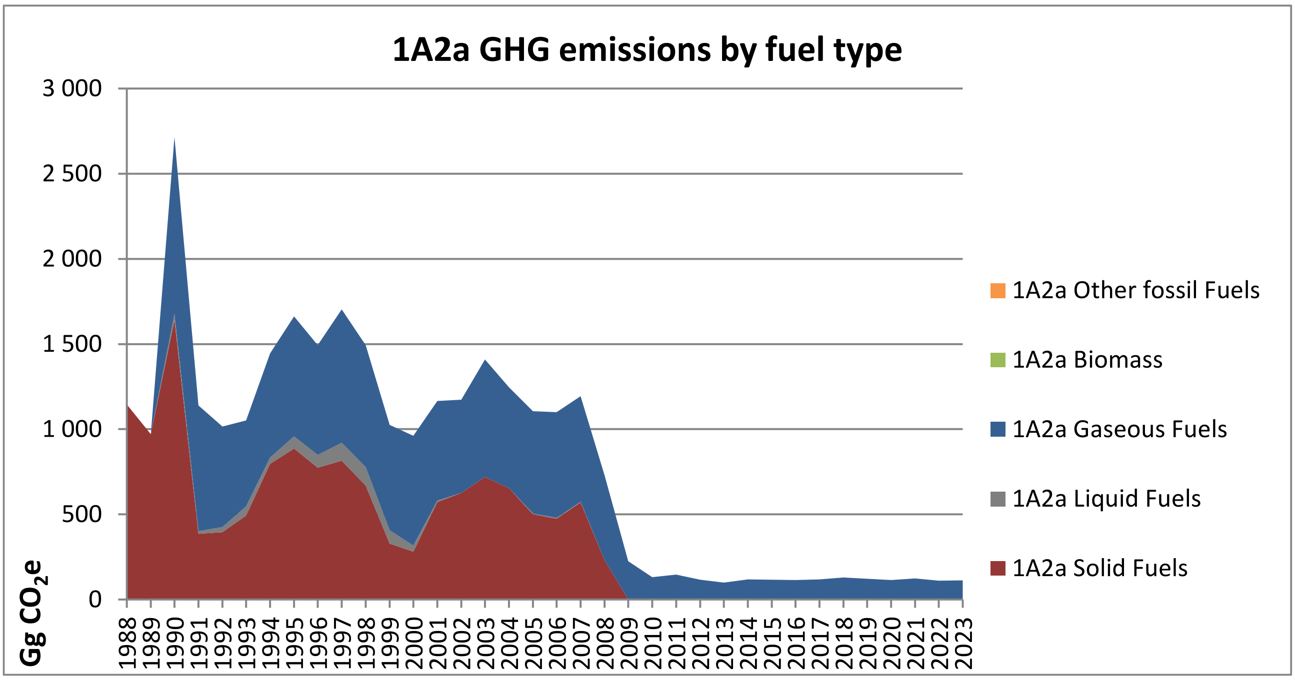


Figure 30 GHG emissions from 1.A.2.a. Iron and Steel

For the year 2023 the share of this subcategory from sector 1A Fuel Combustion is 0.4% , 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 47 CO_2 emissions in CRT 1.A.2.a. Iron and Steel

CO_2 (Gg)	CRT 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
2020	114.89	0.54	0.05	114.30	0.0951	NO
2021	123.43	0.70	0.05	122.67	0.0665	NO

CO_2 (Gg)	CRT 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2022	110.86	0.56	0.05	110.25	0.0426	NO
2023	111.69	0.63	NO	111.06	0.0264	NO
Decrease 1988-2023	90.2%	-	-	-	-	-
Decrease 1990-2023	95.9%	98.3%	-	89.3%	-	-
Decrease 2022-2023	-0.8%	-13.1%	-	-0.7%	37.9%	-

Table 48 CH_4 emissions in CRT 1.A.2.a. Iron and Steel

CH_4 (Gg)	CRT 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
2020	0.0021	0.0000	0.0000	0.0021	0.0000	NO
2021	0.0023	0.0000	0.0000	0.0022	0.0000	NO
2022	0.0020	0.0000	0.0000	0.0020	0.0000	NO
2023	0.0020	0.0000	NO	0.0020	0.0000	NO
Decrease 1988-2023	97.3%	-	-	-	-	-
Decrease 1990-2023	98.8%	99.1%	-	89.3%	-	-
Decrease 2022-2023	-1.0%	-11.3%	-	-1.4%	37.9%	-

Table 49 N_2O emissions in CRT 1.A.2.a. Iron and Steel

N_2O (Gg)	CRT 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
2020	0.0002	0.0000	0.0000	0.0002	0.0000	NO
2021	0.0002	0.0000	0.0000	0.0002	0.0000	NO

N_2O (Gg)	CRT 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2022	0.0002	0.0000	0.0000	0.0002	0.0000	NO
2023	0.0002	0.0000	NO	0.0002	0.0000	NO
Decrease 1988-2023	98.1%	-	-	-	-	-
Decrease 1990-2023	99.2%	99.4%	-	89.3%	-	-
Decrease 2022-2023	-0.8%	-9.7%	-	-1.4%	37.9%	-

Table 50 GHG emissions in CRT 1.A.2.a. Iron and Steel

GHG (Gg)	TJ	CRT 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	16 396.80	1 146.11	NO	1 146.11	NO	NO	NO
1990	35 474.30	2 716.35	37.46	1 640.86	1 038.03	NO	NO
1995	23 228.68	1 663.04	71.78	886.73	704.52	0.0057	NO
2000	16 535.12	961.27	37.31	280.37	643.59	0.0057	NO
2005	16 753.11	1 106.66	6.26	499.76	600.63	0.0095	NO
2010	2 372.60	131.09	NO	NO	131.08	0.0038	NO
2011	2 645.30	146.22	NO	NO	146.22	0.0038	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	0.0038	NO
2017	2 134.99	118.73	0.79	0.25	117.70	0.0029	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
2020	2 068.76	115.00	0.54	0.05	114.41	0.0016	NO
2021	2 222.86	123.55	0.70	0.06	122.79	0.0011	NO
2022	1 986.28	110.97	0.56	0.06	110.35	0.0007	NO
2023	2 014.69	111.80	0.63	NO	111.17	0.0004	NO
Decrease 1988-2023	87.7%	90.2%	-	-	-	-	-
Decrease 1990-2023	94.3%	95.9%	98.3%	-	89.3%	-	-
Decrease 2022-2023	-1.4%	-0.8%	-13.1%	-	-0.7%	37.9%	-

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 (CRT 1.A.2.b.)

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

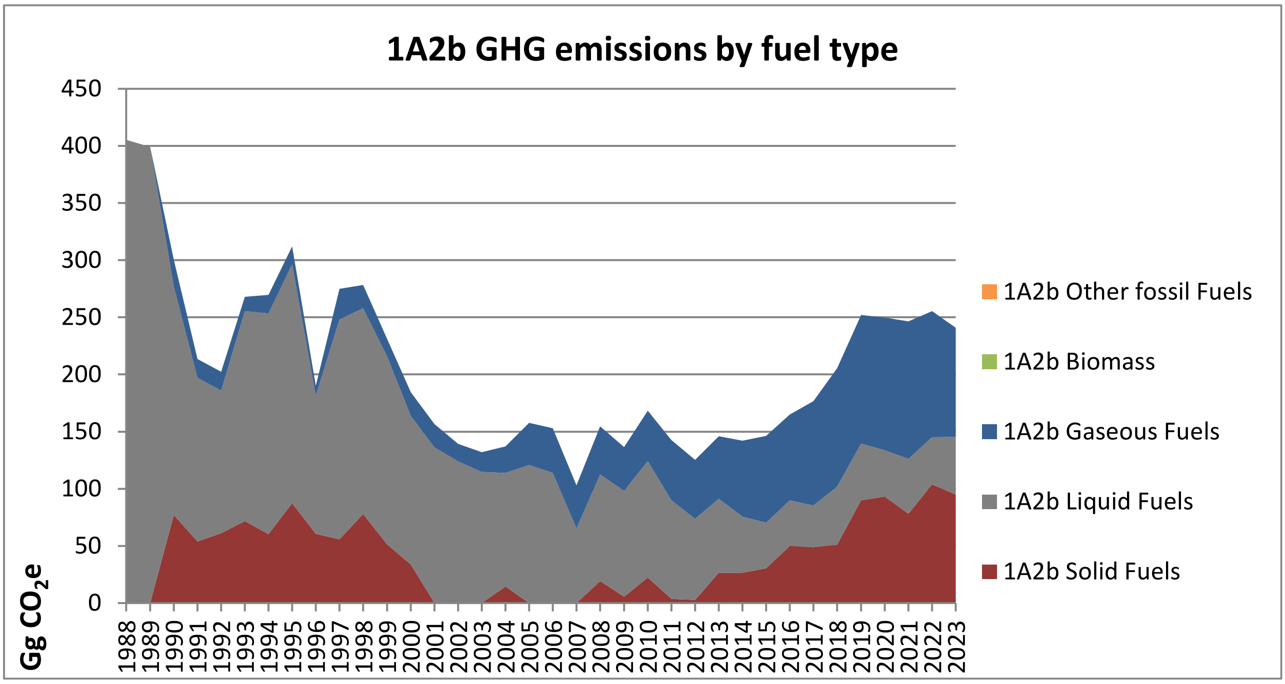


Figure 31 GHG emissions from CRT 1.A.2.b. Non-Ferrous Metals

The share of this subcategory from sector 1.A is 0.8% for the year 2023, which is equivalent to 0.4% of the total GHG emissions.

Table 51 CO_2 emissions in CRT 1.A.2.b. Non-Ferrous Metals

CO_2 (Gg)	CRT 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
2020	249.06	40.47	92.63	115.96	0.0081	NO
2021	245.78	48.14	77.49	120.15	0.0451	NO
2022	254.46	41.09	103.26	110.10	0.0298	NO
2023	239.94	50.35	94.23	95.37	0.0170	NO
Decrease 1988-2023	40.6%	87.5%	-	-	-	-
Decrease 1990-2023	19.8%	74.7%	-23.2%	-307.5%	-	-
Decrease 2022-2023	5.7%	-22.5%	8.8%	13.4%	42.9%	-

Table 52 CH_4 emissions in CRT 1.A.2.b. Non-Ferrous Metals

CH_4 (Gg)	CRT 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

CH_4 (Gg)	CRT 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
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
2020	0.0121	0.0014	0.0087	0.0021	0.0000	NO
2021	0.0111	0.0017	0.0072	0.0022	0.0000	NO
2022	0.0129	0.0013	0.0097	0.0020	0.0000	NO
2023	0.0122	0.0016	0.0088	0.0017	0.0000	NO
Decrease 1988-2023	23.0%	89.6%	-	-	-	-
Decrease 1990-2023	21.6%	79.3%	-22.0%	-306.1%	-	-
Decrease 2022-2023	6.0%	-24.8%	8.8%	12.8%	42.9%	-

Table 53 N_2O emissions in CRT 1.A.2.b. Non-Ferrous Metals

N_2O (Gg)	CRT 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
2020	0.0018	0.0003	0.0013	0.0002	0.0000	NO
2021	0.0016	0.0003	0.0011	0.0002	0.0000	NO
2022	0.0019	0.0002	0.0014	0.0002	0.0000	NO
2023	0.0018	0.0003	0.0013	0.0002	0.0000	NO
Decrease 1988-2023	42.9%	90.2%	-	-	-	-
Decrease 1990-2023	33.3%	80.4%	-22.0%	-306.1%	-	-
Decrease 2022-2023	4.7%	-26.1%	8.8%	12.8%	42.9%	-

Table 54 GHG emissions in CRT 1.A.2.b. Non-Ferrous Metals

GHG (Gg)	TJ	CRT 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	5 267.60	405.34	405.34	NO	NO	NO	NO
1990	3 774.83	300.31	199.94	76.95	23.42	NO	NO
1995	3 876.91	312.25	209.09	87.42	15.72	0.0323	NO
2000	2 383.18	184.58	130.04	33.80	20.74	0.0038	NO
2005	2 238.90	157.57	120.72	NO	36.85	NO	NO

GHG (Gg)	TJ	CRT 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2010	2 347.07	168.41	101.93	22.34	44.14	0.0019	NO
2011	2 128.19	142.72	86.40	3.46	52.87	NO	NO
2012	1 899.14	125.19	70.87	2.75	51.57	NO	NO
2013	2 092.11	145.91	64.62	26.58	54.72	NO	NO
2014	2 103.23	142.03	49.13	26.48	66.42	NO	NO
2015	2 185.40	146.22	39.77	30.47	75.97	NO	NO
2016	2 352.66	164.99	39.77	50.03	75.18	NO	NO
2017	2 590.59	176.72	36.54	48.91	91.27	NO	NO
2018	3 021.83	205.54	50.71	51.12	103.70	NO	NO
2019	3 514.94	251.99	49.53	89.94	112.52	0.0008	NO
2020	3 494.89	249.86	40.57	93.21	116.08	0.0001	NO
2021	3 526.01	246.52	48.27	77.98	120.27	0.0008	NO
2022	3 484.82	255.32	41.19	103.92	110.21	0.0005	NO
2023	3 262.95	240.76	50.47	94.82	95.46	0.0003	NO
Decrease 1988-2023	38.1%	40.6%	87.5%	-	-	-	-
Decrease 1990-2023	13.6%	19.8%	74.8%	-23.2%	-307.5%	-	-
Decrease 2022-2023	6.4%	5.7%	-22.5%	8.8%	13.4%	42.9%	-

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 (CRT 1.A.2.c.)

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

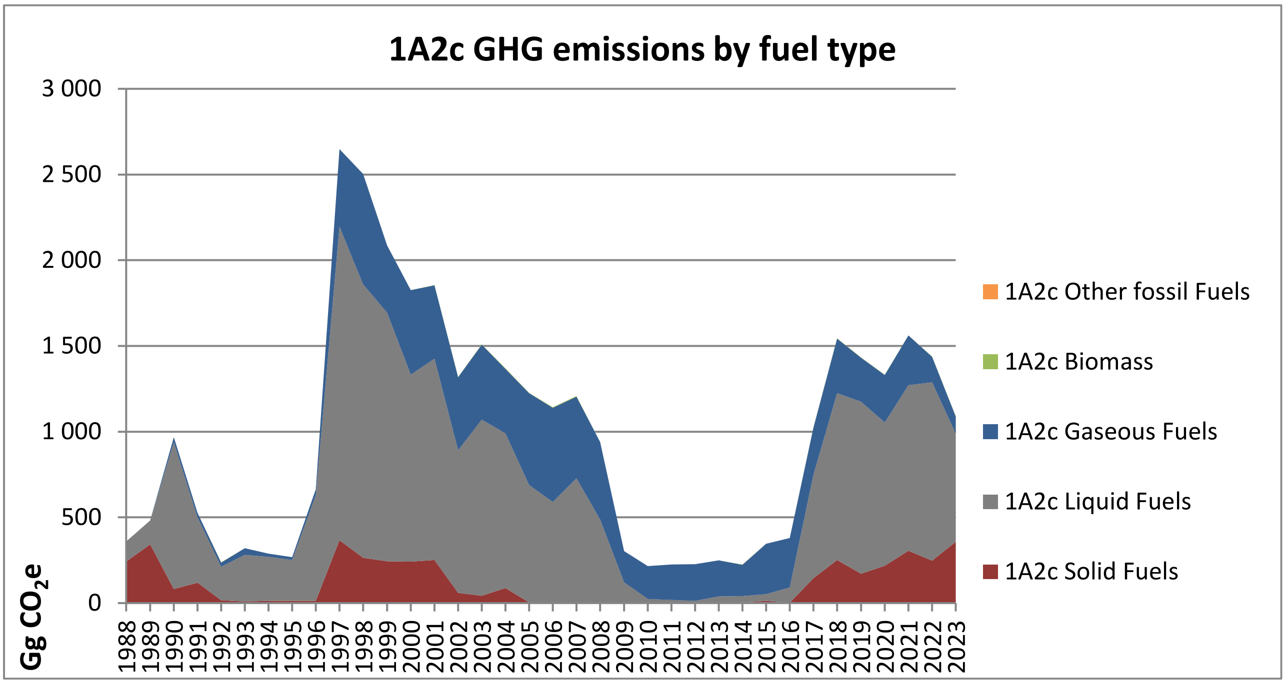


Figure 32 GHG emissions from CRT 1.A.2.c. Chemicals

The share of this subcategory from sector 1.A is 3.5% for the year 2023, which is equivalent to 1.9% 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 55 CO_2 emissions in CRT 1.A.2.c. Chemicals

CO_2 (Gg)	CRT 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	356.63	116.80	239.84	NO	NO	NO
1990	965.52	854.91	80.38	30.23	NO	NO
1995	267.25	238.18	11.56	17.51	0.2240	NO
2000	1 820.83	1 089.77	239.06	492.01	7.9520	NO
2005	1 221.59	684.19	2.21	535.19	189.3920	NO
2010	215.65	24.13	NO	191.52	0.2240	NO
2011	223.71	17.94	NO	205.77	0.1120	NO
2012	225.87	12.46	NO	213.41	0.2240	NO
2013	248.39	38.39	NO	210.00	3.9200	NO
2014	223.43	37.74	2.36	183.33	31.8080	NO
2015	344.97	39.93	12.30	292.74	50.7360	NO
2016	378.74	90.82	0.48	287.44	3.6960	NO
2017	1 020.50	602.41	143.16	274.93	64.1869	NO
2018	1 538.58	971.40	249.36	317.82	30.9213	NO
2019	1 427.41	1 002.41	168.66	256.34	59.2321	NO
2020	1 327.38	833.97	214.60	278.81	51.8222	NO
2021	1 556.46	965.00	301.42	290.05	40.0677	NO
2022	1 432.94	1 036.74	245.87	150.32	60.8724	NO
2023	1 085.10	630.67	353.32	101.12	60.3835	NO
Decrease 1988-2023	-204.3%	-440.0%	-47.3%	-	-	-
Decrease 1990-2023	-12.4%	26.2%	-339.6%	-234.5%	-	-
Decrease 2022-2023	24.3%	39.2%	-43.7%	32.7%	0.8%	-

Table 56 CH_4 emissions in CRT 1.A.2.c. Chemicals

CH_4 (Gg)	CRT 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	0.0557	0.0177	0.0158	0.0050	0.0172	NO
2018	0.0723	0.0301	0.0281	0.0057	0.0083	NO
2019	0.0702	0.0307	0.0190	0.0046	0.0159	NO
2020	0.0695	0.0248	0.0257	0.0050	0.0139	NO
2021	0.0799	0.0290	0.0349	0.0052	0.0107	NO

CH_4 (Gg)	CRT 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2022	0.0759	0.0307	0.0263	0.0027	0.0163	NO
2023	0.0756	0.0176	0.0400	0.0018	0.0162	NO
Decrease 1988-2023	-178.5%	-273.2%	-78.3%	-	-	-
Decrease 1990-2023	-150.4%	20.3%	-431.8%	-233.4%	-	-
Decrease 2022-2023	0.4%	42.5%	-52.2%	32.3%	0.8%	-

Table 57 N_2O emissions in CRT 1.A.2.c. Chemicals

N_2O (Gg)	CRT 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	0.0034	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
2020	0.0109	0.0047	0.0039	0.0005	0.0019	NO
2021	0.0127	0.0055	0.0052	0.0005	0.0014	NO
2022	0.0122	0.0058	0.0039	0.0003	0.0022	NO
2023	0.0116	0.0033	0.0060	0.0002	0.0022	NO
Decrease 1988-2023	-169.3%	-245.4%	-78.3%	-	-	-
Decrease 1990-2023	-147.1%	7.0%	-431.8%	-233.4%	-	-
Decrease 2022-2023	5.1%	44.1%	-52.2%	32.3%	0.8%	-

Table 58 GHG emissions in CRT 1.A.2.c. Chemicals

GHG (Gg)	TJ	CRT 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	3 817.68	358.54	117.18	241.36	NO	NO	NO
1990	14 774.60	967.61	856.46	80.89	30.26	NO	NO
1995	3 762.88	268.00	238.83	11.64	17.53	0.0038	NO
2000	27 881.70	1 825.49	1 092.14	240.73	492.49	0.1349	NO
2005	21 813.74	1 226.92	685.77	2.22	535.72	3.2129	NO
2010	3 821.21	215.90	24.19	NO	191.71	0.0038	NO
2011	3 996.80	223.95	17.97	NO	205.97	0.0019	NO
2012	4 032.82	226.13	12.50	NO	213.62	0.0038	NO
2013	4 442.69	248.73	38.45	NO	210.21	0.0665	NO
2014	4 187.91	224.22	37.79	2.37	183.51	0.5396	NO
2015	6 506.90	346.27	39.99	12.38	293.03	0.8607	NO
2016	6 773.86	379.19	90.92	0.49	287.72	0.0627	NO
2017	14 256.00	1 024.32	603.80	144.24	275.20	1.0889	NO
2018	19 692.97	1 543.73	973.80	251.27	318.14	0.5246	NO
2019	18 410.42	1 432.40	1 004.85	169.95	256.59	1.0048	NO
2020	17 943.89	1 332.22	835.92	216.34	279.08	0.8791	NO
2021	20 398.60	1 562.08	967.28	303.78	290.34	0.6797	NO
2022	17 989.14	1 438.31	1 039.15	247.65	150.47	1.0327	NO

GHG (Gg)	TJ	CRT 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2023	13 992.32	1 090.29	632.03	356.02	101.22	1.0244	NO
Decrease 1988-2023	-266.5%	-204.1%	-439.4%	-47.5%	-	-	-
Decrease 1990-2023	5.3%	-12.7%	26.2%	-340.1%	-234.5%	-	-
Decrease 2022-2023	22.2%	24.2%	39.2%	-43.8%	32.7%	0.8%	-

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 (CRT 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.

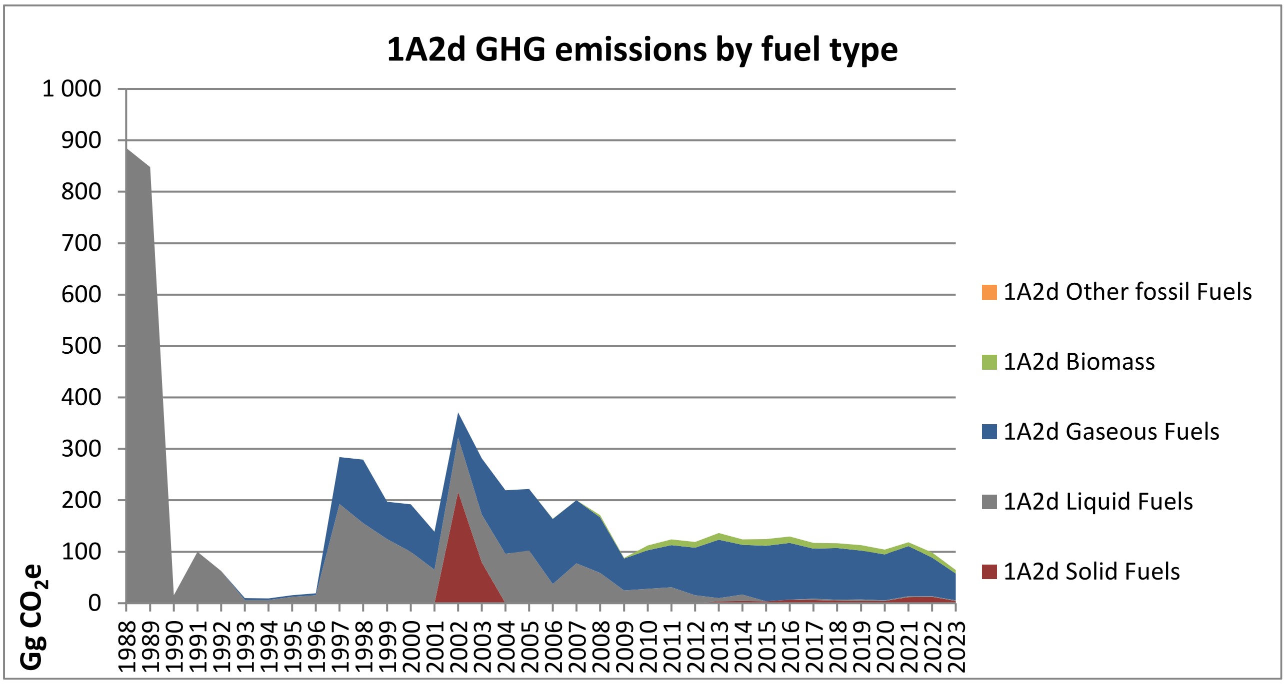


Figure 33 GHG emissions from CRT 1.A.2.d. Pulp, Paper and Print

The share of this subcategory from sector 1.A is 0.2% for 2023, which is equivalent to 0.1% of the total GHG emissions.

Table 59 CO_2 emissions in CRT 1.A.2.d. Pulp, Paper and Print

CO_2 (Gg)	CRT 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
2020	94.63	1.37	4.14	89.12	539.8357	NO
2021	110.25	1.47	11.32	97.45	439.3720	NO
2022	88.12	1.24	11.65	75.24	566.5673	NO
2023	57.63	1.16	4.07	52.40	397.0749	NO
Decrease 1988-2023	93.5%	99.9%	-	-	-	-
Decrease 1990-2023	-270.4%	92.5%	-	-	-	-
Decrease 2022-2023	34.6%	6.6%	65.1%	30.4%	29.9%	-

Table 60 CH_4 emissions in CRT 1.A.2.d. Pulp, Paper and Print

CH_4 (Gg)	CRT 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
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
2020	0.1466	0.0000	0.0004	0.0016	0.1446	NO
2021	0.1208	0.0000	0.0013	0.0018	0.1177	NO
2022	0.1544	0.0000	0.0012	0.0013	0.1518	NO
2023	0.1077	0.0000	0.0004	0.0009	0.1064	NO
Decrease 1988-2023	-215.0%	99.9%	-	-	-	-
Decrease 1990-2023	-17452.5%	95.7%	-	-	-	-
Decrease 2022-2023	30.2%	6.0%	67.4%	29.9%	29.9%	-

Table 61 N_2O emissions in CRT 1.A.2.d. Pulp, Paper and Print

N_2O (Gg)	CRT 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

N_2O (Gg)	CRT 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
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	0.0282	0.0000	0.0003	0.0002	0.0276	NO
2014	0.0226	0.0001	0.0004	0.0002	0.0219	NO
2015	0.0278	NO	0.0003	0.0002	0.0272	NO
2016	0.0269	NO	0.0006	0.0002	0.0261	NO
2017	0.0239	0.0000	0.0006	0.0002	0.0232	NO
2018	0.0203	0.0000	0.0005	0.0002	0.0196	NO
2019	0.0219	0.0000	0.0004	0.0002	0.0213	NO
2020	0.0199	0.0000	0.0004	0.0002	0.0193	NO
2021	0.0172	0.0000	0.0013	0.0002	0.0157	NO
2022	0.0216	0.0000	0.0012	0.0001	0.0202	NO
2023	0.0147	0.0000	0.0004	0.0001	0.0142	NO
Decrease 1988-2023	-114.7%	99.9%	-	-	-	-
Decrease 1990-2023	-11862.8%	96.8%	-	-	-	-
Decrease 2022-2023	32.1%	5.6%	67.4%	29.9%	29.9%	-

Table 62 GHG emissions in CRT 1.A.2.d. Pulp, Paper and Print

GHG (Gg)	TJ	CRT 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	11 400.00	885.13	885.13	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	0.0038	NO
2000	2 967.20	192.47	99.42	NO	93.05	0.0019	NO
2005	3 771.27	222.21	102.50	NO	119.16	0.5567	NO
2010	6 543.50	112.02	27.95	NO	74.90	9.1751	NO
2011	7 770.10	123.86	31.06	NO	81.60	11.2005	NO
2012	7 673.20	118.94	15.53	NO	92.39	11.0219	NO
2013	9 054.56	136.30	6.21	3.46	113.52	13.0986	NO
2014	7 413.95	123.95	12.42	4.26	96.88	10.3854	NO
2015	8 772.00	124.31	NO	3.73	107.64	12.9276	NO
2016	8 560.20	129.68	NO	6.84	110.47	12.3747	NO
2017	7 633.64	116.88	2.68	6.00	97.21	10.9984	NO
2018	6 782.83	116.34	1.41	5.02	100.60	9.3166	NO
2019	7 112.42	112.52	2.78	4.30	95.34	10.1044	NO
2020	6 486.99	103.99	1.37	4.26	89.21	9.1579	NO
2021	5 832.91	118.19	1.48	11.71	97.55	7.4536	NO
2022	6 550.91	98.17	1.24	12.01	75.31	9.6114	NO
2023	4 549.40	64.53	1.16	4.19	52.45	6.7361	NO
Decrease 1988-2023	60.1%	92.7%	99.9%	-	-	-	-
Decrease 1990-2023	-2123.6%	-313.5%	92.6%	-	-	-	-
Decrease 2022-2023	30.6%	34.3%	6.6%	65.2%	30.4%	29.9%	-

3.3.11.5 Food Processing, Beverages and Tobacco (CRT 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.

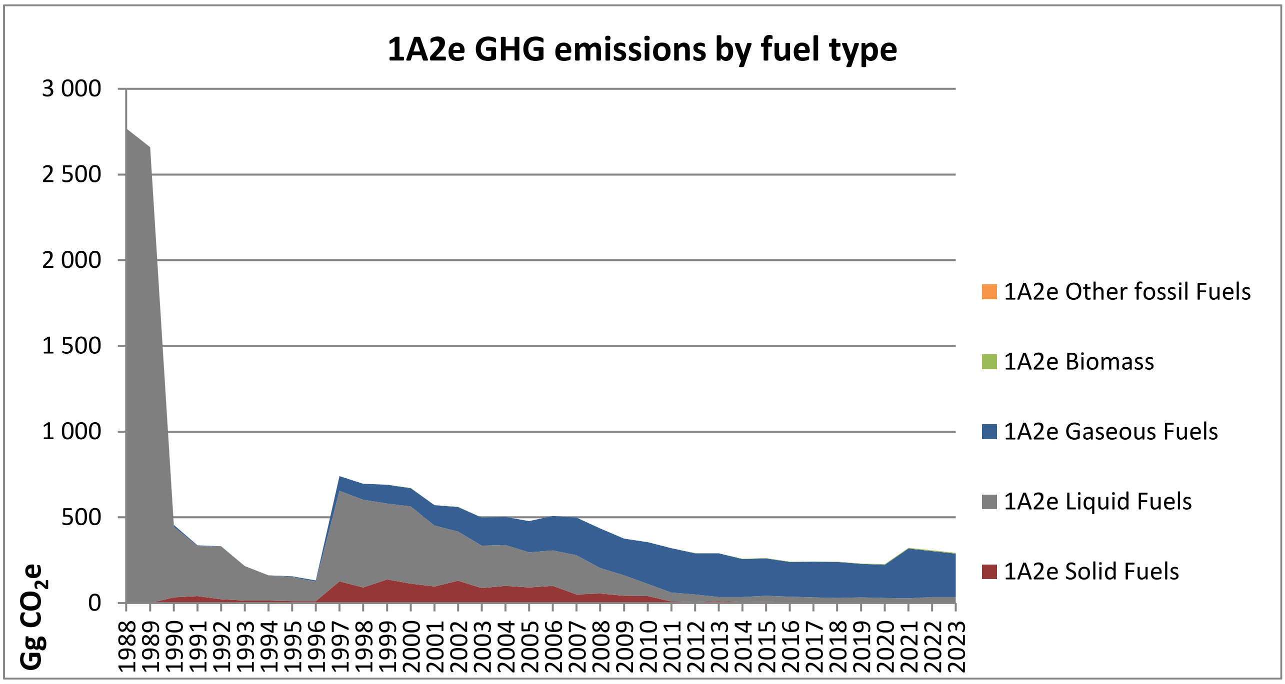


Figure 34 GHG emissions from 1.A.2.e. Food Processing, Beverages and Tobacco

The share of this subcategory from sector 1.A is 0.9% for 2023, which is equivalent to 0.5% of total GHG emissions.

Table 63 CO_2 emissions in CRT 1.A.2.e. Food Processing, Beverages and Tobacco

CO_2 (Gg)	CRT 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
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
2020	222.88	25.23	3.60	194.04	173.7579	NO
2021	318.01	22.76	4.09	291.17	149.2439	NO
2022	302.88	29.23	5.41	268.24	155.7400	NO
2023	288.28	30.67	4.15	253.45	135.3688	NO
Decrease 1988-2023	89.6%	98.9%	-	-	-	-
Decrease 1990-2023	36.4%	92.5%	87.4%	-2117.9%	-	-
Decrease 2022-2023	4.8%	-5.0%	23.2%	5.5%	13.1%	-

Table 64 CH_4 emissions in 1.A.2.e. Food Processing, Beverages and Tobacco

CH_4 (Gg)	CRT 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

CH_4 (Gg)	CRT 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
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
2020	0.0512	0.0008	0.0004	0.0035	0.0465	NO
2021	0.0464	0.0007	0.0005	0.0052	0.0400	NO
2022	0.0480	0.0009	0.0006	0.0048	0.0417	NO
2023	0.0422	0.0009	0.0004	0.0046	0.0363	NO
Decrease 1988-2023	61.0%	99.2%	-	-	-	-
Decrease 1990-2023	-113.5%	94.4%	86.2%	-2110.2%	-	-
Decrease 2022-2023	12.1%	-0.8%	20.8%	4.9%	13.1%	-

Table 65 N_2O emissions in 1.A.2.e. Food Processing, Beverages and Tobacco

N_2O (Gg)	CRT 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
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
2020	0.0068	0.0001	0.0001	0.0003	0.0062	NO
2021	0.0061	0.0001	0.0001	0.0005	0.0053	NO
2022	0.0063	0.0002	0.0001	0.0005	0.0056	NO
2023	0.0055	0.0002	0.0001	0.0005	0.0048	NO
Decrease 1988-2023	74.5%	99.2%	-	-	-	-
Decrease 1990-2023	-46.3%	95.0%	86.2%	-2110.2%	-	-
Decrease 2022-2023	12.2%	1.1%	20.8%	4.9%	13.1%	-

Table 66 GHG emissions in 1.A.2.e. Food Processing, Beverages and Tobacco

GHG (Gg)	TJ	CRT 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	36 011.40	2 769.46	2 769.46	NO	NO	NO	NO
1990	5 984.34	455.14	410.59	33.11	11.44	NO	NO
1995	2 045.98	155.36	140.77	11.12	3.43	0.0323	NO
2000	9 289.09	671.00	451.59	112.20	106.58	0.6251	NO
2005	7 078.26	477.89	204.78	90.56	182.22	0.3306	NO

GHG (Gg)	TJ	CRT 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2010	6 082.06	355.59	70.79	40.14	244.10	0.5605	NO
2011	5 690.71	319.28	51.95	9.02	257.89	0.4199	NO
2012	5 551.54	291.21	46.14	4.45	239.59	1.0336	NO
2013	5 600.49	290.73	24.56	10.42	254.68	1.0697	NO
2014	5 304.20	258.33	30.83	4.16	221.74	1.6017	NO
2015	5 613.63	261.75	33.96	7.50	218.10	2.2002	NO
2016	5 187.53	242.14	33.51	2.54	204.14	1.9380	NO
2017	4 588.44	240.93	30.11	3.18	207.19	0.4442	NO
2018	5 359.80	240.68	25.57	2.85	210.29	1.9685	NO
2019	4 639.86	229.35	26.78	5.70	195.85	1.0187	NO
2020	5 446.92	226.10	25.29	3.63	194.23	2.9477	NO
2021	6 947.22	320.92	22.81	4.12	291.45	2.5318	NO
2022	6 672.04	305.89	29.29	5.45	268.50	2.6420	NO
2023	6 268.07	290.92	30.74	4.18	253.70	2.2964	NO
Decrease 1988-2023	82.6%	89.5%	98.9%	-	-	-	-
Decrease 1990-2023	-4.7%	36.1%	92.5%	87.4%	-2117.9%	-	-
Decrease 2022-2023	6.1%	4.9%	-4.9%	23.2%	5.5%	13.1%	-

3.3.11.6 Non-metallic minerals (CRT 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).

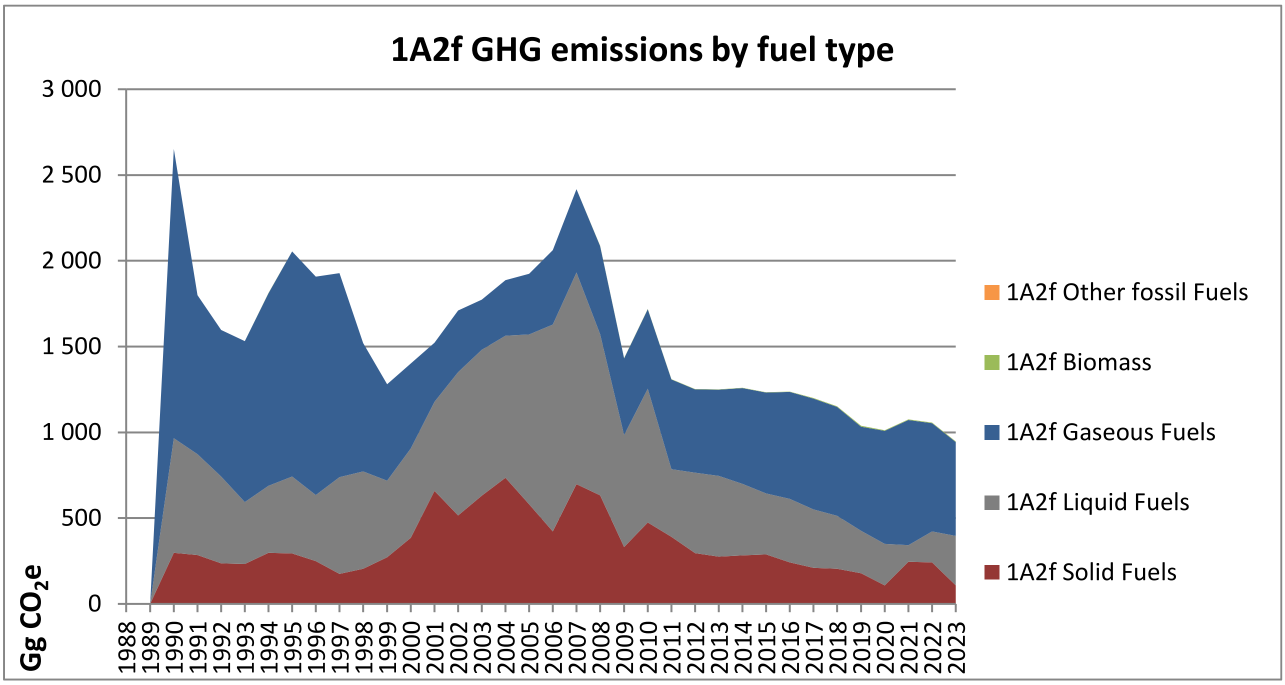


Figure 35 GHG emissions from 1.A.2.f. Non-metallic minerals

The share of this subcategory from sector 1.A is 3.0% for 2023, which is equivalent to 1.6% 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 67 CO_2 emissions in 1.A.2.f. Non-metallic minerals

CO_2 (Gg)	CRT 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	1 030.12	246.98	177.40	605.74	315.0580	NO
2020	1 006.57	241.65	106.90	658.02	222.9204	NO
2021	1 068.87	97.09	243.64	728.14	218.4346	NO
2022	1 049.98	181.64	238.95	629.40	225.7592	NO
2023	940.70	287.87	106.80	546.02	264.2979	NO
Decrease 1988-2023	-	-	-	-	-	-
Decrease 1990-2023	64.4%	56.8%	63.8%	67.6%	-	-
Decrease 2022-2023	10.4%	-58.5%	55.3%	13.2%	-17.1%	-

Table 68 CH_4 emissions in 1.A.2.f. Non-metallic minerals

CH_4 (Gg)	CRT 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	0.1228	0.0080	0.0195	0.0109	0.0844	NO
2020	0.0916	0.0078	0.0122	0.0119	0.0597	NO
2021	0.1000	0.0031	0.0252	0.0131	0.0585	NO
2022	0.1005	0.0045	0.0242	0.0113	0.0605	NO
2023	0.0997	0.0076	0.0115	0.0099	0.0708	NO
Decrease 1988-2023	-	-	-	-	-	-
Decrease 1990-2023	-16.3%	70.5%	61.1%	67.7%	-	-
Decrease 2022-2023	0.7%	-66.4%	52.3%	12.7%	-17.1%	-

Table 69 N_2O emissions in 1.A.2.f. Non-metallic minerals

N_2O (Gg)	CRT 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	0.0169	0.0016	0.0029	0.0011	0.0113	NO
2020	0.0125	0.0016	0.0018	0.0012	0.0080	NO
2021	0.0135	0.0006	0.0038	0.0013	0.0078	NO
2022	0.0136	0.0008	0.0036	0.0011	0.0081	NO
2023	0.0135	0.0013	0.0017	0.0010	0.0094	NO
Decrease 1988-2023	-	-	-	-	-	-
Decrease 1990-2023	-7.3%	73.5%	61.1%	67.7%	-	-
Decrease 2022-2023	0.7%	-73.4%	52.3%	12.7%	-17.1%	-

Table 70 GHG emissions in CRT 1.A.2.f. Non-metallic minerals

GHG (Gg)	TJ	CRT 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	2 651.54	668.50	297.29	1 685.75	NO	NO
1995	32 659.47	2 055.32	447.31	294.23	1 313.75	0.0266	NO
2000	18 825.47	1 401.65	521.42	384.98	495.24	0.0114	NO
2005	22 845.24	1 923.57	989.64	581.04	352.86	0.0322	NO
2010	22 307.72	1 719.41	780.09	473.42	464.72	1.1894	NO
2011	18 324.45	1 309.81	394.36	390.78	523.74	0.9276	NO
2012	17 834.21	1 251.82	469.39	295.82	484.80	1.8068	NO
2013	17 916.26	1 250.26	471.60	274.44	502.38	1.8468	NO
2014	18 135.10	1 259.38	418.07	281.69	558.28	1.3298	NO
2015	18 222.31	1 233.87	354.94	288.65	588.74	1.5433	NO
2016	18 859.20	1 237.72	371.33	241.41	622.66	2.3244	NO
2017	18 928.94	1 199.78	339.53	210.68	646.94	2.6262	NO
2018	19 068.02	1 152.43	307.78	204.85	635.87	3.9235	NO
2019	18 373.20	1 038.03	247.62	178.72	606.34	5.3447	NO
2020	17 713.51	1 012.45	242.28	107.72	658.66	3.7817	NO
2021	18 687.81	1 075.25	97.34	245.35	728.86	3.7056	NO
2022	18 119.33	1 056.40	181.97	240.58	630.01	3.8298	NO
2023	17 003.25	947.07	288.44	107.58	546.56	4.4836	NO
Decrease 1988-2023	-	-	-	-	-	-	-
Decrease 1990-2023	59.8%	64.3%	56.9%	63.8%	67.6%	-	-
Decrease 2022-2023	6.2%	10.3%	-58.5%	55.3%	13.2%	-17.1%	-

3.3.11.7 Other (CRT 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)

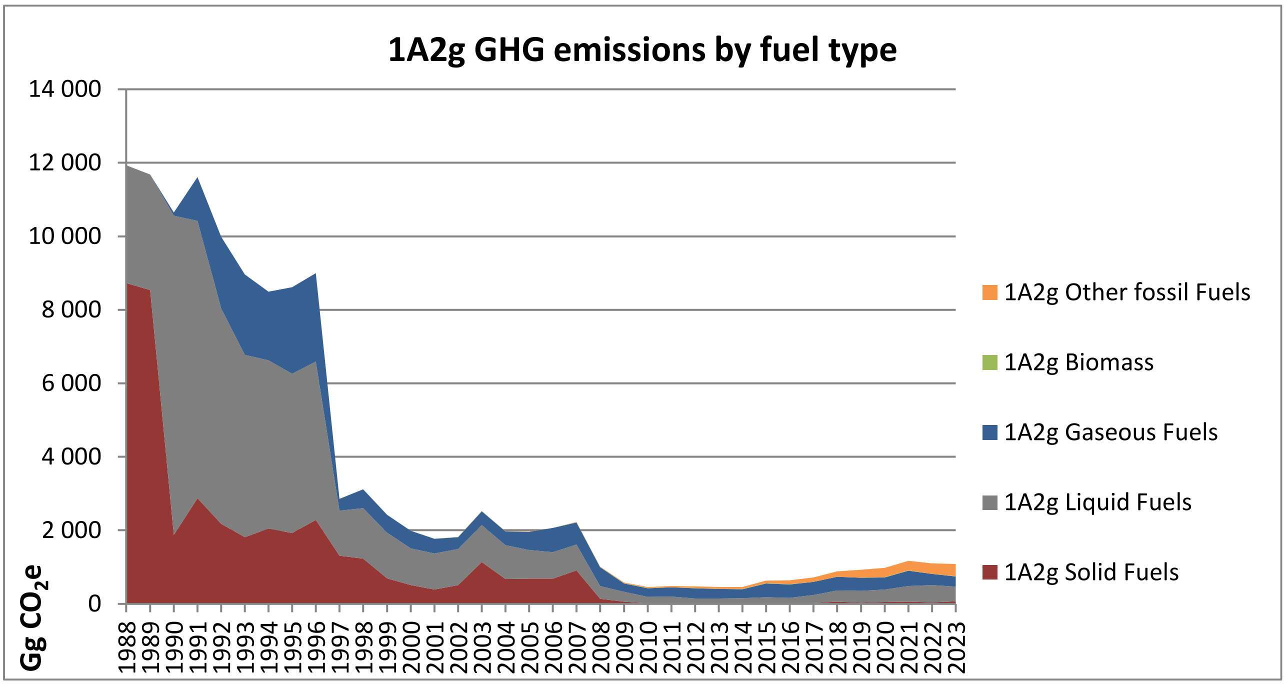


Figure 36 GHG emissions from 1.A.2.g. Other industries

The share of this subcategory from sector 1.A is 3.5% for 2023, which is equivalent to 1.9% 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 71 CO_2 emissions in 1.A.2.g. Other industries

CO_2 (Gg)	CRT 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	10 579.09	8 631.98	1 858.13	88.98	NO	NO
1995	8 571.82	4 311.84	1 909.43	2 350.55	134.9600	NO
2000	1 974.33	990.07	510.62	473.64	128.1280	NO
2005	1 949.59	768.21	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

CO_2 (Gg)	CRT 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
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	613.94	157.05	15.81	372.78	352.0846	68.2941
2016	624.92	143.13	13.24	365.28	338.2638	103.2707
2017	706.40	206.29	24.35	357.68	335.4148	118.0783
2018	867.74	295.83	56.18	373.02	339.9084	142.7187
2019	904.14	311.84	32.71	353.98	386.4356	205.6115
2020	953.86	328.79	45.30	334.47	413.9092	245.3005
2021	1 149.94	419.53	57.43	414.39	453.3897	258.5989
2022	1 076.86	457.87	43.81	297.66	429.7477	277.5221
2023	1 057.64	386.51	64.65	281.12	416.7178	325.3612
Decrease 1988-2023	91.1%	87.8%	99.3%	-	-	-
Decrease 1990-2023	90.0%	95.5%	96.5%	-215.9%	-	-
Decrease 2022-2023	1.8%	15.6%	-47.6%	5.6%	3.0%	-17.2%

Table 72 CH_4 emissions in 1.A.2.g. Other industries

CH_4 (Gg)	CRT 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	0.1491	0.0073	0.0026	0.0064	0.0835	0.0491
2018	0.1691	0.0108	0.0063	0.0067	0.0848	0.0605
2019	0.2024	0.0111	0.0037	0.0064	0.0992	0.0821
2020	0.2118	0.0123	0.0054	0.0060	0.1052	0.0829
2021	0.2344	0.0156	0.0066	0.0075	0.1146	0.0900
2022	0.2321	0.0169	0.0047	0.0053	0.1085	0.0967
2023	0.2461	0.0143	0.0072	0.0051	0.1049	0.1146
Decrease 1988-2023	75.6%	89.1%	99.2%	-	-	-
Decrease 1990-2023	52.3%	95.8%	95.9%	-214.8%	-	-
Decrease 2022-2023	-6.0%	15.1%	-53.5%	4.9%	3.3%	-18.5%

Table 73 N_2O emissions in 1.A.2.g. Other industries

N_2O (Gg)	CRT 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

N_2O (Gg)	CRT 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
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	0.0407	0.0220	0.0004	0.0006	0.0111	0.0066
2018	0.0473	0.0264	0.0009	0.0007	0.0113	0.0081
2019	0.0552	0.0298	0.0006	0.0006	0.0132	0.0109
2020	0.0620	0.0355	0.0008	0.0006	0.0140	0.0111
2021	0.0650	0.0360	0.0010	0.0007	0.0153	0.0120
2022	0.0681	0.0395	0.0007	0.0005	0.0144	0.0129
2023	0.0688	0.0379	0.0011	0.0005	0.0140	0.0153
Decrease 1988-2023	77.2%	77.7%	99.2%	-	-	-
Decrease 1990-2023	67.8%	79.8%	95.9%	-214.8%	-	-
Decrease 2022-2023	-1.0%	4.0%	-53.5%	4.9%	3.3%	-18.5%

Table 74 GHG emissions in CRT 1.A.2.g. Other industries

GHG (Gg)	TJ	CRT 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	129 467.42	11 930.83	3 204.67	8 726.16	NO	NO	NO
1990	134 955.71	10 650.19	8 691.22	1 869.90	89.07	NO	NO
1995	120 844.05	8 613.19	4 336.15	1 921.88	2 352.87	2.2895	NO
2000	28 554.65	1 986.33	996.04	514.01	474.10	2.1736	NO
2005	27 868.06	1 966.10	777.45	684.52	499.27	1.9874	2.8714
2010	8 561.55	454.42	173.28	12.34	240.37	2.7207	25.7067
2011	8 819.60	479.41	186.61	10.43	252.81	2.5676	26.9923
2012	9 383.54	470.85	128.50	12.76	285.24	3.7299	40.6141
2013	9 585.88	460.63	133.16	13.03	257.07	4.7245	52.6413
2014	9 997.93	455.76	146.74	9.88	243.06	5.5691	50.5111
2015	13 073.86	628.77	164.10	15.93	373.15	5.7715	69.8223
2016	13 296.61	639.39	149.15	13.34	365.64	5.4394	105.8376
2017	14 454.73	721.37	212.33	24.53	358.03	5.2846	121.1906
2018	16 299.57	885.02	303.12	56.60	373.39	5.3684	146.5493
2019	17 123.92	924.43	320.06	32.95	354.33	6.2790	210.8087
2020	17 533.40	976.21	338.53	45.67	334.80	6.6592	250.5494
2021	20 914.07	1 173.74	429.51	57.88	414.79	7.2553	264.3014
2022	19 171.65	1 101.41	468.82	44.13	297.95	6.8671	283.6475
2023	18 826.63	1 082.76	396.96	65.14	281.40	6.6416	332.6177
Decrease 1988-2023	85.5%	90.9%	87.6%	99.3%	-	-	-
Decrease 1990-2023	86.0%	89.8%	95.4%	96.5%	-215.9%	-	-
Decrease 2022-2023	1.8%	1.7%	15.3%	-47.6%	5.6%	3.3%	-17.3%

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 (CRT 1.A.3)

The GHG emissions in Transport (CRT 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 75 Transport sector categories

Number	Category	CO_2	CH_4	N_2O	Method
CRT 1.A.3.a	Civil aviation (domestic)	✓	✓	✓	TIER 2
CRT 1.A.3.b	Road transport	✓	✓	✓	TIER 2
CRT 1.A.3.c	Railways	✓	✓	✓	TIER 1
CRT 1.A.3.d	Navigation	✓	✓	✓	TIER 1
CRT 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 CRT 1.A.3 Transport for 1988 – 2023 are shown below.

Table 76 Fuels for CRT 1.A.3 Transport in TJ

CRT 1A3 Transport	a. Civil Aviation	b. Road Transportation	c. Railways	d. Navigation	e. Other Transport
			TJ		
1988	1 091	96 474	NO	NO	NO
1990	706	82 021	4 357	761	1 777
1995	386	56 094	3 066	167	40
2000	242	68 603	1 607	85	6 887
2005	238	97 943	1 227	153	9 042
2010	304	104 193	846	117	5 896
2011	374	104 116	761	127	8 528
2012	345	111 423	931	115	8 519
2013	272	100 029	630	96	7 608
2014	258	113 137	505	116	7 032
2015	264	125 874	673	137	6 141
2016	259	128 231	546	99	6 013
2017	303	129 321	563	88	7 158
2018	302	133 133	462	69	5 751
2019	285	138 358	417	87	2 269
2020	168	130 895	397	65	1 478
2021	203	139 296	429	60	2 326
2022	228	139 387	435	62	3 486
2023	239	141 562	399	79	3 970

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

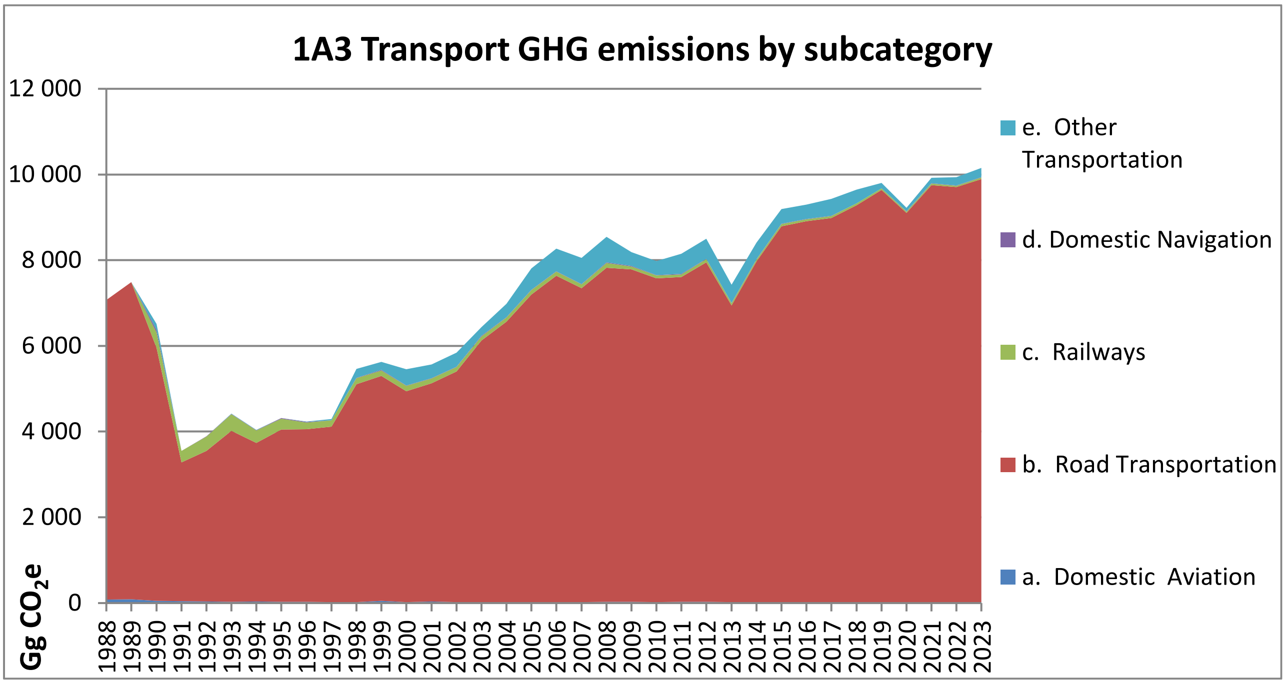


Figure 37 Fuels for CRT 1.A.3 Transport

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 77 Share of fuel consumption in 1A3 Transport fuel

CRT 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%	0.8%	2.0%
1995	0.6%	93.9%	5.1%	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%
2020	0.1%	98.4%	0.3%	0.0%	1.1%
2021	0.1%	97.9%	0.3%	0.0%	1.6%
2022	0.2%	97.1%	0.3%	0.0%	2.4%
2023	0.2%	96.8%	0.3%	0.1%	2.7%

3.3.12.2 CRT 1.A.3.a Civil Aviation

3.3.12.2.1 Source description

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 (CO_2), methane (CH_4) and nitrous oxide (N_2O), 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 2023 there was a decrease of 77.3% in the emissions from civil aviation compared to the base year, and an increase of 5.2% compared to the year before. In 2023 the sector was responsible for 0.06% of the emissions allocated to 1.A Fuel combustion and for 0.03% 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.

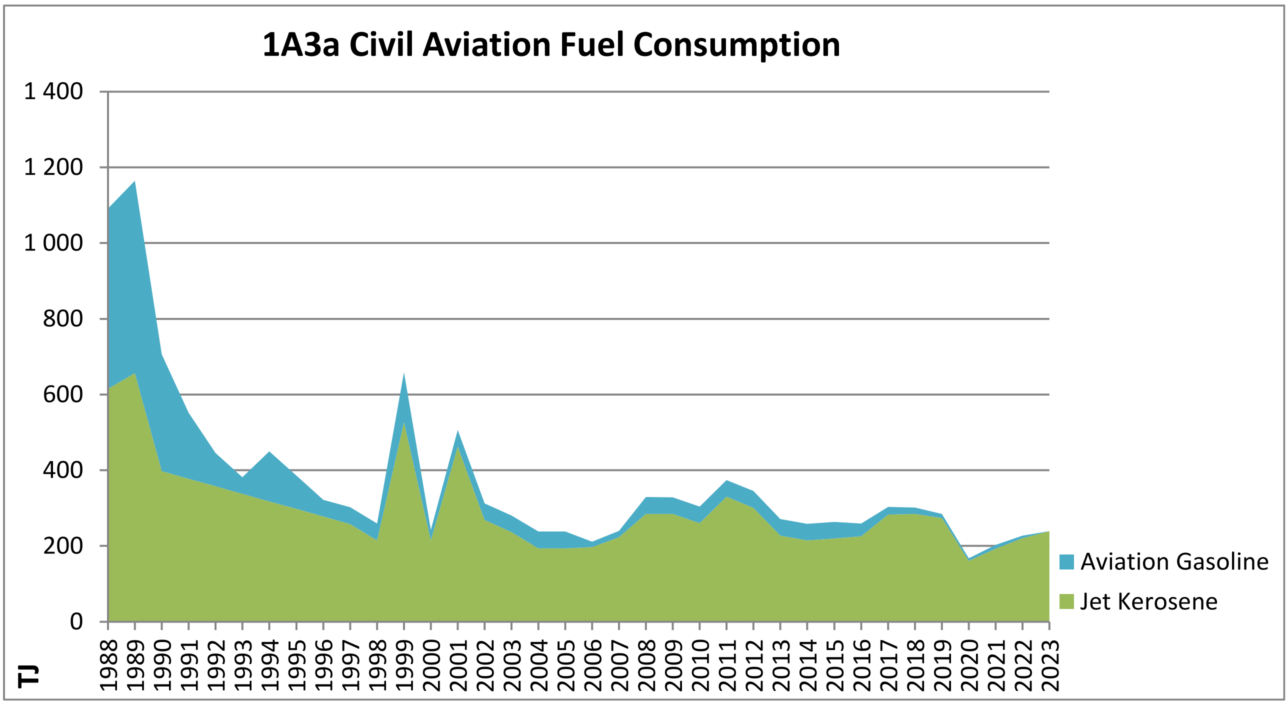


Figure 38 GHG emission in CRT 1.A.3.a Civil aviation – domestic

Table 78 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	1 091.41	76.99	0.0005	0.0022	77.58
1990	705.74	49.78	0.0004	0.0014	50.17
1995	385.92	27.40	0.0002	0.0008	27.61
2000	242.19	17.26	0.0001	0.0005	17.39
2005	237.93	17.21	0.0004	0.0005	17.35
2010	304.31	22.12	0.0004	0.0006	22.29
2011	373.85	27.21	0.0005	0.0007	27.42
2012	345.11	25.11	0.0004	0.0007	25.30
2013	271.61	19.72	0.0004	0.0005	19.88
2014	258.38	18.75	0.0004	0.0005	18.90
2015	263.69	19.14	0.0004	0.0005	19.29
2016	259.45	18.87	0.0004	0.0005	19.02
2017	303.27	22.14	0.0005	0.0006	22.31
2018	301.57	21.97	0.0005	0.0006	22.14
2019	284.58	20.75	0.0004	0.0006	20.91
2020	167.51	12.21	0.0003	0.0003	12.31
2021	203.07	14.80	0.0003	0.0004	14.91
2022	227.71	16.61	0.0004	0.0005	16.74
2023	239.10	17.47	0.0004	0.0005	17.60

Table 79 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	615.10	43.98	0.0003	0.0012	44.31
1990	397.74	28.44	0.0002	0.0008	28.66
1995	297.92	21.30	0.0001	0.0006	21.46
2000	215.00	15.37	0.0001	0.0004	15.49
2005	193.97	14.17	0.0003	0.0004	14.28
2010	260.31	19.07	0.0004	0.0005	19.22
2011	329.85	24.16	0.0004	0.0007	24.35
2012	301.11	22.06	0.0004	0.0006	22.23
2013	227.61	16.67	0.0004	0.0005	16.80
2014	214.38	15.70	0.0003	0.0004	15.83
2015	219.69	16.09	0.0003	0.0004	16.22
2016	225.35	16.51	0.0004	0.0004	16.64
2017	283.12	20.74	0.0005	0.0006	20.90
2018	284.63	20.79	0.0005	0.0006	20.96
2019	273.80	20.00	0.0004	0.0005	20.16
2020	160.83	11.75	0.0002	0.0003	11.84
2021	192.86	14.09	0.0003	0.0004	14.20
2022	220.54	16.11	0.0003	0.0004	16.24
2023	239.10	17.47	0.0004	0.0005	17.60

Table 80 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	0.0002	0.0010	33.27
1990	308.00	21.34	0.0002	0.0006	21.51
1995	88.00	6.10	0.0000	0.0002	6.15
2000	27.19	1.88	0.0000	0.0001	1.90
2005	43.96	3.05	0.0000	0.0001	3.07
2010	44.00	3.05	0.0000	0.0001	3.07
2011	44.00	3.05	0.0000	0.0001	3.07
2012	44.00	3.05	0.0000	0.0001	3.07
2013	44.00	3.05	0.0000	0.0001	3.07
2014	44.00	3.05	0.0000	0.0001	3.07
2015	44.00	3.05	0.0000	0.0001	3.07
2016	34.10	2.36	0.0000	0.0001	2.38
2017	20.15	1.40	0.0000	0.0000	1.41
2018	16.94	1.17	0.0000	0.0000	1.18
2019	10.78	0.75	0.0000	0.0000	0.75
2020	6.69	0.46	0.0000	0.0000	0.47
2021	10.21	0.71	0.0000	0.0000	0.71
2022	7.17	0.50	0.0000	0.0000	0.50
2023	NO	NO	NO	NO	NO

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 adopted from Eurocontrol Advanced Emission Model (AEM) according to a Tier 3 approach based on actual flight trajectory data. This is an upgrade of the previous Tier 2 approach, which relied on data for the number of LTO cycles per aircraft type.

The general procedure for emission estimates is presented in the diagram below:

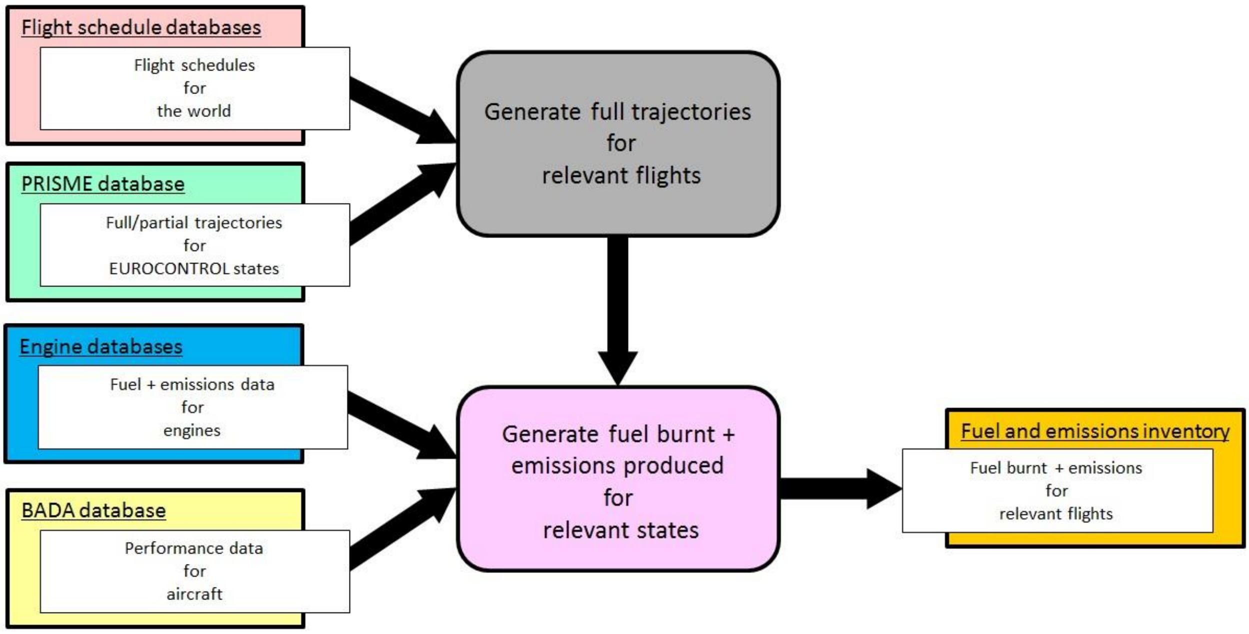


Figure 39 A system model of the fuel and emission inventory procedure. Source: Eurocontrol

A very detailed explanation of the procedure is provided in the methodological document of the European Aviation Fuel Burn and Emissions Inventory System[22].

Eurocontrol emission estimates were adopted directly for civil aviation sector for the period 2005-2023. As the national energy balance provides aggregated information both for civil and military aviation, the difference between Eurocontrol estimates of fuel consumption and reported consumption from NSI was allocated to military aviation. Total fuel consumption is obtained from the Energy balance and converted into energy units using the country-specific NCV. There is a specific case with the activity data concerning the beginning of the timeseries (1988 to 1996, excluding 1990). For those years, the national energy balances do not provide a disaggregation between international and domestic aviation jet kerosene consumption. In order to ensure consistency for the timeseries, we have interpolated the domestic kerosene consumption between 1990 and 1997; and subtracted this consumption from international kerosene consumption.

3.3.12.2.4 Activity data

The Eurocontrol AEM uses a multitude of parameters for each flight, including:

- departure and destination airports;
- taxi-out and taxi-in times at each airport;
- duration of the take-off, climb-out, approach and landing phases at each airport;
- trajectory of the aircraft and aircraft attitude (climb, cruise, or descent) during each flight segment;
- type of the airframe of the aircraft;
- type of the engine(s) of the aircraft;
- number of engines of the aircraft;
- rate at which fuel is burnt by each type of aircraft as a function of the altitude (in flight levels), attitude (climbing, cruising, or descending) and corresponding power levels.

For a full description of the used activity data, please refer to the methodological document of the European Aviation Fuel Burn and Emissions Inventory System.

[22] https://www.eurocontrol.int/publication/european-aviation-fuel-burn-and-emissions-inventory-system-feis-european-environment

3.3.12.2.5 Emission factors

Emission factors used for Eurocontrol calculations are obtained from several databases. For turbojet and turbofan engines was used ICAO Aircraft Engine Emissions Databank, which contains information on exhaust emissions of production aircraft engines, measured according to the procedures in ICAO. Additional databases were also used – Swiss Federal Office of Civil Aviation database (FOCA) for piston engines and the Swedish Defence Research Agency database (FOI) for turboprop engines. Engine-specific emission factors are available for more than 980 different types of engines.

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 NID, background documentation and archive;
- Comparison of Tier 1 and Tier 3 approach.

3.3.12.2.8 Source-specific recalculations

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 CRT category 1.A.5.b Other mobile. Disaggregation was performed based on fuel consumption for civil aviation, provided by Eurocontrol and total fuel consumption reported in the energy balance.
For the 2023 submission a full recalculation was performed for the period 2005-2022, directly utilizing the emission estimates prepared by Eurocontrol AEM (Tier 3 approach). This is an upgrade of the previous approach, which relied on LTO cycles per type of aircraft provided by Eurocontrol (Tier 2 approach) and emission factors provided by the IPCC guidance per representative aircraft types. As a result of the recalculation, the CO_2 emissions from civil aviation increased by approx. 2%.

3.3.12.2.9 Source-specific planned improvements

No improvements are planned for next submission.

3.3.12.3 CRT 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 2021 about 75.5% of the vehicles were above 15 years old, of which 48.6% are more than 20 years old. New vehicles (1 to 5 years) were 4.5% of the total and 6.8% were aged between 6 and 10 years.
The total number of registered vehicles in Bulgaria for the period 1988 – 2023 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	210 802	5 489	217 360	276 901
1990	1 317 437	227 779	7 471	225 533	281 270
1995	1 647 571	289 427	15 374	233 365	285 901
2000	1 993 968	324 997	17 277	236 327	286 047
2005	2 546 657	390 385	12 546	97 733	48 656
2010	2 608 056	362 593	20 400	70 387	54 935
2011	2 700 520	376 638	20 076	73 797	57 954
2012	2 813 277	396 226	19 999	77 972	61 840
2013	2 917 365	417 103	20 239	82 423	65 275
2014	3 022 245	440 994	20 642	87 948	68 696
2015	3 171 307	474 533	21 224	93 765	71 540
2016	3 153 351	486 086	21 262	99 693	74 276
2017	2 785 369	449 881	19 329	105 924	77 595
2018	2 784 082	463 489	19 195	112 251	80 164
2019	2 842 016	476 843	19 154	118 559	82 792
2020	2 882 599	482 838	18 012	124 109	84 349
2021	2 846 969	480 367	16 271	129 274	85 750
2022	2 911 126	494 328	16 356	136 592	87 751
2023	3 016 143	511 313	16 664	146 165	89 956

Road transport accounts for the largest share in total fuel consumption in the Transport subsector. In 2023 road transport was responsible 96.8% of the consumed energy in the sector.

3.3.12.3.2 Emission trend

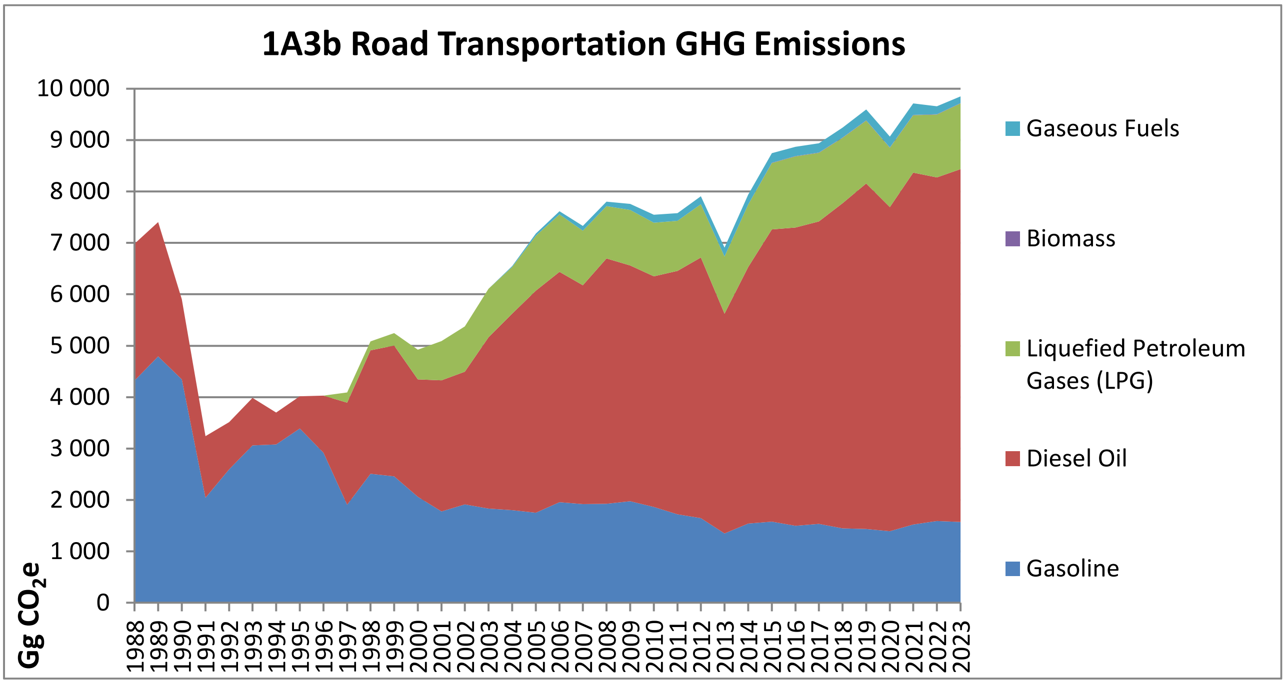


Figure 40 GHG emissions in CRT 1.A.3.b Road transport

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 41.4% compared to the base year level of 6 990 Gg CO_2e and reached 9 883 Gg CO_2e in 2023.

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 2023 passenger cars accounted for 64.5%, light-duty vehicles were responsible for 15.8%, and heavy-duty vehicles (incl. buses) for 19.2% of road transport GHG CO_2e emissions; and the share of passenger cars was clearly increasing over the time series. The remaining 0.5% were shared among mopeds and motorcycles.

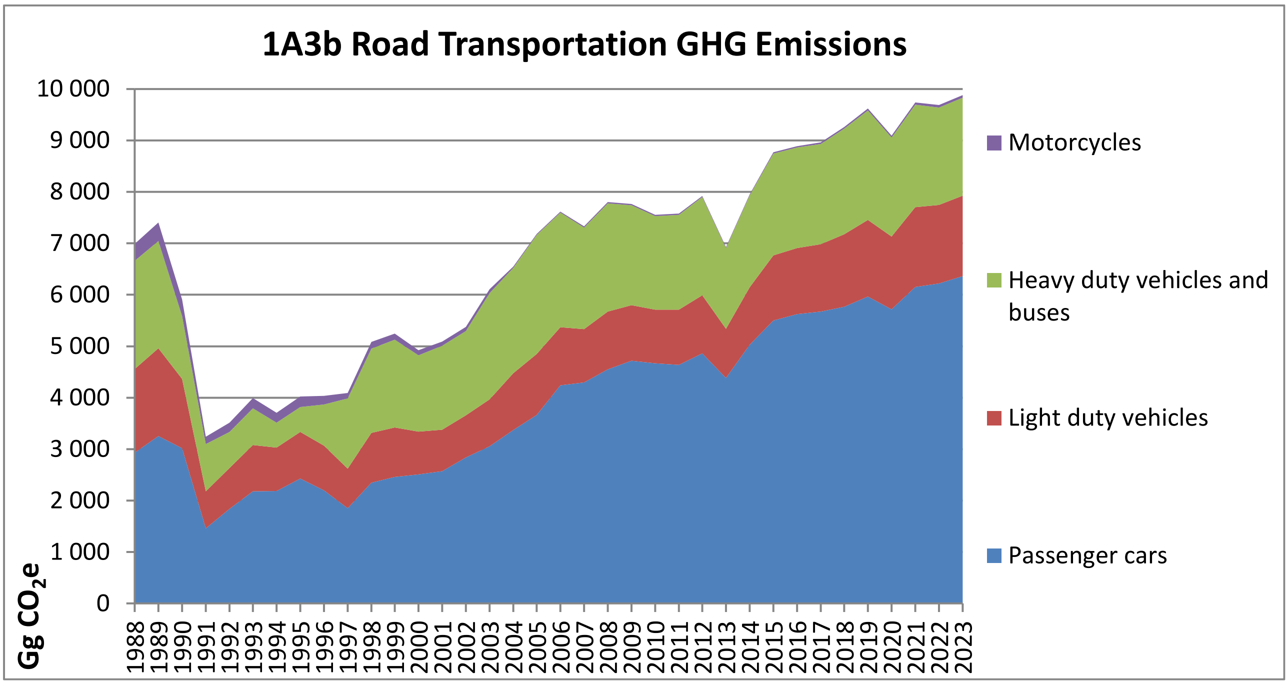


Figure 41 Emissions allocated to vehicle categories

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, for N_2O emissions there is an upward trend mostly due to the increase of diesel vehicles share.

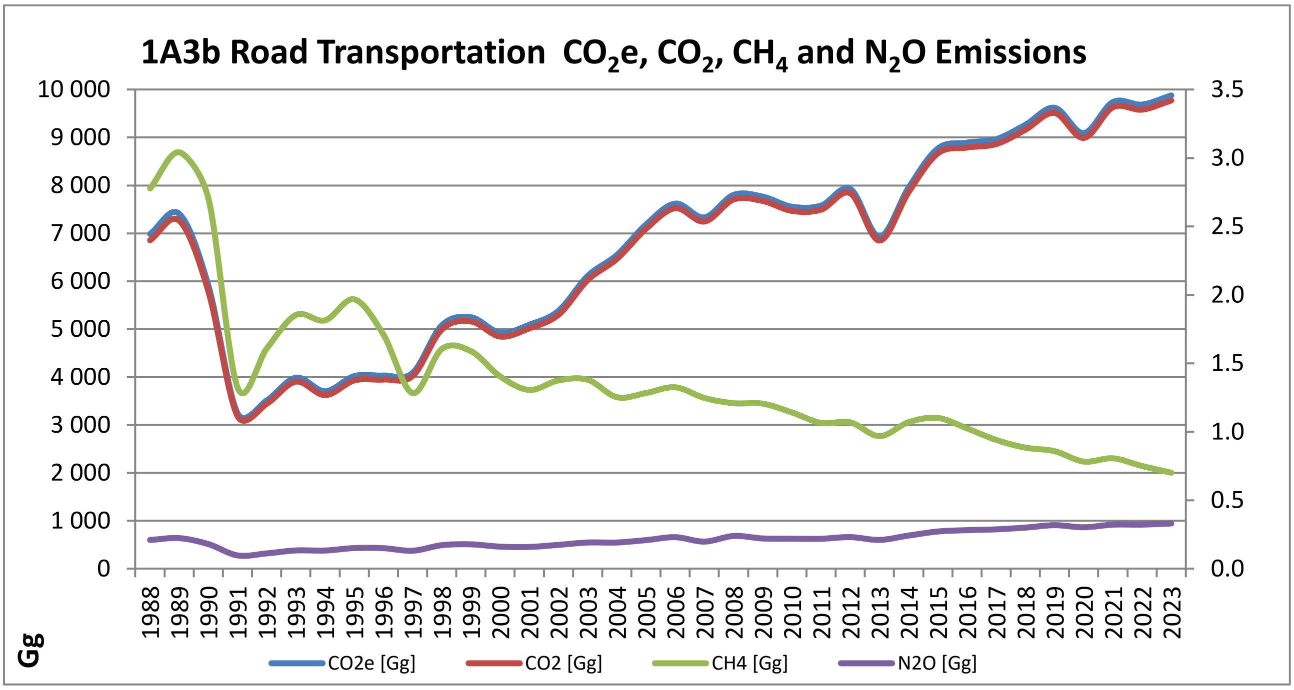


Figure 42 CO_2, CO_2e, CH_4 and N_2O emissions trends

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.

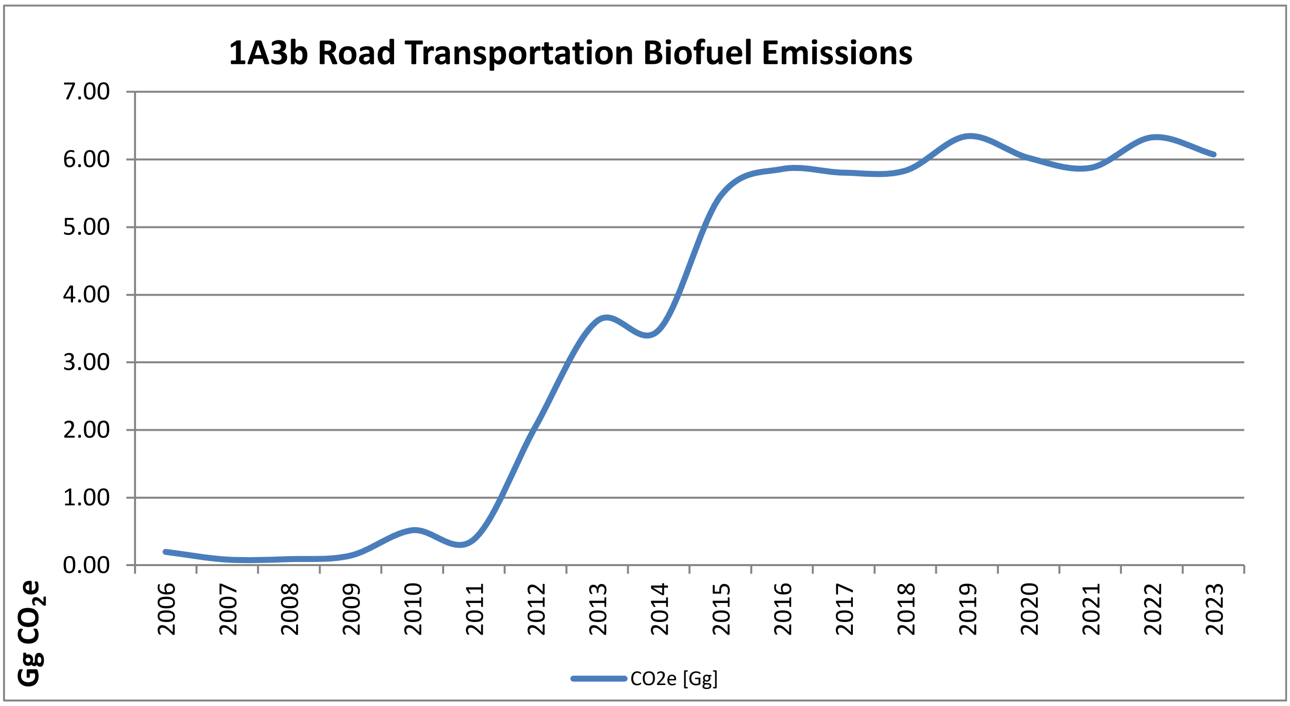


Figure 43 Emissions from biofuels in Road Transport

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. Starting from the 2020 submission biofuel consumption is corrected 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, 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.
For the 2025 submission, the latest COPERT 5.8.1 version was used.
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 fuel 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.

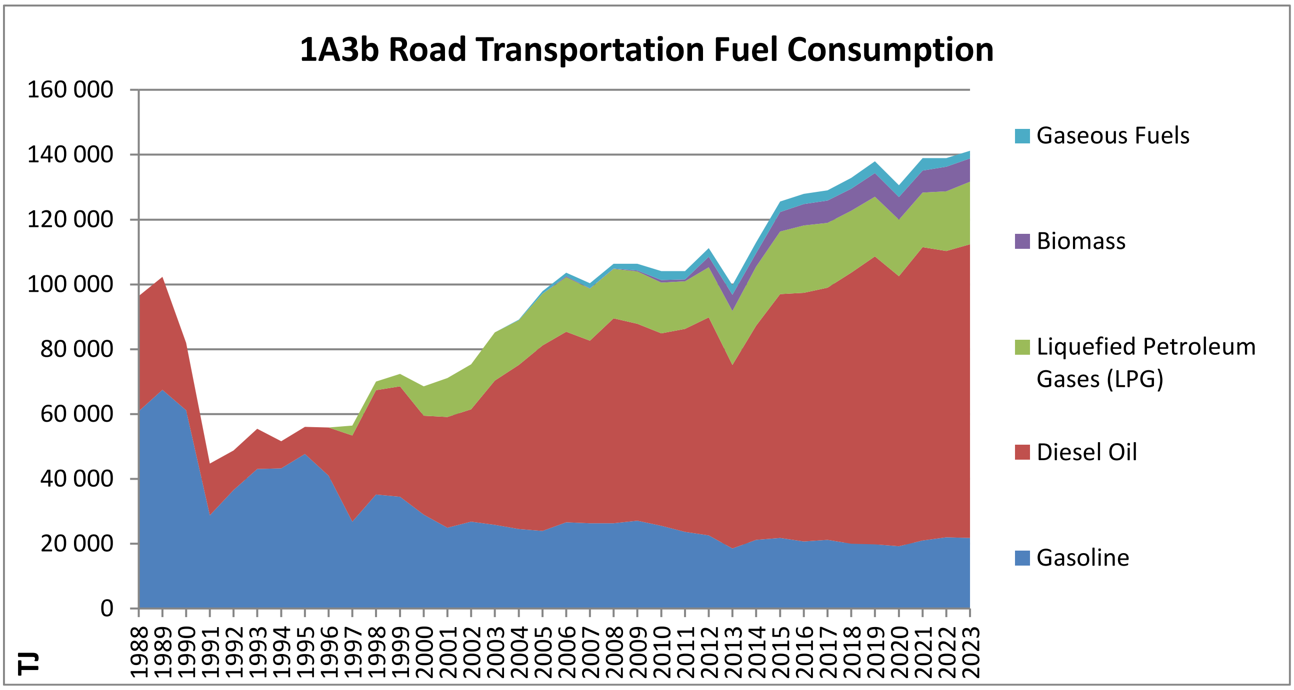


Figure 44 Fuel consumption in CRT 1.A.3.b Road transport

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

Starting from COPERT v. 5.6.1, the average trip length should be provided separately for passenger cars, light commercial vehicles, heavy duty trucks, buses and L-category vehicles. As it was not feasible to calculate national values for these parameters, the COPERT default values were used (12 km for PC and L-category and 44 km for HDV and busses). Time trip duration is estimated at 0.25 and 0.85 hours respectively. Since previously we were applying a value, estimated based on the maps of largest Bulgarian cities, the change of this parameter has led to recalculation of some of the emissions for the entire timeseries.

Minimum and maximum temperatures

Complete, country-specific data on monthly average minimum and maximum temperatures for the whole period of 1988 to 2023 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 2005-2023 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 2006-2021 (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 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 – 2021. 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 2005-2021. 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 – 2021 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-stroke 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	41.48	2.16	71.73	20.33	2.69

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
1990	69.30	41.57	2.21	74.10	7.72	2.10
1995	69.30	39.94	2.84	74.10	7.74	1.76
2000	69.30	34.76	3.59	74.10	7.23	1.47
2005	71.60	25.63	3.83	74.93	6.14	1.38
2010	71.73	20.33	2.69	74.93	4.44	1.62
2011	71.62	19.47	2.61	74.93	4.22	1.69
2012	71.54	18.88	2.50	74.93	4.00	1.72
2013	71.49	18.18	2.37	74.93	3.77	1.78
2014	71.64	17.68	2.31	74.93	3.55	1.86
2015	71.63	16.51	2.15	74.93	3.31	1.96
2016	71.64	15.37	1.98	74.93	2.99	2.07
2017	71.73	14.28	1.77	74.93	2.59	2.22
2018	71.76	13.39	1.65	74.93	2.36	2.30
2019	71.75	12.62	1.56	74.93	2.17	2.39
2020	71.78	12.24	1.50	74.93	2.02	2.44
2021	71.83	12.34	1.51	74.93	1.99	2.43
2022	71.84	11.61	1.40	74.93	1.84	2.48
2023	71.84	10.85	1.30	74.93	1.68	2.55

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	kg/TJ	t/TJ	kg/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	19.41	1.30	NO	NO	NO
2005	65.73	17.95	2.28	56.71	40.33	1.11
2010	65.73	16.40	3.11	56.04	35.22	1.13
2011	65.73	16.05	3.17	56.03	40.37	1.27
2012	65.73	15.58	3.07	55.96	43.12	1.35
2013	65.73	15.15	2.98	56.08	45.41	1.43
2014	65.73	14.83	2.98	56.14	48.46	1.54
2015	65.73	14.35	2.90	56.20	49.29	1.60
2016	65.73	13.74	2.82	56.04	45.08	1.58
2017	65.73	12.98	2.66	56.03	42.45	1.61
2018	65.73	12.58	2.60	56.05	41.59	1.67
2019	65.73	12.24	2.56	56.08	40.53	1.70
2020	65.73	12.00	2.51	56.00	36.97	1.62
2021	65.73	11.94	2.56	55.94	34.81	1.55
2022	65.73	11.52	2.47	55.86	32.99	1.56
2023	65.73	11.09	2.36	55.59	30.84	1.55

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 Lukoil 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):

			EF CO_2	EF N_2O	EF CH_4
AD	+/-5%	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 NID, 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 2004-2021 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 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. 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 5.4 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.
For the 2022 submission we transitioned to the latest version of COPERT 5.5.1, which included correction in the calculation of N_2O emissions for buses and other improvements. This led to significant decrease in N_2O estimates from diesel vehicles for the entire timeseries, compared to 2021 estimates, but still comparable to 2020 estimates. Additionally, for the 2022 submission reallocated the emissions from lubricants consumed in 2-stroke engines to the Energy sector, as they were previously reported under the IPPU sector.
For the 2023 submission was introduced an updated version of the COPERT 5.6.1 model, which introduced some changes related to trip length and duration per vehicle category, but also fixed some errors in the software related to N_2O emission estimates. We have also changed the approach for allocation of energy consumption and emissions between fossil fuels and biofuels. Previously, the

allocation was performed manually outside of COPERT based on the reported quantities of biofuels as a share of all reported fuels. Currently, the exact energy consumption and emission estimates calculated by COPERT separately for fossil fuels, biofuels (bioethanol and biodiesel, including ETBE and FAME) are reported. As a result of the QAQC procedures, a minor error in the previous submission related to NCVs for 1988, 1989 and 2020 was identified and corrected.
For the 2025 submission were performed some adjustments in the vehicle fleet matrix related to pre-ECE vehicles, which resulted in minor recalculation for the entire time series. Additionally, a new vehicle category was introduced (EURO 5 for motorcycles), which did not have any significant impact on the emission estimates due to the relatively small number of motorcycles.
For the 2025 submission an updated version of COPERT 5.8.1 was introduced, which have corrected some bugs and provided updated emission factors regarding CH4 emissions. An additional improvement of the vehicle fleet categorisation was introduced due to the following reasons:

- Previously, electric vehicles were not subtracted from the total number of vehicles (e.g. they were accounted as ICE vehicles), due to their small numbers. Their share is still insignificant, but for accuracy purposes they were separated from ICEs.
- Due to the lack of gasoline buses category in COPERT model, those were previously considered as diesel busses. Currently those gasoline busses are accounted as gasoline light commercial vehicles and heavy duty trucks.

Those improvements lead to minor revisions of both the vehicle distribution across categories and average annual mileage per category.

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).

3.3.12.4 Railways (CRT 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 0.1% 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, followed by a stabilization after 2020:

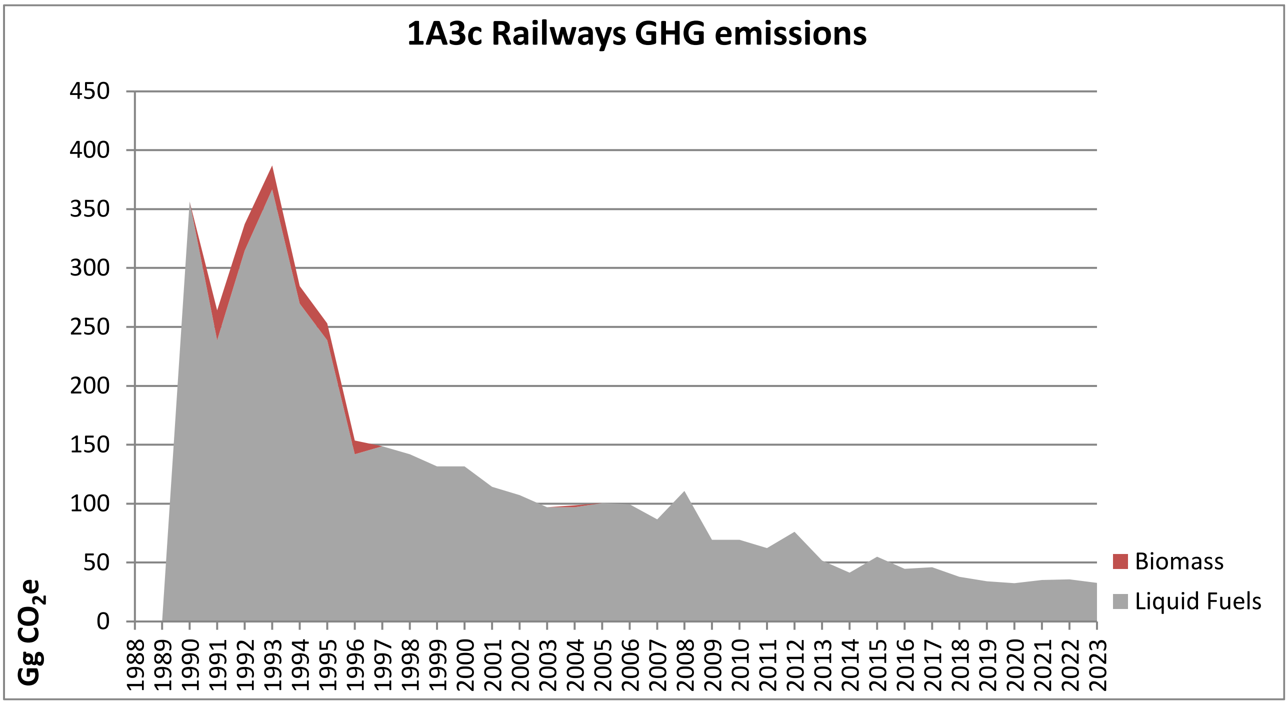


Figure 45 GHG emissions in CRT 1.A.3.c Railway transport

As the figure above demonstrates, emissions from Railway transport in 2023 have plummeted by 90.8% since 1993. 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 CRT 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.

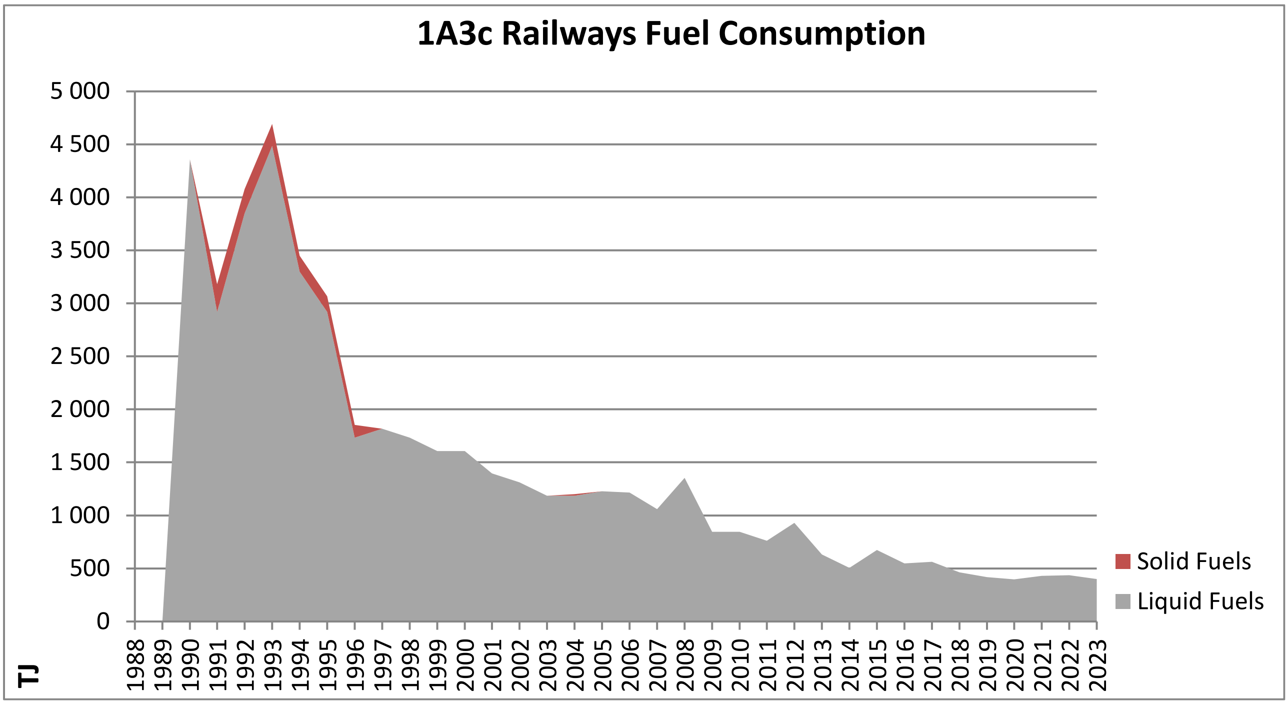


Figure 46 Fuel consumption in CRT 1.A.3.c Railway transport

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	NO	NO	42.6	74.10	NO	0.0286	NO	0.00415	NO
1990	103.00	4 356.90	42.3	74.10	322.85	0.0286	0.125	0.00415	0.018
1995	69.00	2 918.70	42.3	74.10	216.28	0.0286	0.083	0.00415	0.012
2000	38.00	1 607.40	42.3	74.10	119.11	0.0286	0.046	0.00415	0.007
2005	29.00	1 226.70	42.3	74.10	90.90	0.0286	0.035	0.00415	0.005
2010	20.00	846.00	42.3	74.10	62.69	0.0286	0.024	0.00415	0.004
2011	18.00	761.40	42.3	74.10	56.42	0.0286	0.022	0.00415	0.003
2012	22.00	930.60	42.3	74.10	68.96	0.0286	0.027	0.00415	0.004
2013	15.00	630.39	42.0	74.10	46.71	0.0286	0.018	0.00415	0.003
2014	12.00	504.61	42.1	74.10	37.39	0.0286	0.014	0.00415	0.002
2015	16.00	672.56	42.0	74.10	49.84	0.0286	0.019	0.00415	0.003
2016	13.00	546.04	42.0	74.10	40.46	0.0286	0.016	0.00415	0.002
2017	13.41	562.99	42.0	74.10	41.72	0.0286	0.016	0.00415	0.002
2018	11.00	462.21	42.0	74.10	34.25	0.0286	0.0132	0.00415	0.002
2019	9.92	416.58	42.0	74.10	30.87	0.0286	0.0119	0.00415	0.002
2020	9.45	396.54	42.0	74.10	29.38	0.0286	0.0113	0.00415	0.002
2021	10.23	428.96	41.9	74.10	31.79	0.0286	0.0123	0.00415	0.002
2022	10.36	434.93	42.0	74.10	32.23	0.0286	0.0124	0.00415	0.002
2023	9.52	399.34	42.0	74.10	29.59	0.0286	0.0114	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 NID, 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 have been reallocated to the category commercial/institutional for the entire time series.

3.3.12.5 Navigation (CRT 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.

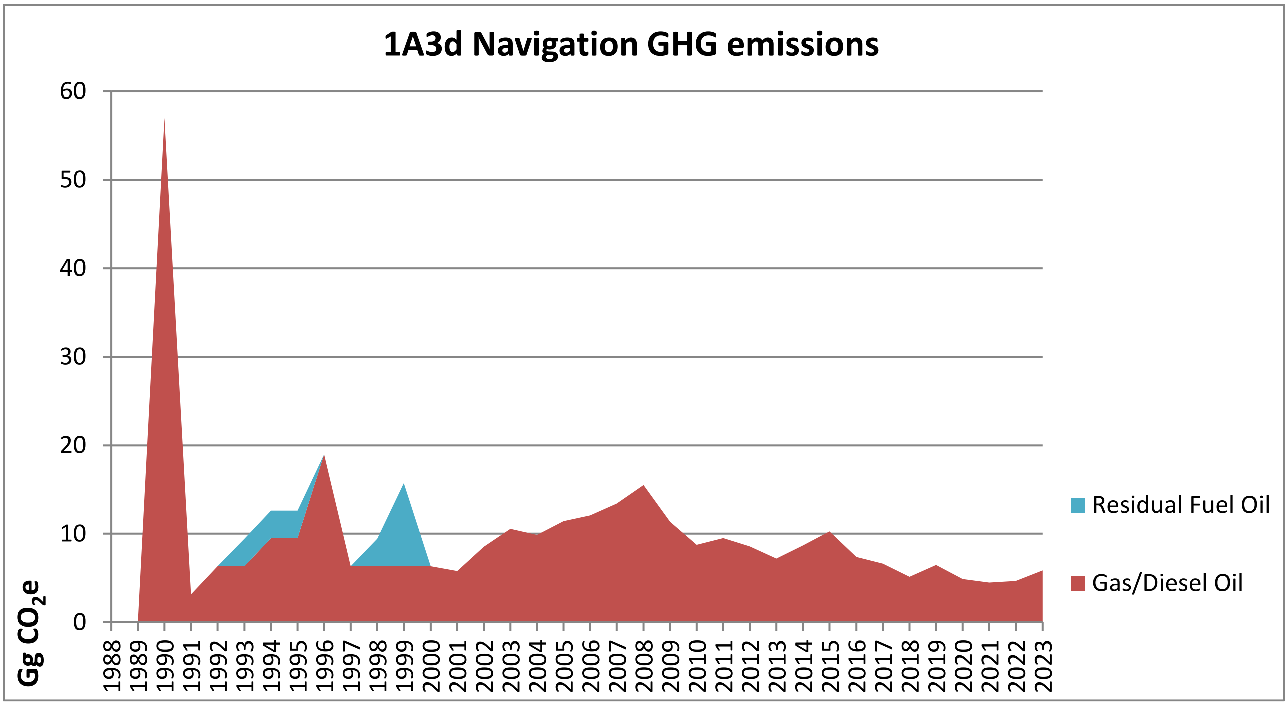


Figure 47 GHG emissions in CRT 1.A.3.d Navigation

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	-	950	205	194 647 500	0.00939	1828
2002	1402	-	1402	205	287 410 000	0.00939	2699
2003	1731	-	1731	205	354 855 000	0.00939	3332
2004	1621	-	1621	205	332 202 500	0.00939	3119
2005	1741	1875	1875	205	384 375 000	0.00939	3609

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
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	-	1407	1407	205	288 435 000	0.00939	2708
2013	-	1190	1190	205	243 950 000	0.00939	2291
2014	-	1431	1431	205	293 355 000	0.00939	2755
2015	-	1695	1695	205	347 475 000	0.00939	3263
2016	-	1222	1222	205	250 510 000	0.00939	2352
2017	-	1092	1092	205	223 860 000	0.00939	2102
2018	-	850	850	205	174 250 000	0.00939	1636
2019	-	1070	1070	205	219 350 000	0.00939	2060
2020	-	810	810	205	166 050 000	0.00939	1559
2021	-	742	742	205	152 110 000	0.00939	1428
2022	-	771	771	205	158 055 000	0.00939	1484
2023	-	972	972	205	199 260 000	0.00939	1871

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 gas-diesel oil subcategory of 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	NO	NO	42.60	74.10	NO	0.002	NO	0.007	NO
1990	18.00	761.40	42.30	74.10	56.4	0.002	0.0015	0.007	0.0053
1995	3.00	126.90	42.30	74.10	9.4	0.002	0.0003	0.007	0.0009
2000	2.00	84.60	42.30	74.10	6.3	0.002	0.0002	0.007	0.0006
2005	3.61	152.67	42.30	74.10	11.3	0.002	0.0003	0.007	0.0011
2010	2.76	116.76	42.30	74.10	8.7	0.002	0.0002	0.007	0.0008
2011	3.01	127.27	42.30	74.10	9.4	0.002	0.0003	0.007	0.0009
2012	2.71	114.57	42.30	74.10	8.5	0.002	0.0002	0.007	0.0008
2013	2.29	96.27	42.03	74.10	7.1	0.002	0.0002	0.007	0.0007
2014	2.75	115.83	42.05	74.10	8.6	0.002	0.0002	0.007	0.0008
2015	3.26	137.15	42.04	74.10	10.2	0.002	0.0003	0.007	0.0010
2016	2.35	98.80	42.00	74.10	7.3	0.002	0.0002	0.007	0.0007
2017	2.10	88.26	41.99	74.10	6.5	0.002	0.0002	0.007	0.0006
2018	1.64	68.73	42.01	74.10	5.1	0.002	0.0001	0.007	0.0005
2019	2.06	86.50	42.00	74.10	6.4	0.002	0.0002	0.007	0.0006
2020	1.56	65.44	41.97	74.10	4.8	0.002	0.0001	0.007	0.0005
2021	1.43	59.87	41.92	74.10	4.4	0.002	0.0001	0.007	0.0004
2022	1.48	62.30	41.97	74.10	4.6	0.002	0.0001	0.007	0.0004
2023	1.87	78.52	41.97	74.10	5.8	0.002	0.0002	0.007	0.0005

Table 89 Activity data, emissions and emission factors for residual fuel oil subcategory of 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	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
1990	NO	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
1995	1.00	40.00	40	77.40	3.1	0.002	0.0001	0.007	0.0003
2000	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2005	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2010	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2011	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2012	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2013	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2014	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2015	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2016	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2017	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2018	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2019	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2020	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2021	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2022	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2023	NO	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 NID, 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 (CRT 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 2021, 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	NO	NO	42.60	74.10	NO	0.0286	NO	0.00415	NO
1990	42.00	1 776.60	42.30	74.10	131.65	0.0286	0.051	0.00415	0.0074
1995	NO	NO	42.30	74.10	NO	0.0286	NO	0.00415	NO
2000	NO	NO	42.30	74.10	NO	0.0286	NO	0.00415	NO
2005	NO	NO	42.30	74.10	NO	0.0286	NO	0.00415	NO
2010	NO	NO	42.30	74.10	NO	0.0286	NO	0.00415	NO
2011	NO	NO	42.30	74.10	NO	0.0286	NO	0.00415	NO
2012	NO	NO	42.30	74.10	NO	0.0286	NO	0.00415	NO
2013	NO	NO	42.03	74.10	NO	0.0286	NO	0.00415	NO
2014	NO	NO	42.05	74.10	NO	0.0286	NO	0.00415	NO
2015	NO	NO	42.04	74.10	NO	0.0286	NO	0.00415	NO
2016	NO	NO	42.00	74.10	NO	0.0286	NO	0.00415	NO
2017	NO	NO	41.99	74.10	NO	0.0286	NO	0.00415	NO
2018	NO	NO	42.01	74.10	NO	0.0286	NO	0.00415	NO
2019	NO	NO	42.00	74.10	NO	0.0286	NO	0.00415	NO
2020	NO	NO	41.97	74.10	NO	0.0286	NO	0.00415	NO
2021	NO	NO	41.92	74.10	NO	0.0286	NO	0.00415	NO
2022	NO	NO	41.97	74.10	NO	0.0286	NO	0.00415	NO
2023	NO	NO	41.97	74.10	NO	0.0286	NO	0.00415	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	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
1990	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
1995	1.00	40.00	40.00	77.40	3.1	0.002	0.0001	0.007	0.0003
2000	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2005	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2010	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2011	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2012	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2013	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2014	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2015	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2016	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2017	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2018	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2019	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2020	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2021	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2022	NO	NO	40.00	77.40	NO	0.002	NO	0.007	NO
2023	NO	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

	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
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
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
2020	1478.0	55.51	82.0	0.10	0.000	1.0	0.001
2021	2326.0	55.48	129.0	0.10	0.000	1.0	0.002
2022	3486.2	55.77	194.4	0.10	0.000	1.0	0.003
2023	3969.9	55.40	219.9	0.10	0.000	1.0	0.004

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 NID, 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 (CRT 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);

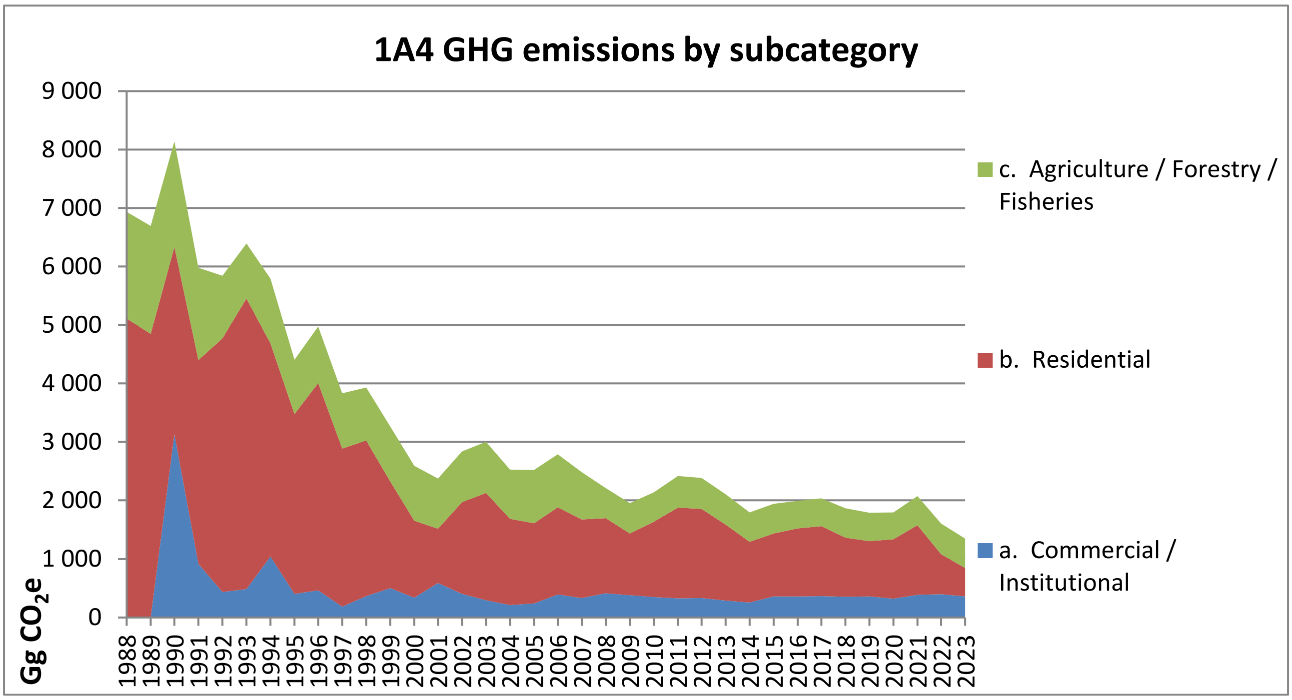


Figure 48 Total GHG emissions from 1.A.4 Other Sectors

The general trend in CRT category 1.A.4 is a decrease of 80.5% compared to base year and a decrease of 16.0% compared to last year.

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

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

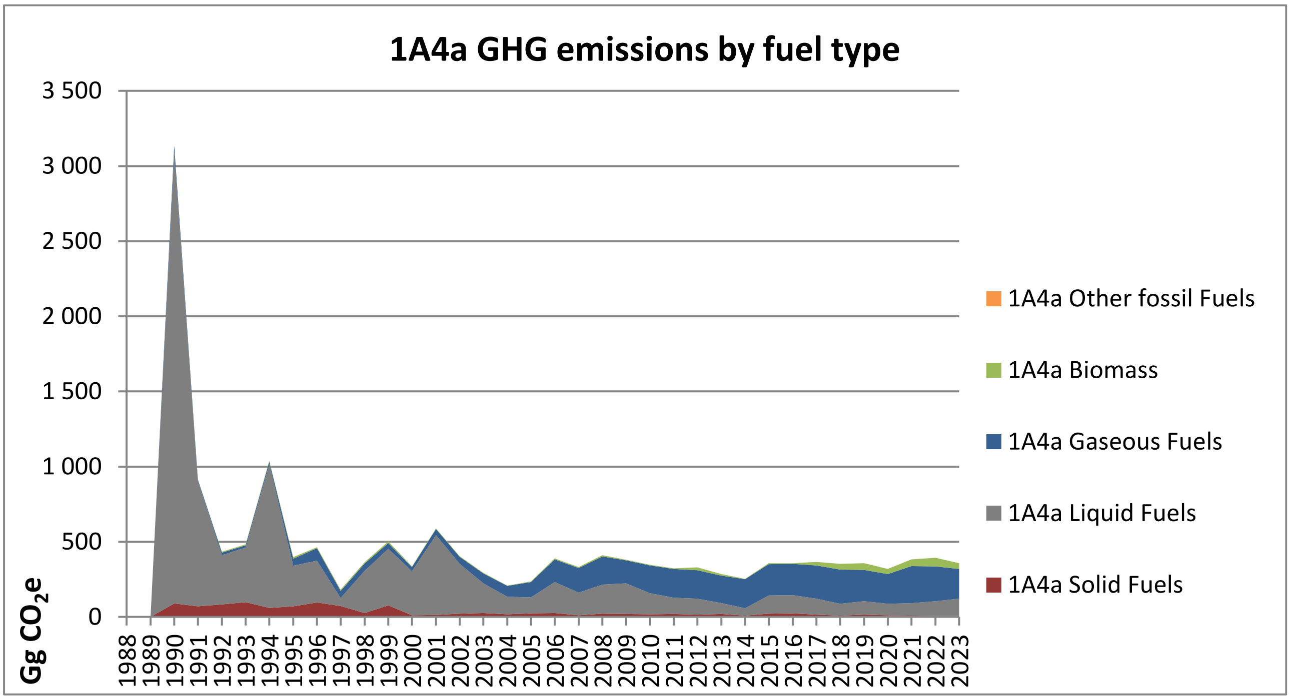


Figure 49 GHG emissions from CRT 1.A.4.a. Commercial/Institutional

The share of this subcategory from sector 1.A is 1.1% for 2023, 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 CRT 1.A.4.a. Commercial/Institutional

CO_2 (Gg)	CRT 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	386.17	268.64	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	312.79	89.19	15.07	208.53	534.9191	NO
2020	284.28	74.79	12.16	197.33	411.3882	NO
2021	337.19	82.63	9.60	244.96	557.7113	NO
2022	334.63	99.23	6.14	229.26	713.4031	NO
2023	318.93	113.37	7.14	198.41	457.7045	NO
Decrease 1988-2023	-	-	-	-	-	-
Decrease 1990-2023	89.8%	96.2%	92.0%	-372.0%	-	-
Decrease 2022-2023	4.7%	-14.3%	-16.3%	13.5%	35.8%	-

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

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

CH_4 (Gg)	CRT 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	0.3840	0.0358	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	1.4321	0.0105	0.0016	0.0188	1.4012	NO
2020	1.0898	0.0088	0.0014	0.0178	1.0619	NO
2021	1.4893	0.0096	0.0011	0.0221	1.4566	NO
2022	1.9038	0.0116	0.0006	0.0206	1.8710	NO
2023	1.2163	0.0133	0.0008	0.0179	1.1843	NO
Decrease 1988-2023	-	-	-	-	-	-
Decrease 1990-2023	-196.4%	96.6%	91.1%	-370.4%	-	-
Decrease 2022-2023	36.1%	-15.3%	-22.4%	12.9%	36.7%	-

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

N_2O (Gg)	CRT 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
2020	0.0149	0.0005	0.0002	0.0004	0.0139	NO
2021	0.0202	0.0005	0.0002	0.0004	0.0191	NO
2022	0.0257	0.0006	0.0001	0.0004	0.0246	NO
2023	0.0166	0.0007	0.0001	0.0004	0.0154	NO
Decrease 1988-2023	-	-	-	-	-	-
Decrease 1990-2023	34.3%	97.1%	91.1%	-370.4%	-	-
Decrease 2022-2023	35.5%	-16.2%	-22.4%	12.9%	37.3%	-

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

GHG (Gg)	TJ	CRT 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	3 135.14	3 003.05	89.92	42.16	NO	NO
1995	6 279.60	398.99	270.21	71.57	46.59	10.6141	NO

GHG (Gg)	TJ	CRT 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2000	4 930.42	336.45	292.24	11.97	28.41	3.8408	NO
2005	4 042.48	237.24	106.01	24.85	101.01	5.3638	NO
2010	5 916.11	347.59	140.40	17.53	185.90	3.7612	NO
2011	5 636.14	323.79	108.58	19.66	191.61	3.9371	NO
2012	7 130.77	330.52	107.25	14.87	189.30	19.0942	NO
2013	5 664.80	284.74	73.51	19.45	181.33	10.4591	NO
2014	4 530.63	253.46	49.18	8.69	193.61	1.9885	NO
2015	6 339.38	356.72	120.89	22.42	208.04	5.3693	NO
2016	6 306.57	357.49	120.70	24.40	209.38	3.0112	NO
2017	8 159.24	365.38	105.80	16.11	220.69	22.7762	NO
2018	9 547.41	353.35	76.93	10.28	228.08	38.0601	NO
2019	10 011.73	358.07	89.63	15.18	209.15	44.1147	NO
2020	8 512.98	318.75	75.16	12.25	197.92	33.4139	NO
2021	10 746.37	384.24	83.03	9.68	245.69	45.8482	NO
2022	12 030.50	394.75	99.71	6.18	229.95	58.9132	NO
2023	9 432.90	357.38	113.93	7.20	199.01	37.2479	NO
Decrease 1988-2023	-	-	-	-	-	-	-
Decrease 1990-2023	77.3%	88.6%	96.2%	92.0%	-372.0%	-	-
Decrease 2022-2023	21.6%	9.5%	-14.3%	-16.4%	13.5%	36.8%	-

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

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

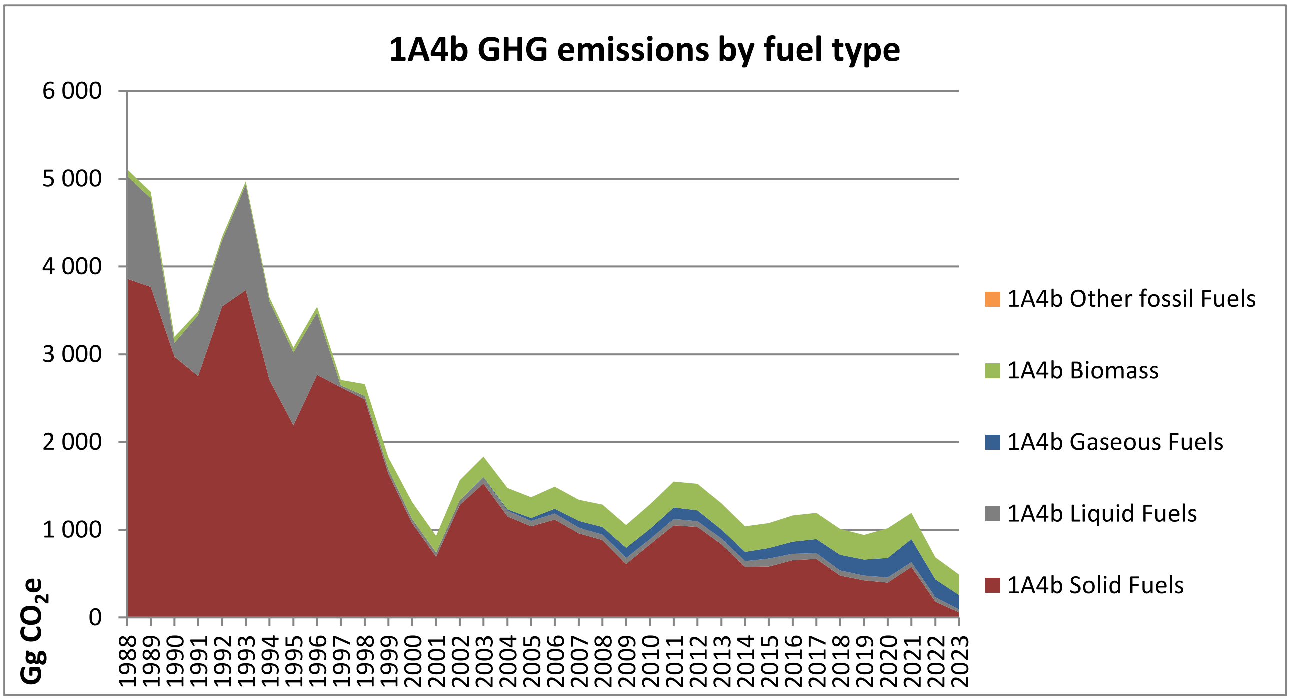


Figure 50 GHG emissions from CRT 1.A.4.b. Residential

The share of this subcategory from sector 1.A is 1.6% for 2023, whereas the share of total GHG emissions is 0.8%. The emissions from this category decreased by 90.4% 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. Liquid fuels previously used for heating were partially substituted with 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 2023 about 2 times more biomass was used by the residential sector compared to 1988. This trend is also complimented by the increasing gasification and electrification of households, although to a smaller extent.

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

CO_2 (Gg)	CRT 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	622.68	52.37	387.07	183.24	3 331.9829	NO
2020	642.97	56.28	363.42	223.27	3 975.2795	NO
2021	842.91	55.80	523.66	263.45	3 521.0980	NO
2022	417.19	48.35	165.73	203.11	3 002.0987	NO
2023	252.10	34.27	52.94	164.90	2 737.9987	NO
Decrease 1988-2023	94.7%	97.1%	98.5%	-	-207.9%	-
Decrease 1990-2023	91.3%	78.3%	98.1%	-	-238.5%	-
Decrease 2022-2023	39.6%	29.1%	68.1%	18.8%	8.8%	-

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

CH_4 (Gg)	CRT 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	10.2306	0.0042	1.2850	0.0165	8.9250	NO
2020	11.9214	0.0047	1.2485	0.0201	10.6481	NO
2021	11.2138	0.0045	1.7540	0.0237	9.4315	NO
2022	8.5912	0.0040	0.5277	0.0182	8.0413	NO
2023	7.5269	0.0027	0.1754	0.0149	7.3339	NO
Decrease 1988-2023	43.4%	97.9%	98.4%	-	-207.9%	-
Decrease 1990-2023	28.1%	79.6%	97.9%	-	-238.5%	-
Decrease 2022-2023	12.4%	31.6%	66.8%	18.3%	8.8%	-

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

N_2O (Gg)	CRT 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
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
2020	0.1487	0.0001	0.0062	0.0004	0.1420	NO
2021	0.1351	0.0001	0.0088	0.0005	0.1258	NO
2022	0.1103	0.0001	0.0026	0.0004	0.1072	NO
2023	0.0990	0.0001	0.0009	0.0003	0.0978	NO
Decrease 1988-2023	-7.5%	99.1%	98.4%	-	-207.9%	-
Decrease 1990-2023	-40.0%	83.7%	97.9%	-	-238.5%	-
Decrease 2022-2023	10.2%	41.1%	66.8%	18.3%	8.8%	-

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

GHG (Gg)	TJ	CRT 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	61 036.20	5 112.34	1 173.25	3 863.97	NO	75.1219	NO
1990	37 335.50	3 199.25	158.16	2 972.78	NO	68.3107	NO
1995	38 144.56	3 076.83	830.20	2 189.63	NO	57.0060	NO
2000	31 163.18	1 316.05	44.62	1 077.38	0.45	193.5989	NO
2005	36 470.41	1 371.92	61.33	1 040.40	32.64	237.5501	NO
2010	40 801.64	1 291.68	61.60	834.02	114.44	281.6147	NO
2011	44 743.19	1 550.58	73.00	1 051.87	129.85	295.8520	NO
2012	44 734.15	1 523.80	67.18	1 032.23	123.87	300.5158	NO
2013	42 191.49	1 300.83	64.03	835.39	104.51	296.9116	NO
2014	39 114.84	1 038.09	64.27	578.19	105.19	290.4409	NO
2015	39 162.39	1 076.52	90.22	581.75	120.92	283.6297	NO
2016	41 657.59	1 164.02	72.76	653.42	137.61	300.2320	NO
2017	42 340.78	1 193.19	66.44	667.30	158.58	300.8611	NO
2018	39 889.81	1 009.62	58.62	478.19	180.24	292.5677	NO
2019	38 158.63	942.49	52.51	424.75	183.79	281.4336	NO
2020	44 561.29	1 016.18	56.44	400.03	223.94	335.7691	NO
2021	42 914.92	1 192.70	55.96	575.10	264.24	297.4070	NO
2022	32 964.04	686.98	48.49	181.20	203.72	253.5701	NO
2023	28 549.42	489.10	34.36	58.08	165.39	231.2631	NO
Decrease 1988-2023	53.2%	90.4%	97.1%	98.5%	-	-207.9%	-
Decrease 1990-2023	23.5%	84.7%	78.3%	98.0%	-	-238.5%	-
Decrease 2022-2023	13.4%	28.8%	29.1%	67.9%	18.8%	8.8%	-

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

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

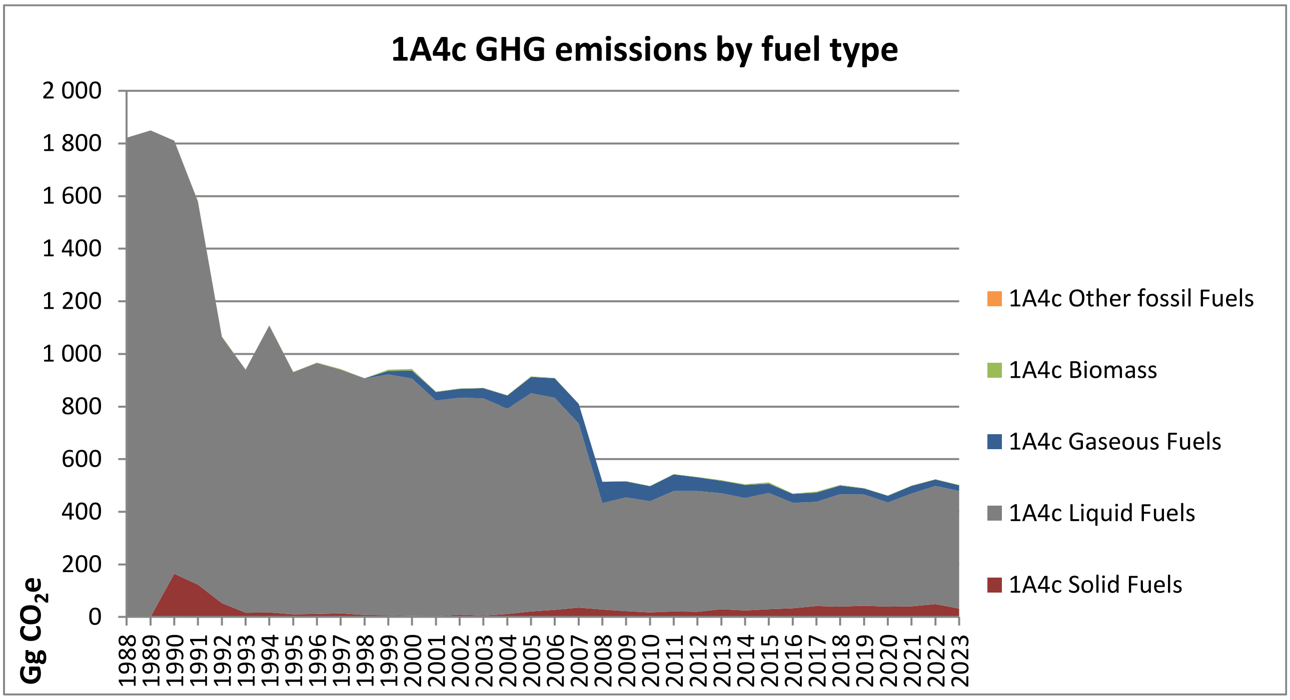


Figure 51 GHG emissions from CRT 1.A.4.c. Agriculture/Forestry/Fisheries

The share of this subcategory from sector 1.A is 1.6% for 2023, whereas the share of total GHG emissions is 0.9%.

Table 101 CO_2 emissions in CRT 1.A.4.c. Agriculture/Forestry/Fisheries

CO_2 (Gg)	CRT 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1 657.25	1 657.25	NO	IE,NO	IE,NO	NO
1990	1 649.29	1 498.15	150.94	0.20	IE,NO	NO
1995	854.38	845.22	9.16	IE,NO	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
2020	420.45	358.89	36.02	25.53	20.0372	NO
2021	454.60	388.77	36.81	29.02	30.7705	NO
2022	476.63	408.25	44.60	23.78	30.6839	NO
2023	456.15	404.27	29.60	22.28	35.6036	NO
Decrease 1988-2023	72.5%	75.6%	-	-	-	-
Decrease 1990-2023	72.3%	73.0%	80.4%	-11110.5%	-	-
Decrease 2022-2023	4.3%	1.0%	33.6%	6.3%	-16.0%	-

Table 102 CH_4 emissions in CRT 1.A.4.c. Agriculture/Forestry/Fisheries

CH_4 (Gg)	CRT 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0987	0.0987	NO	IE,NO	IE,NO	NO
1990	0.5496	0.0897	0.4599	0.0000	IE,NO	NO
1995	0.0957	0.0564	0.0283	IE,NO	0.0111	NO

CH_4 (Gg)	CRT 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
2020	0.1791	0.0202	0.1189	0.0023	0.0377	NO
2021	0.1842	0.0219	0.1200	0.0026	0.0397	NO
2022	0.2091	0.0230	0.1407	0.0021	0.0433	NO
2023	0.1795	0.0228	0.0991	0.0020	0.0557	NO
Decrease 1988-2023	-82.0%	76.9%	-	-	-	-
Decrease 1990-2023	67.3%	74.6%	78.5%	-11071.3%	-	-
Decrease 2022-2023	14.1%	1.0%	29.6%	5.7%	-28.6%	-

Table 103 N_2O emissions in CRT 1.A.4.c. Agriculture/Forestry/Fisheries

N_2O (Gg)	CRT 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.6116	0.6116	NO	IE,NO	IE,NO	NO
1990	0.5530	0.5507	0.0023	0.0000	IE,NO	NO
1995	0.2809	0.2806	0.0001	IE,NO	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
2020	0.1376	0.1365	0.0006	0.0000	0.0005	NO
2021	0.1493	0.1481	0.0006	0.0001	0.0005	NO
2022	0.1570	0.1557	0.0007	0.0000	0.0006	NO
2023	0.1555	0.1542	0.0005	0.0000	0.0008	NO
Decrease 1988-2023	74.6%	74.8%	-	-	-	-
Decrease 1990-2023	71.9%	72.0%	78.5%	-11071.3%	-	-
Decrease 2022-2023	0.9%	0.9%	29.6%	5.7%	-28.2%	-

Table 104 GHG emissions in CRT 1.A.4.c. Agriculture/Forestry/Fisheries

GHG (Gg)	TJ	CRT 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	22 365.00	1 822.09	1 822.09	NO	NO	NO	NO
1990	21 759.27	1 811.22	1 646.60	164.42	0.20	NO	NO
1995	11 487.90	931.51	921.16	9.99	NO	0.3500	NO
2000	12 319.45	942.53	902.65	4.20	29.90	5.7801	NO
2005	11 763.22	914.23	829.74	20.84	61.54	2.1001	NO

GHG (Gg)	TJ	CRT 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2010	6 540.96	498.47	422.83	17.47	56.85	1.3244	NO
2011	7 136.82	543.67	457.13	21.17	63.95	1.4190	NO
2012	6 940.35	532.42	459.20	19.37	52.27	1.5798	NO
2013	6 793.46	520.15	440.87	29.52	47.58	2.1853	NO
2014	6 685.78	504.40	427.21	24.97	49.49	2.7245	NO
2015	6 833.55	511.73	441.30	29.78	36.20	4.4462	NO
2016	6 587.72	469.16	400.32	33.73	34.05	1.0620	NO
2017	6 220.66	475.88	395.81	42.19	35.28	2.6096	NO
2018	6 429.00	501.59	426.88	39.84	33.39	1.4786	NO
2019	6 221.16	489.85	422.18	43.03	23.19	1.4478	NO
2020	5 948.13	461.94	395.63	39.51	25.61	1.1901	NO
2021	6 610.97	499.31	428.62	40.33	29.11	1.2543	NO
2022	6 830.65	524.09	450.14	48.73	23.85	1.3683	NO
2023	6 660.48	502.39	445.78	32.51	22.35	1.7587	NO
Decrease 1988-2023	70.2%	72.4%	75.5%	-	-	-	-
Decrease 1990-2023	69.4%	72.3%	72.9%	80.2%	-11110.4%	-	-
Decrease 2022-2023	2.5%	4.1%	1.0%	33.3%	6.3%	-28.5%	-

3.3.14 OTHER (CRT 1.A.5)

CRT 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 (CRT category 1.A.5.a).

Table 105 GHG emissions in CRT 1.A.5.a. Other Stationary

GHG (Gg)	TJ	CO_2	CH_4	N_2O
1988	75 318.93	5 093.82	0.1926	0.0329
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
2020	NO	NO	NO	NO
2021	NO	NO	NO	NO
2022	NO	NO	NO	NO
2023	448.08	31.22	0.0012	0.0002
Decrease 1988-2023	99.4%	99.4%	99.4%	99.3%
Decrease 1990-2023	-	-	-	-
Decrease 2022-2023	-	-	-	-

Starting from the 2021 submission, emissions from military aviation were reallocated from CRT 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 CRT 1.A.5.b. Other Mobile

GHG (Gg)	TJ	CO_2	CH_4	N_2O
1988	1 845.33	131.94	0.0009	0.0037
1990	1 193.26	85.32	0.0006	0.0024
1995	893.79	63.91	0.0004	0.0018
2000	645.00	46.12	0.0003	0.0013
2005	323.47	23.13	0.0002	0.0006
2010	341.69	24.43	0.0002	0.0007
2011	530.15	37.91	0.0003	0.0011
2012	128.89	9.22	0.0001	0.0003
2013	245.39	17.55	0.0001	0.0005
2014	129.62	9.27	0.0001	0.0003
2015	296.31	21.19	0.0001	0.0006
2016	591.65	42.30	0.0003	0.0012
2017	559.30	39.99	0.0003	0.0011
2018	432.15	30.90	0.0002	0.0009
2019	381.62	27.29	0.0002	0.0008
2020	258.34	18.47	0.0001	0.0005
2021	392.06	28.03	0.0002	0.0008
2022	548.89	39.25	0.0003	0.0011
2023	437.62	31.29	0.0002	0.0009
Decrease 1988-2023	76.3%	76.3%	76.3%	76.3%
Decrease 1990-2023	63.3%	63.3%	63.3%	63.3%
Decrease 2022-2023	20.3%	20.3%	20.3%	20.3%

3.4 FUGITIVE EMISSIONS FROM SOLID FUELS AND OIL AND NATURAL GAS (CRT 1.B)

Fugitive emissions from fuels are responsible for 3.7% of total GHG emissions for 2023. The fugitive emissions from gas and oil have a share of approx. 1.5% of total GHG emissions, whereas the fugitive emissions of solid fuels are approx. 2.2% of total GHG emissions.

3.4.1 COAL MINING AND HANDLING (CRT 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 of 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
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

Years since closure	Anthracite	Bituminous	Sub-bituminous
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
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 (CRT 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 0.3% of the total consumption in 2023, 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 CRT 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	0.00	30049	2.01	24.16	1400	0.0686	18	0.4796
1990	3848	6.45	46.41	0.00	27827	1.86	22.37	1854	0.0908	20	0.5203
1995	3381	5.66	40.77	0.00	27449	1.84	22.07	1693	0.0830	20	0.5177
2000	1621	2.72	19.55	0.00	24811	1.66	19.95	1325	0.0649	8	0.2080
2005	585	0.98	7.06	1.68	24110	1.62	19.38	1051	0.0515	24	0.6240
2010	744	1.25	8.97	0.96	28649	1.92	23.03	NO	NO	17	0.4420
2011	872	1.46	10.52	0.89	36250	2.43	29.15	NO	NO	16	0.4160
2012	688	1.15	8.30	0.82	32732	2.19	26.32	NO	NO	4	0.1040
2013	550	0.92	6.63	0.77	28071	1.88	22.57	NO	NO	5	0.1300
2014	472	0.79	5.69	0.72	30796	2.06	24.76	NO	NO	6	0.1560
2015	447	0.75	5.39	0.67	35412	2.37	28.47	NO	NO	6	0.1560
2016	270	0.45	3.26	0.64	30961	2.07	24.89	NO	NO	4	0.1040
2017	134	0.23	1.62	0.60	34143	2.29	27.45	NO	NO	2	0.0635
2018	51	0.09	0.61	0.57	30212	2.02	24.29	NO	NO	2	0.0530
2019	NO	NO	NO	0.54	28001	1.88	22.51	NO	NO	2	0.0547
2020	NO	NO	NO	0.52	22298	1.49	17.93	NO	NO	2	0.0597
2021	NO	NO	NO	0.50	28289	1.90	22.74	NO	NO	3	0.0754
2022	NO	NO	NO	0.48	35516	2.38	28.55	NO	NO	2	0.0602
2023	NO	NO	NO	0.46	20970	1.41	16.86	NO	NO	1	0.0292

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

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	
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
2020	C	5670.2	C	3275	413.0	5292	IE	IE	8174.3	IE
2021	C	4857.6	C	3276	470.3	5461	IE	IE	6653.3	IE
2022	C	8198.3	C	3318	240.6	5587	IE	IE	7895.2	IE
2023	C	7312.1	C	3594	109.3	5665	IE	IE	7204.9	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. 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
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

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
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	0.0732	0.0006	0.2476	0.0023	0.1812	0.0222	5.8240	0.1039	1.1861	IE	IE	0.0089	IE
2020	0.0005	0.0711	0.0006	0.1757	0.0034	0.2880	0.0328	6.8120	0.1198	1.2172	IE	IE	0.0082	IE
2021	0.0005	0.0689	0.0006	0.1502	0.0019	0.1157	0.0182	6.8141	0.1364	1.2560	IE	IE	0.0067	IE
2022	0.0005	0.0670	0.0006	0.2542	0.0010	0.0652	0.0097	6.9014	0.0698	1.2850	IE	IE	0.0079	IE
2023	0.0005	0.0713	0.0006	0.2267	0.0006	0.0391	0.0055	7.4755	0.0317	1.3030	IE	IE	0.0072	IE

3.4.3 METHODOLOGICAL ISSUES

Fugitive emissions from coal mining were estimated by Tier 1 method.

3.4.4 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.

$$\textit{Emissions}_{\textit{gas, industry segment}} = \textit{Activity data}_{\textit{industry segment}} \bullet \textit{EF}_{\textit{gas, industry segment}}$$

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/$10^6 m^3$ CO_2: 0.0000033 Gg/$10^6 m^3$ 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 CRT 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).

3.4.5 UNCERTAINTIES

The uncertainty of this emission source category was estimated as follows:

- 200% for coal mining;
- 50% for oil and natural gas systems.

3.4.6 SOURCE-SPECIFIC QA/QC AND VERIFICATION

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

3.4.7 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 CRT subcategory 1.A.1.b were reallocated under CRT 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 CRT subcategory 1.A.1.b were reallocated under CRT 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.

3.4.8 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 (CRT 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 2023.

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 2023 for each of the IPCC Categories under CRT Sector 2 for which GHG emissions are reported (as given in table 10s1).

Industrial process emissions sector includes 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 CRT 2 IPPU, 1988 – 2023

IPCC category	Emissions [Gg CO_2 eq]		Share [%]		Trend 1988 – 2023 [%]
	Base year*	2023	Base year*	2023	
2 Industrial processes	13155.10	3855.65	100.00	100.00	-70.69
2.A Mineral Industry	3739.87	1967.87	28.43	51.04	-47.38
2.B Chemical Industry	5210.66	1033.67	39.61	26.81	-80.16
2.C Metal Industry	4028.54	158.11	30.62	4.10	-96.08
2.D Non-energy Products from Fuels and Solvent Use	138.57	12.83	1.05	0.33	-90.74
2.E Electronics Industry	NO	NO	NO	NO	NO
2.F Product Uses as Substitutes for ODS	0.000	631.39	0.000	16.38	63139.07
2.G Other Product Manufacture and Use	37.46	51.78	0.28	1.34	38.20
2.H Other	NA,NO	NA,NO	NO	NO	NO

* Base year 1988

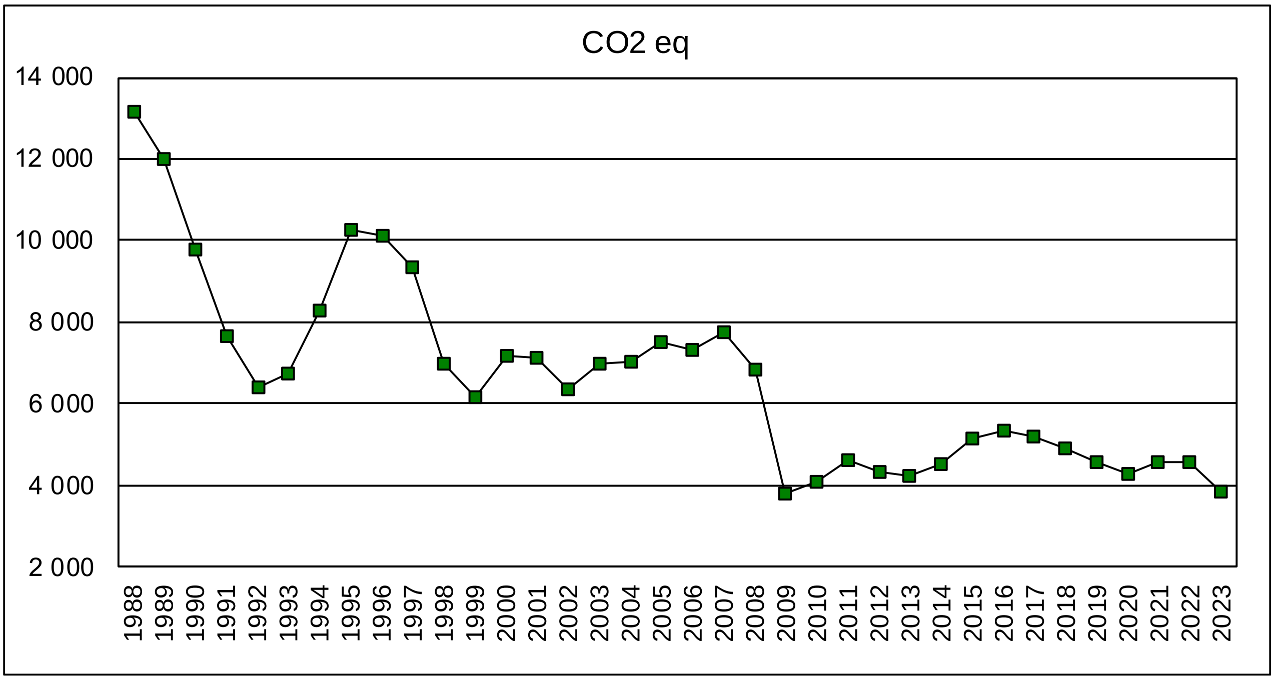


Figure 52 CO2 Emission trends for CRT Sector 2 IPPU for 1988-2023

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 and/or due to plant closures in the country.

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 2023.

Table 114 GHG emissions from CRT 2 IPPU by gas in 1988 and 2023

GHG	Base year*	2023	Base year*	2023
	CO_2 equivalent [Gg CO_2 eq]		[%]	
Total	13155.10	3855.65	100.00	100.00
CO2	11346.24	3118.42	86.25	80.88
CH4	58.39	0.00	0.44	0.0000
N2O	1964.63	96.94	14.93	2.51
HFCs	0.00	631.39	0.00	16.38
PFCs	0.00	0.00	0.00	0.0000
SF6	3.40	19.64	0.03	0.51

*1988 for: CO2, CH4, N2O and SF6.

**1995 for: HFCs and PFCs.*

Table 115 GHG Emissions from CRT 2 IPPU by gases 1988 – 2023

GHG emissions [Gg CO_2 eq]							
Year	**Total**	**CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**
1988	13155.10	11346.24	58.388	1964.63	NO	NO	3.40
1989	11983.84	10365.33	64.946	1556.92	NO	NO	3.60
1990	9799.69	8257.23	44.704	1680.00	NO	NO	3.81
1991	7667.87	6593.67	34.233	1164.93	0.00	NO	4.03
1992	6423.15	5509.30	31.941	986.92	0.01	NO	4.26
1993	6725.33	5907.12	36.844	873.57	0.02	NO	4.51
1994	8266.61	7373.61	50.085	941.40	1.00	NO	4.77
1995	10257.08	8964.17	54.843	1383.16	3.03	NO	5.05
1996	10114.46	8784.19	53.977	1423.24	5.31	NO	5.34
1997	9362.16	8336.18	57.658	1073.05	8.44	NO	5.65
1998	6991.82	6335.67	49.612	661.05	12.72	NO	5.98
1999	6184.12	5625.27	41.528	552.51	19.67	NO	6.32

GHG emissions [Gg CO_2 eq]							
Year	**Total**	**CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**
2000	7155.31	6345.42	42.130	819.08	32.69	NO	6.69
2001	7111.20	6284.69	42.477	821.71	46.23	NO	7.08
2002	6340.42	5626.19	38.013	683.47	60.95	NO	7.49
2003	6988.24	6224.20	47.356	709.36	77.95	NO	7.92
2004	7051.19	6149.00	40.766	841.48	104.74	NO	8.38
2005	7504.16	6485.52	39.337	904.79	166.28	NO	8.42
2006	7318.85	6582.87	40.369	496.49	245.36	NO	8.74
2007	7770.17	6900.19	39.104	606.65	282.32	NO	9.08
2008	6846.43	5871.02	21.741	583.02	425.74	0.021	9.44
2009	3818.37	3131.73	5.455	284.70	418.15	0.056	9.81
2010	4076.82	3388.63	0.018	286.21	414.21	0.102	19.34
2011	4619.91	3910.37	0.005	252.10	467.76	0.100	17.49
2012	4338.48	3701.95	0.001	153.98	483.00	0.009	16.59
2013	4225.19	3542.12	0.001	137.95	539.34	0.007	21.05
2014	4518.70	3767.88	0.001	139.90	609.02	0.005	17.40
2015	5132.26	4306.76	0.000	140.65	681.81	0.004	18.62
2016	5338.84	4493.58	0.000	126.70	713.25	0.003	19.32
2017	5218.85	4393.21	0.00	105.51	713.75	0.00	18.05
2018	4890.06	4039.10	NO	127.59	718.95	NO	18.54
2019	4561.88	3674.44	NO	98.43	781.08	NO	18.82
2020	4280.67	3409.92	NO	93.14	767.48	NO	20.45
2021	4562.20	3692.11	NO	93.74	763.45	NO	23.27
2022	4554.75	3775.99	NO	88.09	676.46	NO	23.96
2023	3855.65	3118.42	NO	96.94	631.39	NO	19.64

The emission trends of the three GHG – CO_2, CH_4 and N_2O, are presented on the following figure.

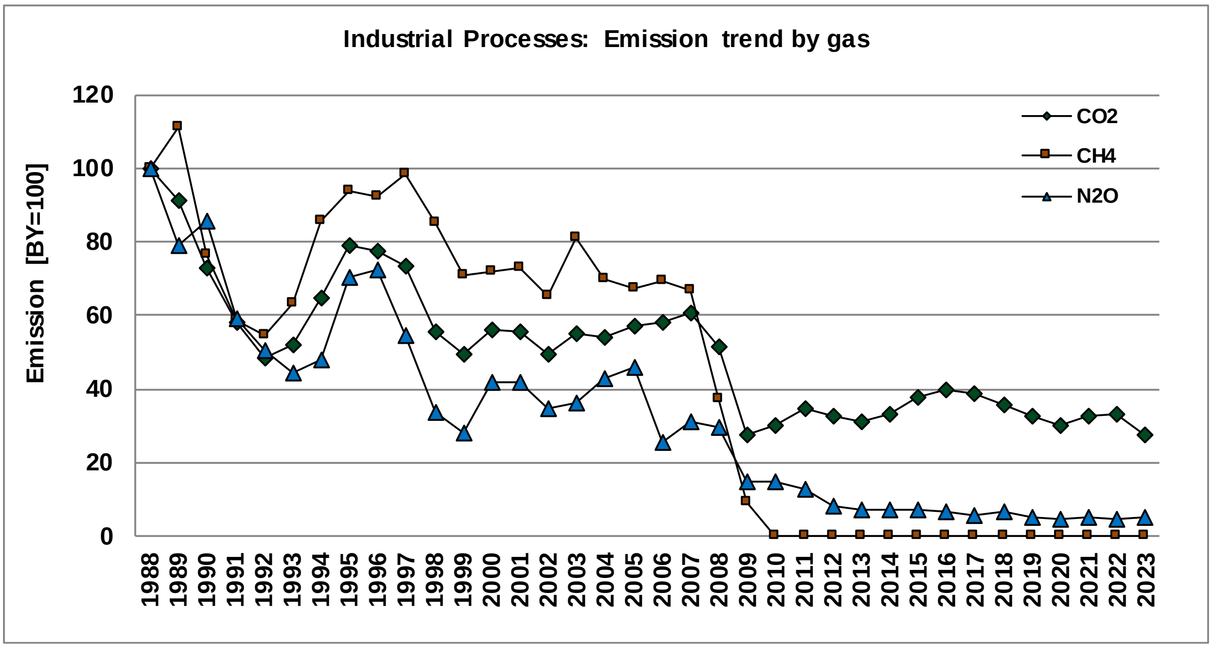


Figure 53 IPPU: Emission trend by gas – CO_2, N_2O, CH_4

The scale is logarithmic so that all the trends could be visible.

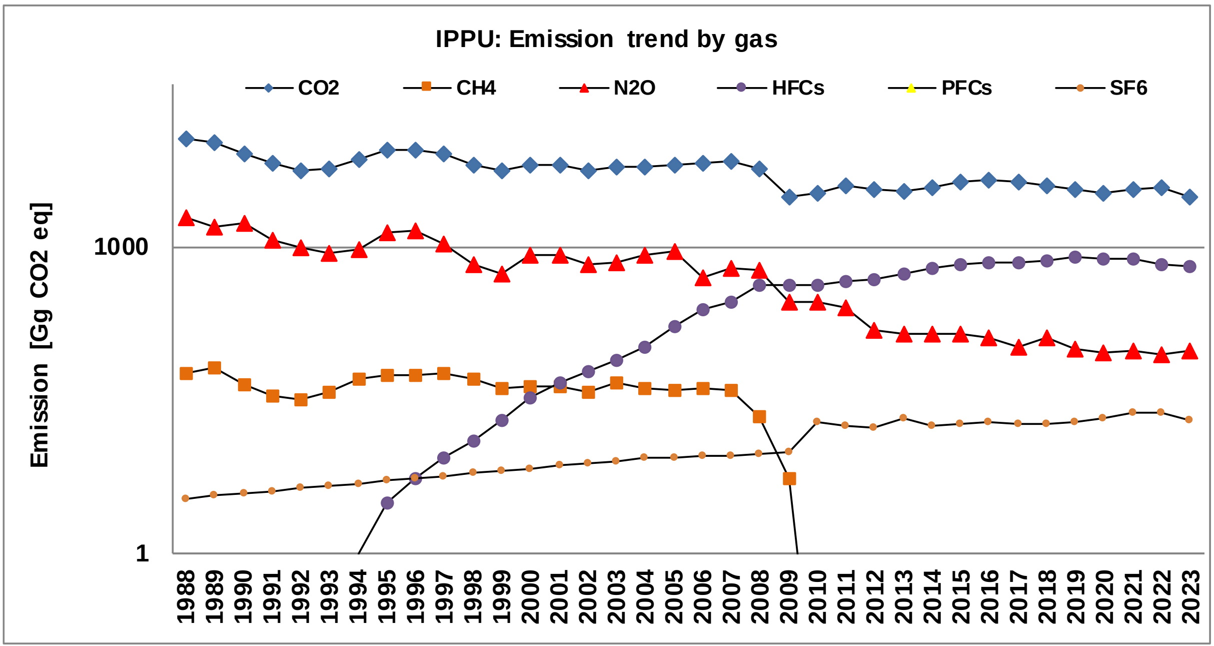


Figure 54 IPPU: Emission trend by gas – CO_2, N_2O, CH_4, HFCs PFCs and SF_6

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 CRT 2 IPPU by sector 1988 to 2023

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.E Electronic Industry	2.F Product Uses as Substitutes for ODS	2.G Other Product Manufacture and Use	2.H Other
1988	3739.87	5210.66	4028.54	138.57	NO	0.00	37.46	IE,NA
1989	3556.28	5002.64	3252.39	113.75	NO	0.00	58.77	IE,NA
1990	3277.86	4762.46	1632.56	82.11	NO	0.00	44.71	IE,NA
1991	2065.61	3788.21	1713.46	55.66	NO	0.00	44.93	IE,NA
1992	1746.74	2993.09	1594.29	43.87	NO	0.01	45.15	IE,NA
1993	1769.82	2764.59	2087.45	60.44	NO	0.02	43.01	IE,NA
1994	2096.87	3110.18	2943.41	44.49	NO	1.00	70.68	IE,NA
1995	2731.32	4058.51	3364.79	37.04	NO	3.03	62.39	IE,NA
1996	2689.69	4245.18	3065.53	43.65	NO	5.31	65.10	IE,NA
1997	2117.07	3578.70	3584.83	12.01	NO	8.44	61.10	IE,NA
1998	1548.53	2389.59	2966.49	23.17	NO	12.72	51.32	IE,NA
1999	1448.47	1900.09	2729.16	39.31	NO	19.67	47.42	IE,NA
2000	1629.25	2782.44	2634.72	22.59	NO	32.69	53.61	IE,NA
2001	1654.50	2813.89	2531.56	18.07	NO	46.23	46.95	IE,NA
2002	1720.66	2181.95	2301.95	22.85	NO	60.95	52.06	IE,NA
2003	1758.53	2244.38	2831.72	28.00	NO	77.95	47.66	IE,NA
2004	1989.29	2529.15	2346.04	29.68	NO	104.74	52.28	IE,NA
2005	2196.40	2689.91	2373.56	28.26	NO	166.28	49.75	IE,NA
2006	2330.46	2104.33	2559.30	30.30	NO	245.36	49.09	IE,NA
2007	2825.39	2314.54	2269.63	27.64	NO	282.32	50.66	IE,NA
2008	2814.61	2254.02	1280.65	22.07	NO	425.76	49.32	IE,NA
2009	1746.34	1282.59	308.17	19.48	NO	418.20	43.59	IE,NA
2010	1811.79	1473.37	288.66	28.50	NO	414.31	60.19	IE,NA
2011	1953.77	1801.33	315.88	27.27	NO	467.86	53.80	IE,NA

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.E Electronic Industry	2.F Product Uses as Substitutes for ODS	2.G Other Product Manufacture and Use	2.H Other
2012	2056.84	1430.90	290.17	23.83	NO	483.01	53.73	IE,NA
2013	1941.35	1459.71	221.79	18.62	NO	539.34	44.37	IE,NA
2014	2005.29	1590.85	249.29	20.35	NO	609.02	43.91	IE,NA
2015	2385.67	1776.40	224.06	14.24	NO	681.82	50.08	IE,NA
2016	2508.21	1825.33	223.42	18.92	NO	713.26	49.69	IE,NA
2017	2521.48	1735.87	183.08	17.18	NO	713.76	47.48	IE,NA
2018	2478.52	1442.77	186.11	15.40	NO	718.95	48.31	IE,NA
2019	2357.68	1196.52	160.65	16.44	NO	781.08	49.51	IE,NA
2020	2280.77	1018.29	148.93	16.08	NO	767.48	49.13	IE,NA
2021	2348.90	1247.40	132.65	16.28	NO	763.45	53.53	IE,NA
2022	2650.52	1003.50	151.22	14.73	NO	676.46	58.32	IE,NA
2023	1967.87	1033.67	158.11	12.83	NO	631.39	51.78	IE,NA

The following figure presents greenhouse gas emissions from IPCC Category 2 IPPU by sub category for the years 1988 to 2023 in both logarithmic and non-logarithmic scale.

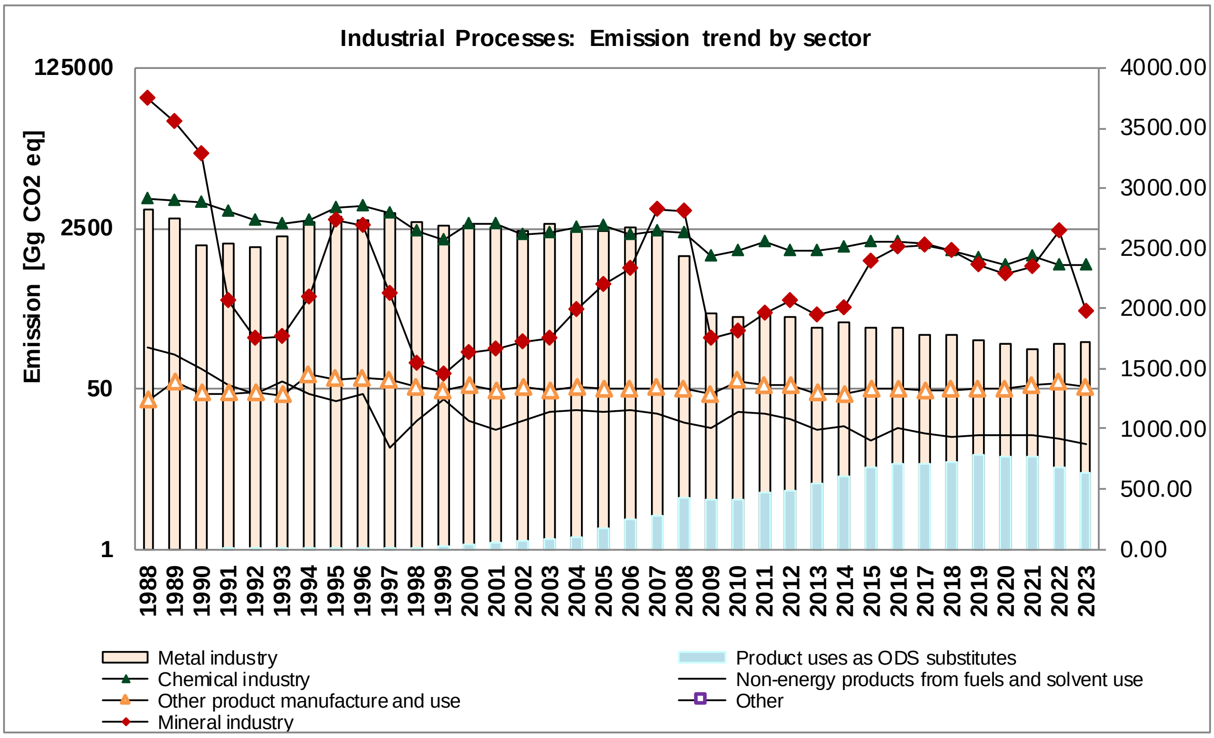


Figure 55 CRT 2 IPPU: Emission trend by sector – [Gg CO2 eq]

The emissions reduction during the whole time period from 1988 to 2023 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 followed by stabilization and increase of the production rates period. In 1996 a privatization process begins in the country which leads to decrease in the production of plants'. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation, some of them forever. Later 2008 – 2009 the world economic crisis was reflected in the trend of the Bulgarian industry. In the end of the line in the time series the Covid 19 closure gave reflection on the rates of production in the country due to the specific of the work (the business held the home – office, the manufacture decresed rates in some industrial braches).

The general reduction in the emissions in the years that followed of the time series is influenced also by the introduction of better technologies on plant level or plants closovers.

One of the most important factors leading to emission reduction in Metal Industry sector is that the biggest plant from this sector (whose share in the steel production of the country 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 compared to the years between 2008 and 2023 is more than 90%.

The existing ammonia and nitric acid plants ceased operation and this 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. Later in 2010 the market rates were recovered and the production followed it.

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. In 2020 it was followed by a decrease in some sectors provoked by the closedowns because of the Covid 19. Then a slight increase, in attempt to return to a steady rate.

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, is used.

In some categories emission and production data were reported directly by industry or EU ETS, IPPC and/or E-PRTR reports, thus they represent plant and country specific data. Methodologies are described for all IPCC categories in the relevant chapters.

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 2007-2023. 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 is used in some emissions estimation.

Planned Improvements

All planned improvements (described in the following sub-chapters) are described in the relevant subsector.

4.2 MINERAL INDUSTRY (CRT 2.A)

4.2.1 CEMENT PRODUCTION (CRT 2.A.1)

4.2.1.1 Source category description

Period 1988 – 2023 subsector overview. There were 6 existing/operational cement plants in Bulgaria in the beginning of the period. One of the six installations was operational since 1988 till 1996 and decommissioned finally during the last year(1996). One from the five left/operational installations had substantial decrease in production during 2010. This factory completely ceased operation and all equipment was decommissioned in 2011. 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 past 10 years. In addition all plants 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 between 1989/1991 and 1997/1999 represent the economic crisis time followed by stabilization and increase in the production rates. In 1996 a privatization process begun which led 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 ceased their operation. The reduction in 2020 is because of the Covid – 19 pandemic many bussines have remained closed and reduced their production.

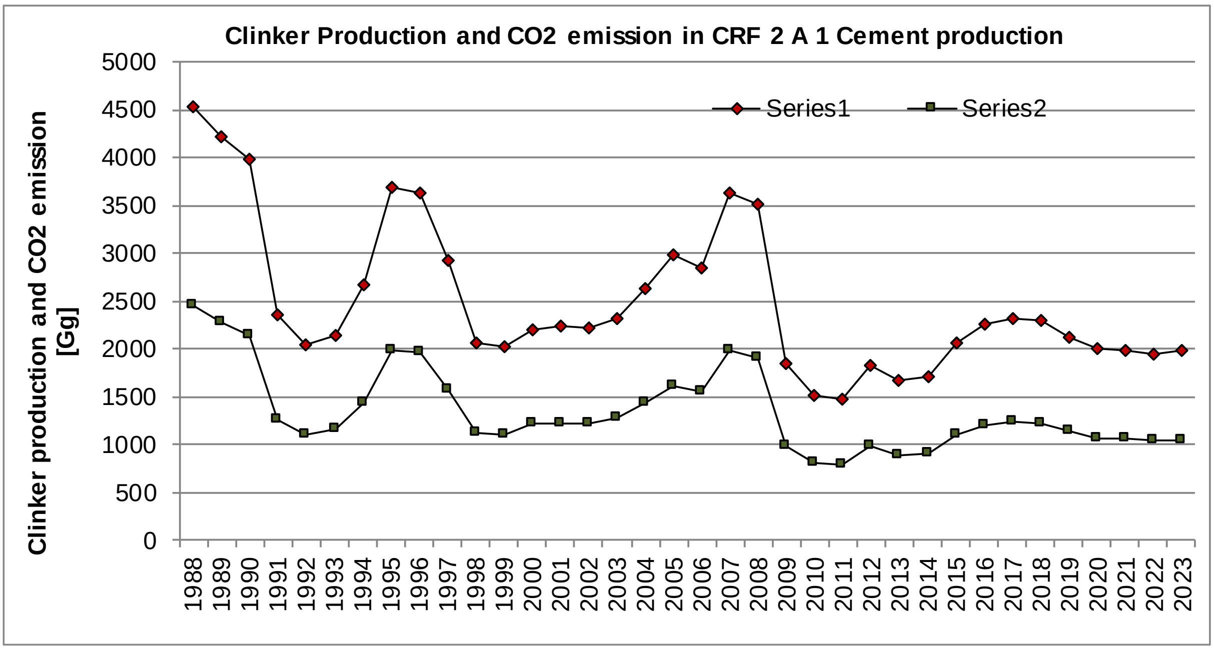


Figure 56 Clinker Production and CO2 emission in CRT 2 A 1 Cement production

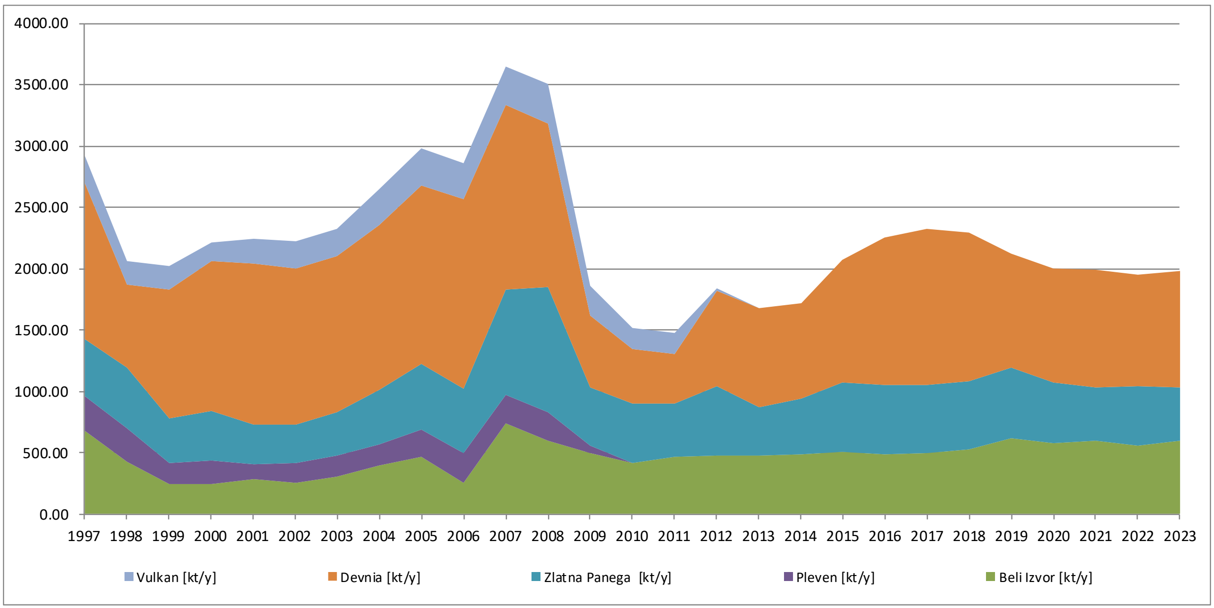


Figure 57 Clinker Production by plant

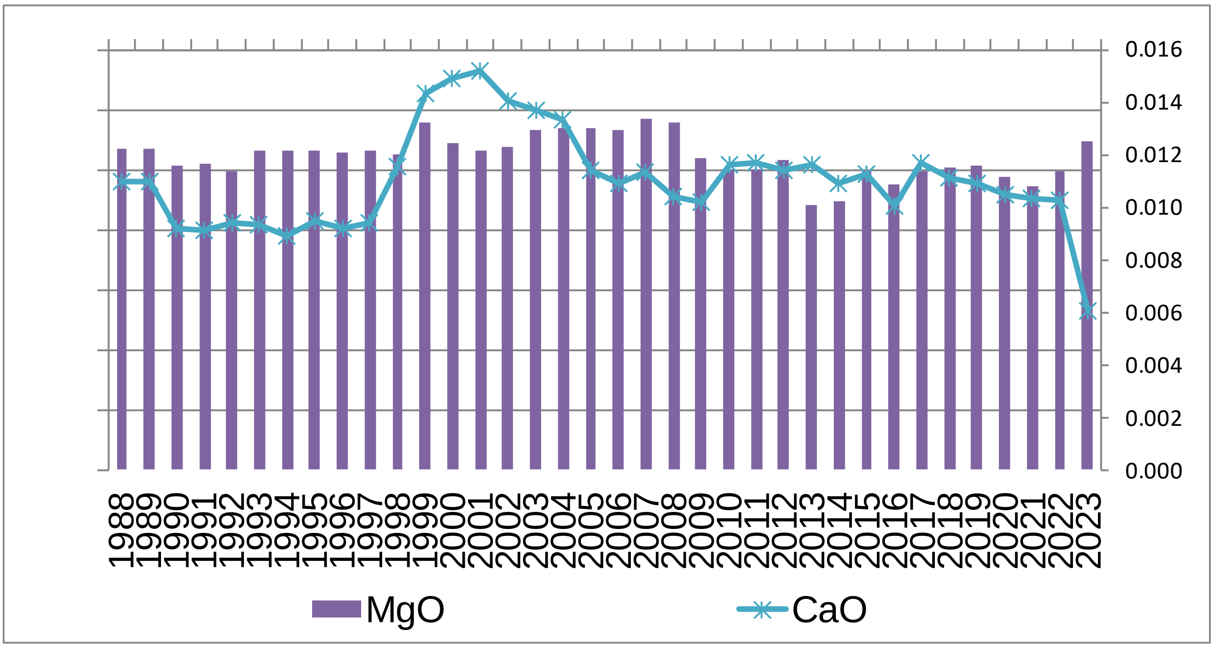


Figure 58 Average CaO and MgO for the country, based on plant specific activity data in logarithmic scale.

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 is taken from the annual reports under the IPPC permits. In addition, information for the content of calcium and magnesium oxide in the clinker is required from the plants.

The emissions calculations and the applied emission factor are according to equation 2.2 on pages 2.9 from item 2.2.1.1 (2006 IPCC GL):

$$\textbf{Emissions} = \textbf{EF}_{\textbf{clinker}} \bullet \textbf{CP} \bullet \textbf{CKD Correction Factor}$$

$$\textbf{EF}_{\textbf{clinker}} = \sum \textbf{M} \bullet \textbf{C}_{\textbf{(MeO)}}$$

$$C_{(MeO)} = ((\sum Cn_{(MeO)}) \bullet CPn) / CP)/100$$

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 2009-2023) 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 = 0.533• CP (for 2023)

The CO_2 emissions for 2023 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 2023. 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

Clinker Production Data		IEF [kt CO2/ kt production]	CO2 Emissions [kt]
Year	[kt/y]		
2008	3509,82	0,541	1899,69
2009	1858,85	0,529	982,97
2010	1514,55	0,533	807,29
2011	1475,70	0,534	787,30
2012	1839,27	0,534	981,29
2013	1676,00	0,532	891,63
2014	1716,92	0,531	911,12
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	0,535	1137,77
2020	1999,88	0,533	1065,90
2021	1989,26	0,533	1060,39
2022	1951,98	0,533	1039,99
2023	1986,48	0,527	1045,91

Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 1997/1998 and 2008/2010 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%

4.2.1.4 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 publically available at: http://eea.government.bg/bg/r-r/r-te/verifitsirani-dokladi-19

4.2.1.5 Source specific recalculations

No recalculations were made in the sector for the inventory year.

4.2.1.6 Source specific planned improvements

Major improvements in this category are not planned.

4.2.2 LIME PRODUCTION (CRT 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.

The reduction in 2020 is because of the Covid – 19 pandemic many bussines have remained closed and reduced their production. Later in 2021 and 2022 a recocery of the trend can be seen.

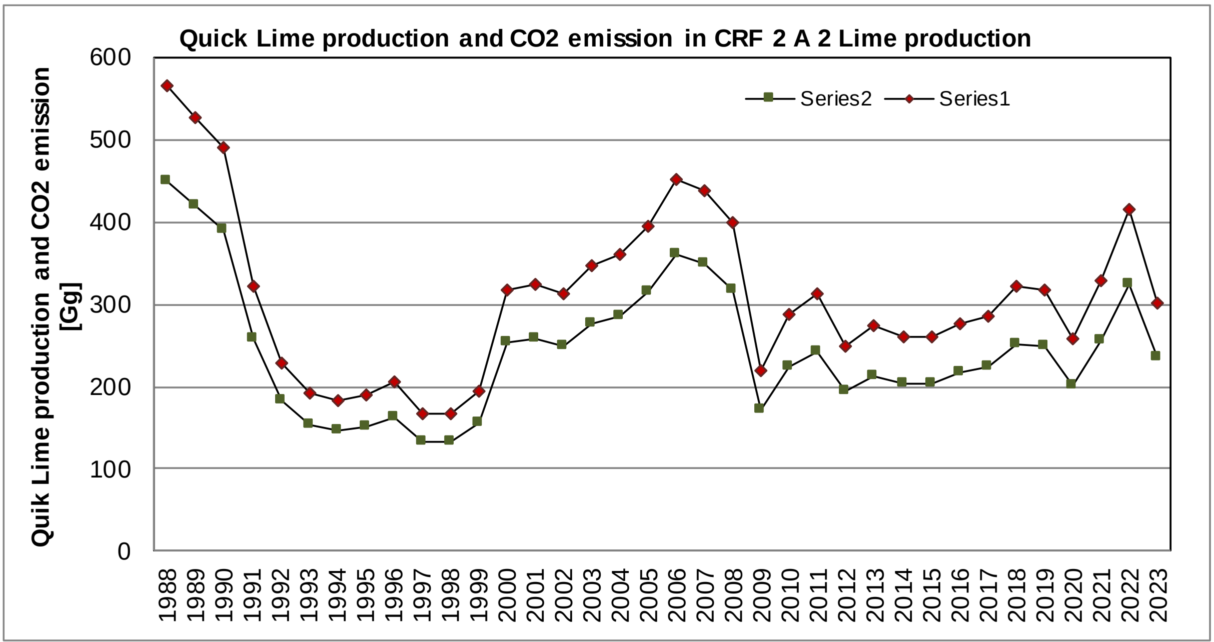


Figure 59 Lime Production and CO_2 emission in CRT 2.A.2 Lime production

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):

CO_2 Emissions = $\sum (EF_{Lime,i} \cdot M_{Lime,i} \cdot CF_{LKD,I})$

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.

$M_{Lime} = 0.85 \cdot M_{high\ calciumlime} + 0.15 \cdot M_{dolomitic\ lime}$

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.

The reduction in 2008 – 2009 reduction in the construction works and other quicklime consuming production processes and world economic crises lead to reduction in the Imlied emissionfactor in 2008.

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.
IEF = AD Lime Production [kt/y] / C2O Emmissions [kt CO_2].

4.2.2.3.3 Activity data

Country specific data on the total lime production (quicklime) are provided by the National Statistical Institute (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	0,80	450,07
1989	527,93	0,80	420,38
1990	490,39	0,80	390,49
1991	323,18	0,80	257,34
1992	228,88	0,80	182,26
1993	192,93	0,80	153,62
1994	183,49	0,80	146,11
1995	190,48	0,80	151,67
1996	205,21	0,80	163,40
1997	167,39	0,80	133,29
1998	167,90	0,80	133,70
1999	195,22	0,80	155,45
2000	318,70	0,80	253,78
2001	323,84	0,80	257,87
2002	312,45	0,80	248,80
2003	346,88	0,80	276,21
2004	359,90	0,80	286,59
2005	395,12	0,80	314,63
2006	452,75	0,80	360,52
2007	439,09	0,80	349,64
2008	399,27	0,80	317,93
2009	220,38	0,78	171,91
2010	288,60	0,78	225,13
2011	312,25	0,78	243,58
2012	249,03	0,78	194,26
2013	273,62	0,78	213,45
2014	260,94	0,78	203,55
2015	261,59	0,78	204,06
2016	277,69	0,78	216,61
2017	286,55	0,78	223,53
2018	322,69	0,78	251,72
2019	318,73	0,78	248,63
2020	257,98	0,78	201,24
2021	327,99	0,78	255,85
2022	416,13	0,78	324,61
2023	301.74	0.78	235.38

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 (CRT 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 production 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.

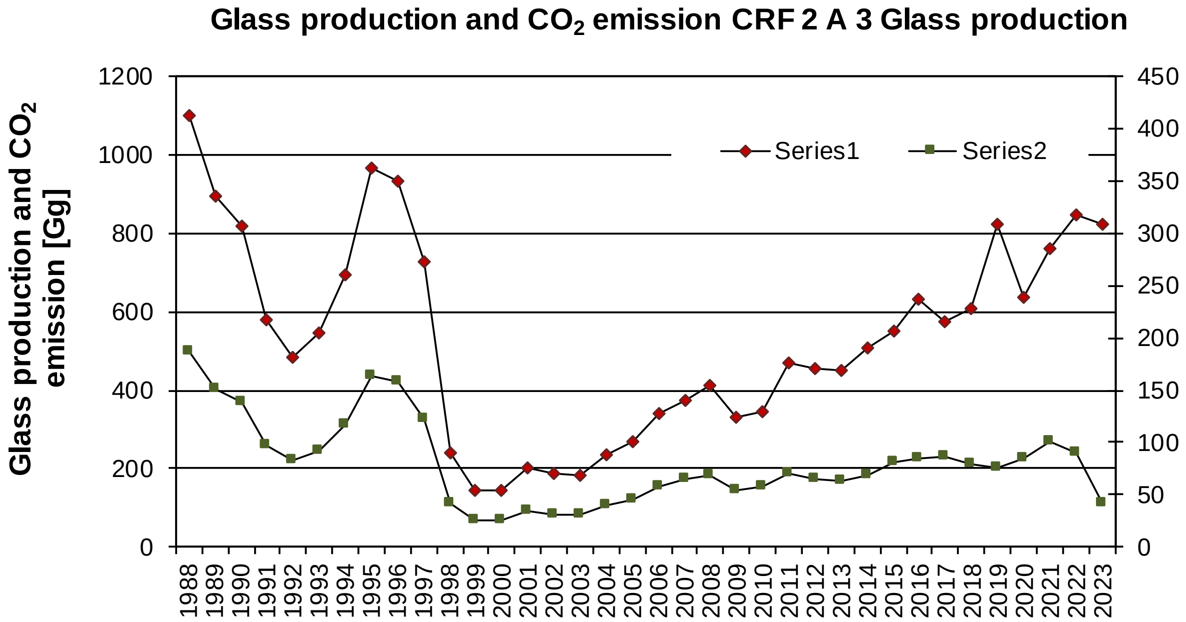


Figure 60 Glass Production and CO_2 emission in CRT 2.A.3 Glass production

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 - 2023 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 7). 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 – 2023. For the time series 1988 – 2023 statistical activity data was 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 CRT 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	0,17	186,24
1989	896,74	0,17	151,54
1990	818,04	0,17	138,24
1991	579,65	0,17	97,96
1992	485,66	0,17	82,07
1993	547,33	0,17	92,49
1994	694,82	0,17	117,42
1995	968,79	0,17	163,72
1996	935,62	0,17	158,11
1997	727,54	0,17	122,95
1998	242,41	0,17	40,97
1999	145,54	0,17	24,60
2000	146,66	0,17	24,78
2001	199,59	0,17	33,73
2002	186,58	0,17	31,53
2003	180,62	0,17	30,52
2004	237,31	0,17	40,10
2005	267,94	0,17	45,28
2006	340,01	0,17	57,46
2007	374,65	0,17	64,21
2008	410,19	0,17	68,33
2009	332,20	0,16	54,21
2010	344,16	0,17	57,11
2011	468,41	0,15	70,35
2012	454,32	0,14	64,62
2013	452,32	0,14	62,54
2014	508,00	0,14	68,64
2015	550,91	0,15	80,41
2016	631,60	0,13	84,01
2017	575,64	0,15	85,78
2018	607,46	0,13	79,40
2019	612,27	0,12	76,06
2020	635,40	0,13	84,83
2021	764,13	0,13	100,03
2022	849,94	0,11	90,77
2023	824,13	0,05	40,84

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., m^2). 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

For the subsector it is planned to obtain more detailed activity data and to reallocate the emissions from 2A4b, on soda ash used in glass production. This improvement has not yet been implemented.

4.2.4 OTHER PROCESS USES OF CARBONATES (CRT 2.A.4): CERAMICS PRODUCTION (CRT 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.

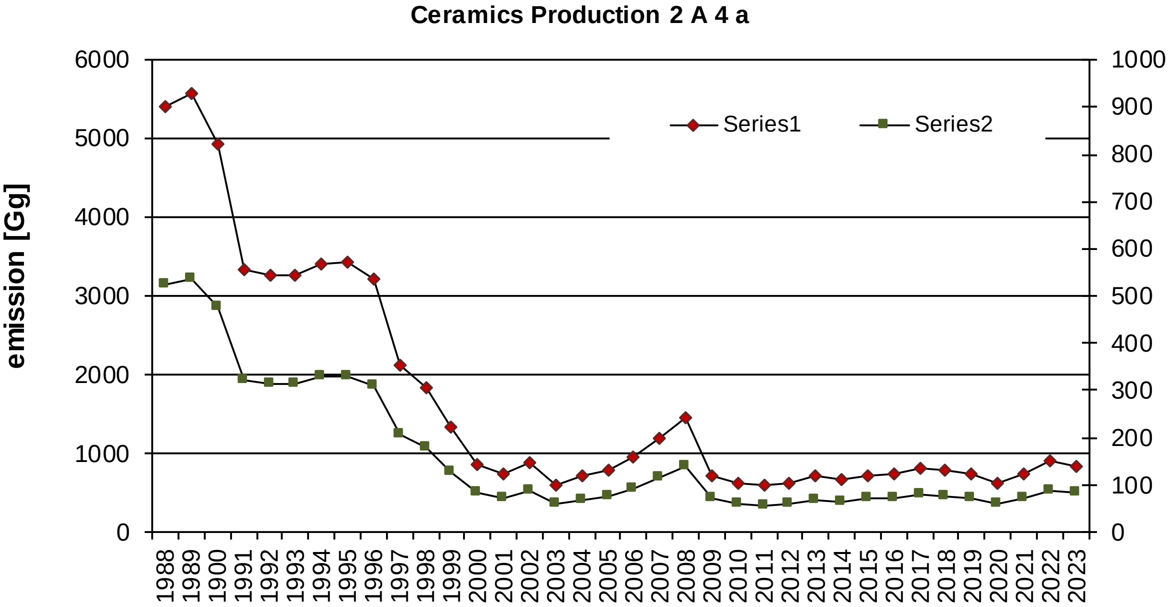


Figure 61 Ceramics Production and CO_2 emission in 2A4a "Other Process Uses of Carbonates"

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 for 2A4a Ceramic Production (Bricks and Tiles).

In emissions estimations the general approach described in the 2006 IPCC Guidelines is applied using the following equation:

TOTAL CO_2 = (AD • 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 are given in the following table.

Table 120 Ceramic production and CO2 emission in CRT 2.A.4.a

Year	Ceramic Production (CP) [kt/y]	Emission Factor [kt CO_2/kt CP]	CO_2 Emissions [kt CO_2]
1988	5419,08	0,096	522,51
1989	5571,17	0,096	537,17
1990	4929,78	0,096	475,33
1991	3338,48	0,096	321,90
1992	3255,69	0,096	313,91
1993	3268,13	0,096	315,11
1994	3418,26	0,096	329,59
1995	3428,06	0,096	330,53
1996	3218,09	0,096	310,29
1997	2124,06	0,096	204,80
1998	1845,24	0,096	177,92
1999	1329,34	0,096	128,17
2000	859,69	0,096	82,89
2001	745,66	0,096	71,90
2002	892,53	0,096	86,06
2003	598,29	0,096	57,69
2004	716,09	0,096	69,05
2005	790,03	0,096	76,17
2006	947,76	0,096	91,38
2007	1188,96	0,096	114,64
2008	1450,24	0,096	139,83
2009	725,03	0,096	69,91
2010	621,63	0,096	59,94
2011	585,70	0,096	56,47
2012	615,71	0,096	59,37
2013	710,42	0,096	68,50
2014	660,14	0,096	63,65
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
2020	629,79	0,096	60,72
2021	740,61	0,096	71,41
2022	916,60	0,096	88,38
2023	845,94	0,096	81,57

** 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 (CRT 2.A.4): SODA ASH USE (CRT 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 it is used about 80-90% of the total quantity used 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 caused by a new approach used to calculate the amounts of soda ash used in the country as = production + export – import, and not on the actual used 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 caused by fluctuation in export: approximately 100 000 t less quantity exported than previous years, approximately the same amount of output and about 2000 t more imported quantity compared to 2005.

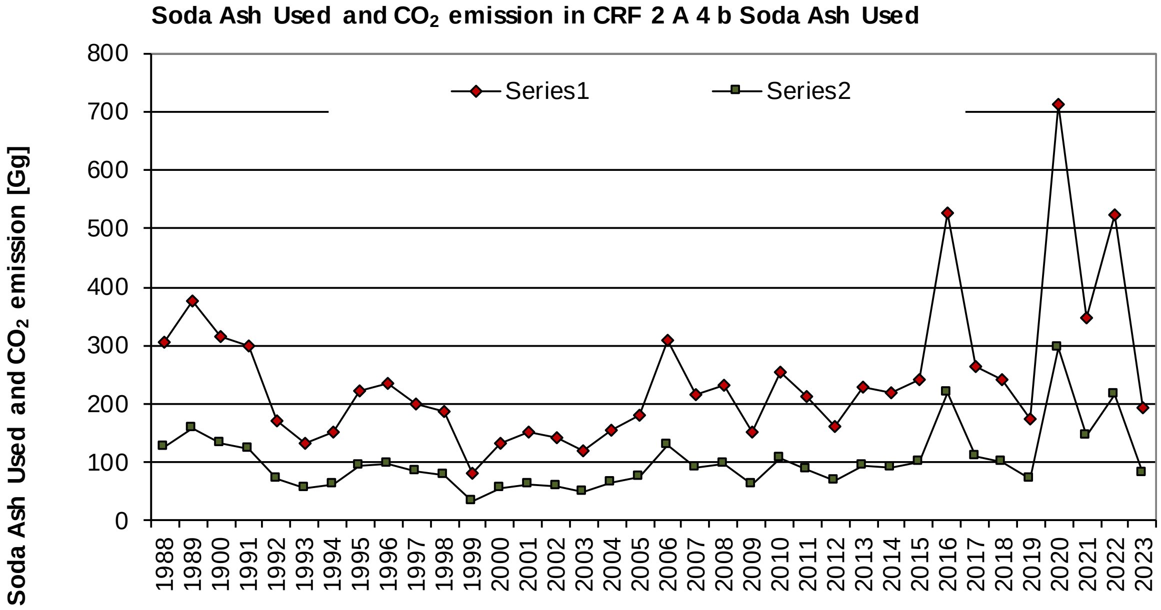


Figure 62 Soda ash used and CO_2 emission in CRT 2.A.4.b "Other Process Uses of Carbonates"

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:

TOTAL CO_2 = AD • 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 are given in the following table along with the implied emission factor.

Table 121 Soda ash used and CO2 emission in CRT 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
1989	376,79	415,229	156,45
1990	316,39	415,229	131,37
1991	297,79	415,229	123,65
1992	171,96	415,229	71,40
1993	131,96	415,229	54,79
1994	151,86	415,229	63,06
1995	223,34	415,229	92,74
1996	234,48	415,229	97,36
1997	199,95	415,229	83,03
1998	186,70	415,229	77,53
1999	81,41	415,229	33,80
2000	133,50	415,229	55,43
2001	150,73	415,229	62,59
2002	141,56	415,229	58,78
2003	119,17	415,229	49,48
2004	155,47	415,229	64,55
2005	179,07	415,229	74,35
2006	307,56	415,229	127,71
2007	214,85	415,229	89,21
2008	232,72	415,229	96,63
2009	150,95	415,229	62,68
2010	254,42	415,229	105,64
2011	211,72	415,229	87,91
2012	161,80	415,229	67,18
2013	227,35	415,229	94,40
2014	217,94	415,229	90,49
2015	242,46	415,229	100,68
2016	528,03	415,229	219,25
2017	264,95	415,229	110,01
2018	240,60	415,229	99,91
2019	174,34	415,229	72,39
2020	475,06	415,229	197,26
2021	347,20	415,229	144,17
2022	522,77	415,229	217,07
2023	194,11	415,229	80,60

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 during the reporting year.

4.2.5.7 Source specific planned improvements

For the subsector it is planned to obtain more detailed activity data and to reallocate the emissions from 2A4b, on soda ash used in glass production. This improvement has not yet been implemented.

4.2.6 OTHER PROCESS USES OF CARBONATES (CRT 2.A.4): DESULPHURISATION CRT 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:

<u>Use of adsorbents in fluidised bed combustion systems</u>

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).

<u>Wet scrubbers</u>

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.

The reduction in 2020 is because of the Covid – 19 pandemic many bussines have remained closed and reduced their production. In 2021 and 2022 an up – going tendency can be seen. Then in 2023 the trend will start coming to a stable rate.

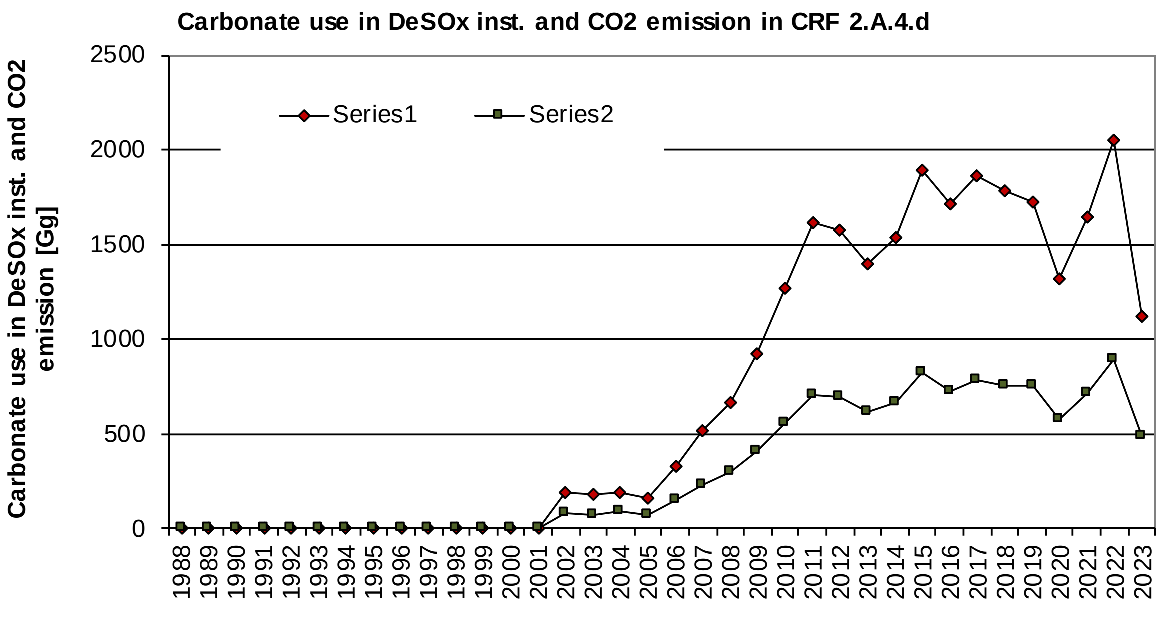


Figure 63 CaCO3, MgCO3 use and CO2 emission in CRT 2.A.4.d "Other Process Uses of Carbonates"

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:

CO_2 Emissions = (M_{Ca} • EF_{Ca}) + (M_{Mg} • 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 CRT 2.A.3 Limestone and dolomite use.

Table 122 Carbonate use in DeSOx inst.(CaCO3 and MgCO3) use and CO2 emission in CRT 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]
1988-2001	0,0	-	0
2002	183,58	0,440	80,77
2003	173,28	0,416	72,10
2004	192,61	0,440	84,75
2005	154,26	0,440	67,87
2006	326,62	0,440	143,71
2007	518,91	0,440	228,32
2008	663,61	0,440	292,19
2009	919,70	0,440	404,66
2010	1271,65	0,438	556,68
2011	1618,22	0,438	708,16
2012	1572,51	0,439	690,11
2013	1400,64	0,436	610,83
2014	1532,72	0,436	667,83
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	1721,55	0,436	750,95
2020	1313,87	0,435	572,19
2021	1646,52	0,435	717,05

2022	2049,07	0,435	890,44
2023	1114,97	0,434	483,58

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 (CRT 2.B)

4.3.1 AMMONIA PRODUCTION (CRT 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 → 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 (CO_2) at high temperature and pressure to form ammonium carbamate ($H_2N\text{-}COONH_4$):

$$2NH_3 + CO_2 \rightleftharpoons H2N\text{-}COONH_4$$

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 has been stopped since 2003 with enclosure of operations of two of the four factories for the production of fertilizers in Bulgaria. The two remaining plants do not produce urea.

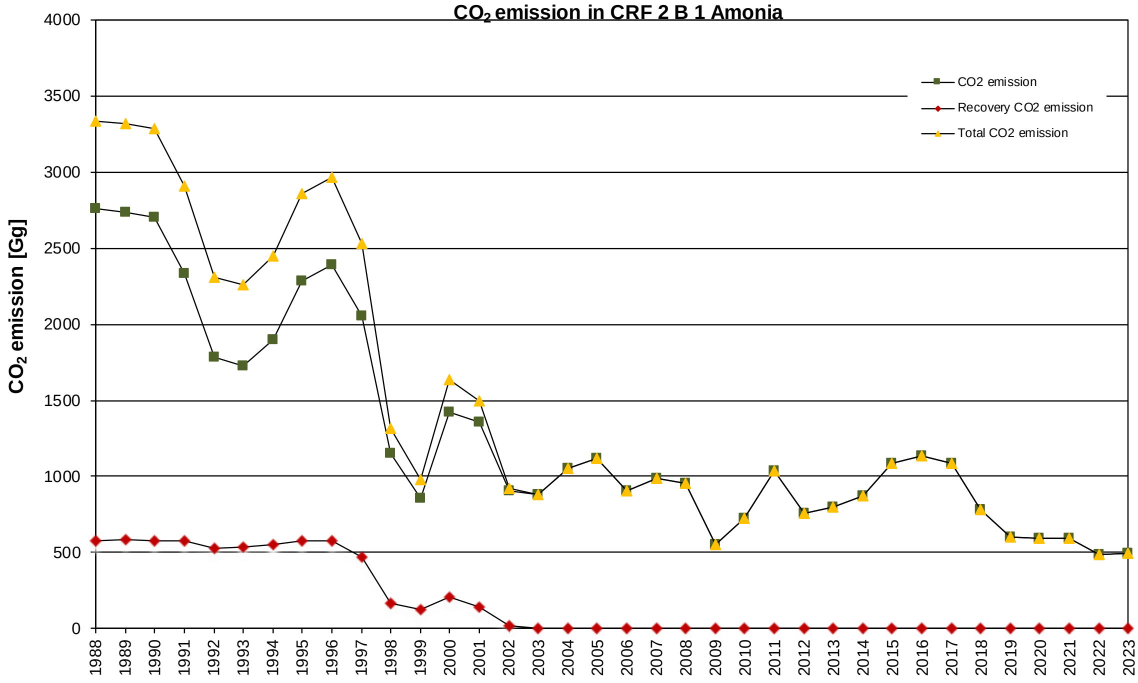


Figure 64 CO2 emissions, recovery CO2 emissions and total CO2 emissions in CRT 2 B 1 Ammonia production

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

$$\boldsymbol{TFR_i = \sum_j (AP_{ij} \times FR_{ij})}$$

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

$$\boldsymbol{E_{CO_2} = \sum_i \left(TFR_i \times CCF_i \times COF_i \times \frac{44}{12}\right) - R_{CO_2}}$$

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. For more information refer to the relevant part of the BG NID.

Table 124 Ammonia production and CO2 emission in CRT 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 *(without urea)* [Gg CO_2]	Recovery CO_2 Emissions *(urea)*[Gg CO_2]
1988	PS data / NSI	C	C	3135,82	3135,82	578,35
1989	PS data / NSI	C	C	3117,49	3117,49	582,51
1990	PS data / NSI	C	C	3086,75	3086,75	578,89
1991	PS data / NSI	C	C	2735,18	2735,18	573,68
1992	PS data / NSI	C	C	2172,80	2172,80	530,31
1993	PS data / NSI	C	C	2126,91	2126,91	536,29
1994	PS data / NSI	C	C	2302,31	2302,31	554,81
1995	PS data / NSI	C	C	2690,86	2690,86	577,19
1996	PS data / NSI	C	C	2787,39	2787,39	576,60
1997	PS data / NSI	C	C	2375,82	2375,82	473,44
1998	PS data / NSI	C	C	1318,42	1318,42	169,15
1999	PS data / NSI	C	C	983,09	983,09	126,57
2000	PS data / NSI	C	C	1634,10	1634,10	209,59
2001	PS data / NSI	C	C	1493,80	1493,80	139,53
2002	PS data / NSI	C	C	919,29	919,29	16,79
2003	PS data	C	C	884,10	884,10	0,00
2004	PS data	C	C	1051,19	1051,19	0,00

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 (*without urea*) [Gg CO_2]	Recovery CO_2 Emissions (*urea*)[Gg CO_2]
2005	PS data	C	C	1121,06	1121,06	0,00
2006	PS data	C	C	908,57	908,57	0,00
2007	PS data	C	C	983,35	983,35	0,00
2008	PS data	C	C	957,38	957,38	0,00
2009	PS data	C	C	549,63	549,63	0,00
2010	PS data	C	C	726,11	726,11	0,00
2011	PS data	C	C	1035,75	1035,75	0,00
2012	PS data	C	C	757,51	757,51	0,00
2013	PS data	C	C	802,18	802,18	0,00
2014	PS data	C	C	872,52	872,52	0,00
2015	PS data	C	C	1084,79	1084,79	0,00
2016	PS data	C	C	1137,62	1137,62	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
2020	PS data	C	C	592,92	592,92	0,00
2021	PS data	C	C	594,52	594,52	0,00
2022	PS data	C	C	485,63	485,63	0,00
2023	PS data	C	C	492,94	492,94	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 CRT 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 (CRT 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:

$4\ NH_3 + 3\ O_2 = 2\ N_2 + 6\ H_2O$

$4\ NH_3 + 4\ O_2 = 2\ N2O + 6\ H_2O$

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:

$2\ NO + O_2 = 2\ NO_2$

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:

$3\ NO_2 + H_2O = 2\ HNO_3 + NO$

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. In the period 2008/2009 the world economic crisis gave its print on the rates of production in the country.

Emission reduction also is caused by implementin of new and efficient facilities:

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.

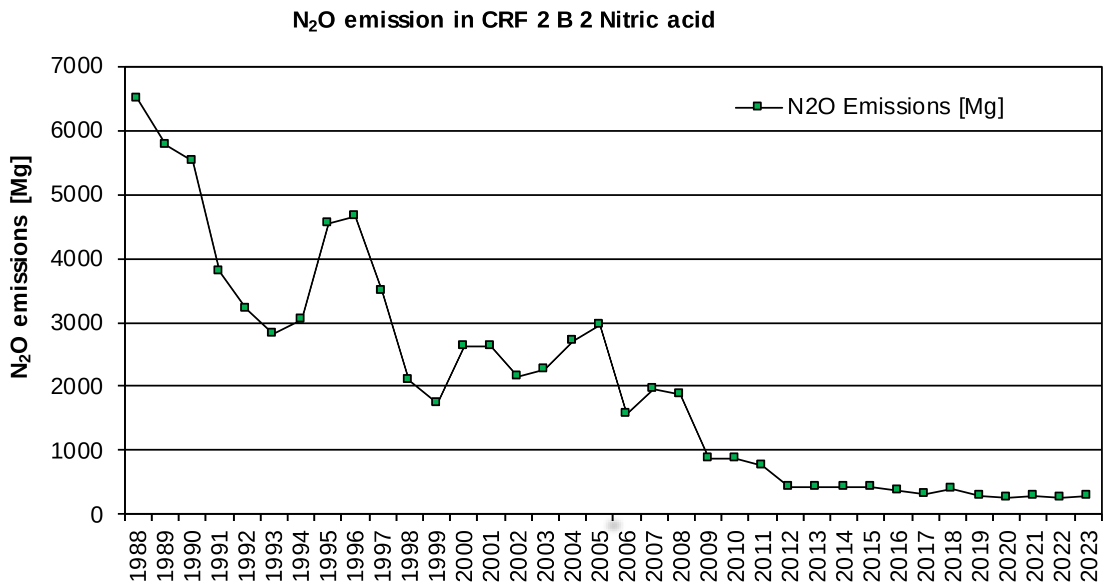


Figure 65 Nitric acid production and N2O emission in CRT 2 B 2 Nitric acid production

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:

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 and unfortunately nowadays no information can be obtained.

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 the NSI were used.

The following questionnaire is regularly sent to the plant operators:

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
1989	PS data / NSI	C	C	5.77
1990	PS data / NSI	C	C	5.53
1991	PS data / NSI	C	C	3.80
1992	PS data / NSI	C	C	3.20
1993	PS data / NSI	C	C	2.82
1994	PS data / NSI	C	C	3.04
1995	PS data / NSI	C	C	4.54
1996	PS data / NSI	C	C	4.67
1997	PS data / NSI	C	C	3.49
1998	PS data / NSI	C	C	2.09
1999	PS data / NSI	C	C	1.73
2000	PS data	C	C	2.63
2001	PS data	C	C	2.63
2002	PS data	C	C	2.16
2003	PS data	C	C	2.26
2004	PS data	C	C	2.72
2005	PS data	C	C	2.95
2006	PS data	C	C	1.58
2007	PS data	C	C	1.95
2008	PS data	C	C	1.87
2009	PS data	C	C	0.88
2010	PS data	C	C	0.86
2011	PS data	C	C	0.76
2012	PS data	C	C	0.42
2013	PS data	C	C	0.41
2014	PS data	C	C	0.42
2015	PS data	C	C	0.42
2016	PS data	C	C	0.38
2017	PS data	C	C	0.31

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]
2018	PS data	C	C	0.39
2019	PS data	C	C	0.29
2020	PS data	C	C	0.27
2021	PS data	C	C	0.28
2022	PS data	C	C	0.25
2023	PS data	C	C	0.28

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 CRT 2.B.2 Nitric acid production the production data and the EF as well as IEF is marked as confidential "C", because the 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 work in 1999 – 2000, statistical data had to be used. Therefore an uncertainty of 2 % 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 (CRT 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:

$$CaO + 3C \rightarrow CaC_2 + CO \ (+ \tfrac{1}{2} O_2 \rightarrow CO_2)$$

The CaO used for carbide production is produced by the same plant from limestone. This limestone usage is included in CRT 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:

CaC2 + 2H2O → Ca(OH)2 + C2H2 (+ 2.5O2 → 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.

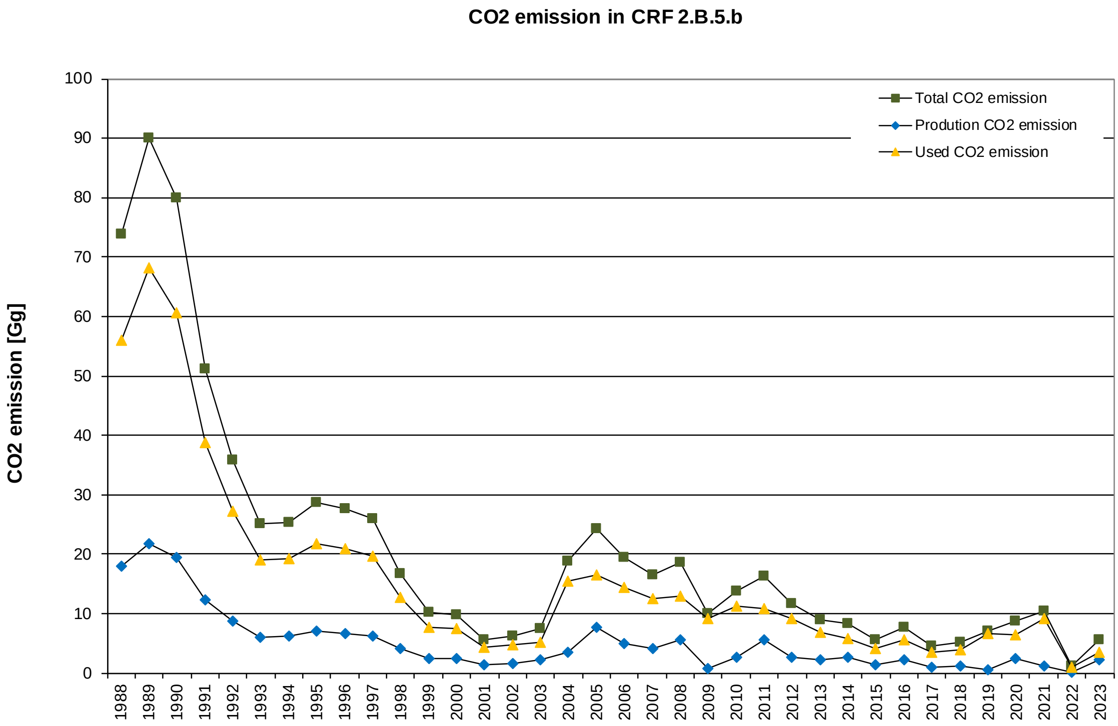


Figure 66 CO_2 emission of Carbide production and use in in logarithmic scale for CRT 2.B.5.b

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:

$$\mathbf{E_{CO2} = (ADc \cdot EFc + ADe \cdot EFe - ADp \cdot EFp) \cdot 44/12}$$

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

$$\mathbf{ECO2 = ADp \cdot EFp \cdot 44/12}$$

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 CRT 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	73,94	17,89	56,04
1989	C	C	89,94	21,77	68,18
1990	C	C	79,89	19,34	60,56
1991	C	C	51,16	12,38	38,78
1992	C	C	35,76	8,65	27,11
1993	C	C	25,12	6,08	19,04
1994	C	C	25,35	6,13	19,21
1995	C	C	28,65	6,93	21,72
1996	C	C	27,61	6,68	20,93
1997	C	C	26,01	6,30	19,72
1998	C	C	16,68	4,04	12,64
1999	C	C	10,17	2,46	7,71
2000	C	C	9,85	2,38	7,47
2001	C	C	5,63	1,36	4,27
2002	C	C	6,25	1,51	4,74
2003	C	C	7,37	2,18	5,19
2004	C	C	18,70	3,37	15,34
2005	C	C	24,20	7,67	16,53
2006	C	C	19,37	4,90	14,46
2007	C	C	16,54	4,11	12,43
2008	C	C	18,52	5,52	13,00
2009	C	C	10,03	0,81	9,22
2010	C	C	13,70	2,56	11,14
2011	C	C	16,35	5,55	10,80
2012	C	C	11,64	2,54	9,10
2013	C	C	9,01	2,14	6,88
2014	C	C	8,25	2,54	5,71
2015	C	C	5,54	1,43	4,11
2016	C	C	7,63	2,16	5,48
2017	C	C	4,46	1,05	3,42
2018	C	C	5,15	1,23	3,92
2019	C	C	7,12	0,46	6,65

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]
2020	C	C	8,81	2,32	6,49
2021	C	C	10,45	1,26	9,20
2022	C	C	1,11	0,11	1,01
2023	C	C	5,52	2,14	3,38

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 CRT 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:

Two aspects are relevant (2006 IPCC GL, p. 3.45)

Where activity data are obtained directly from plants, uncertainty estimates can be obtained from operators. This will include uncertainty estimates for petroleum coke and limestone used and for carbide production data. Data obtained from national statistical agencies or from industrial and trade organizations usually does not include uncertainty estimates. It is good practice to consult the national statistical agencies in order 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:

In general, the default CO_2 emission factors are relatively uncertain because industrial-scale carbide production 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 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 (CRT 2.B.6)

There is no production of Titanium Dioxide In Bulgaria.

4.3.7 SODA ASH PRODUCTION (CRT 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 plant and 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. A revitalization period followed and the production rates were restored to some degree.

The reason for the declining from 2018 to 2019 is market fluctuation and is not a stable rate decrease. The reduction in 2020 is because of the Covid – 19 pandemic many bussines have remained closed and reduced their production. Since 2021 a process of recoverycan be seen.

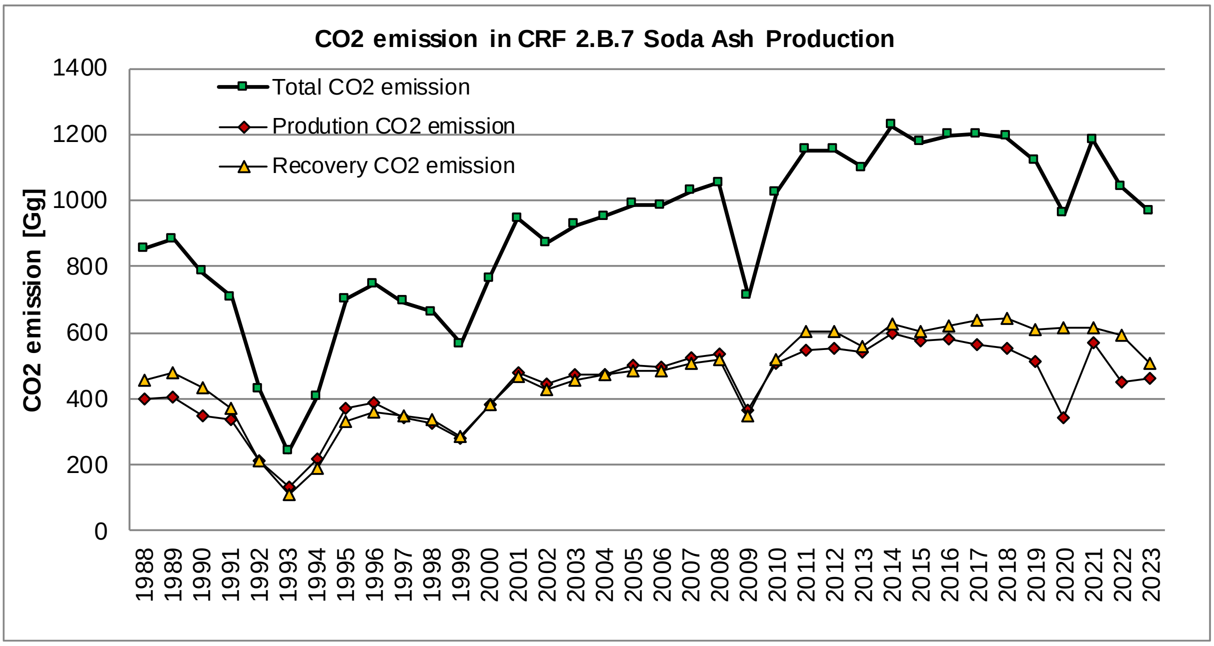


Figure 67 Soda ash production and CO_2 emission in CRT 2.B.7

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:

$E_{CO2} = E_{CO2}$ (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 CRT 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
1989	C	C	883,38	404,63	478,75
1990	C	C	783,55	349,14	434,41
1991	C	C	707,83	336,92	370,91
1992	C	C	426,55	212,02	214,53
1993	C	C	239,17	131,44	107,73
1994	C	C	404,91	217,66	187,25
1995	C	C	701,22	370,68	330,54
1996	C	C	747,22	387,60	359,62
1997	C	C	691,89	342,79	349,10
1998	C	C	660,79	322,85	337,94
1999	C	C	565,83	279,08	286,75
2000	C	C	763,55	379,54	384,01
2001	C	C	946,05	479,71	466,34
2002	C	C	871,68	442,62	429,05
2003	C	C	926,11	471,25	454,85
2004	C	C	950,16	475,94	474,22
2005	C	C	988,47	503,30	485,17
2006	C	C	985,37	498,51	486,87
2007	C	C	1028,13	521,43	506,69
2008	C	C	1054,84	533,90	520,94
2009	C	C	709,69	362,61	347,08
2010	C	C	1024,44	504,88	519,55
2011	C	C	1151,87	548,82	603,05
2012	C	C	1151,67	550,17	601,50
2013	C	C	1099,71	538,76	560,95
2014	C	C	1227,85	599,18	628,67
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
2020	C	C	959,50	442,62	516,88
2021	C	C	1184,93	569,43	615,50
2022	C	C	1042,78	450,68	592,10
2023	C	C	965,90	460,03	505,87

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 proportional to 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 was used the uncertainty of 2 % for activity data can be 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 (CRT 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. In the official information from the National statistical institute there is no information about vinyl chloride production in the country.

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 for harmful substances.

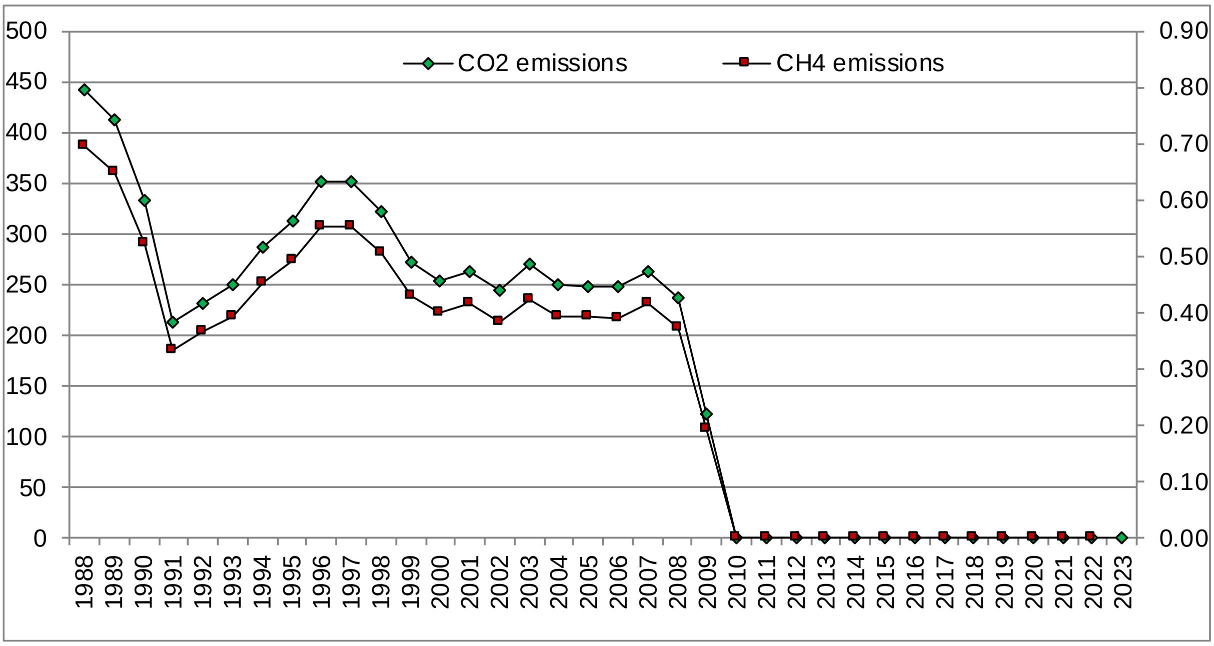


Figure 68 CO2 and CH4 emissions in CRT 2.B.2.b Ethylene production

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.

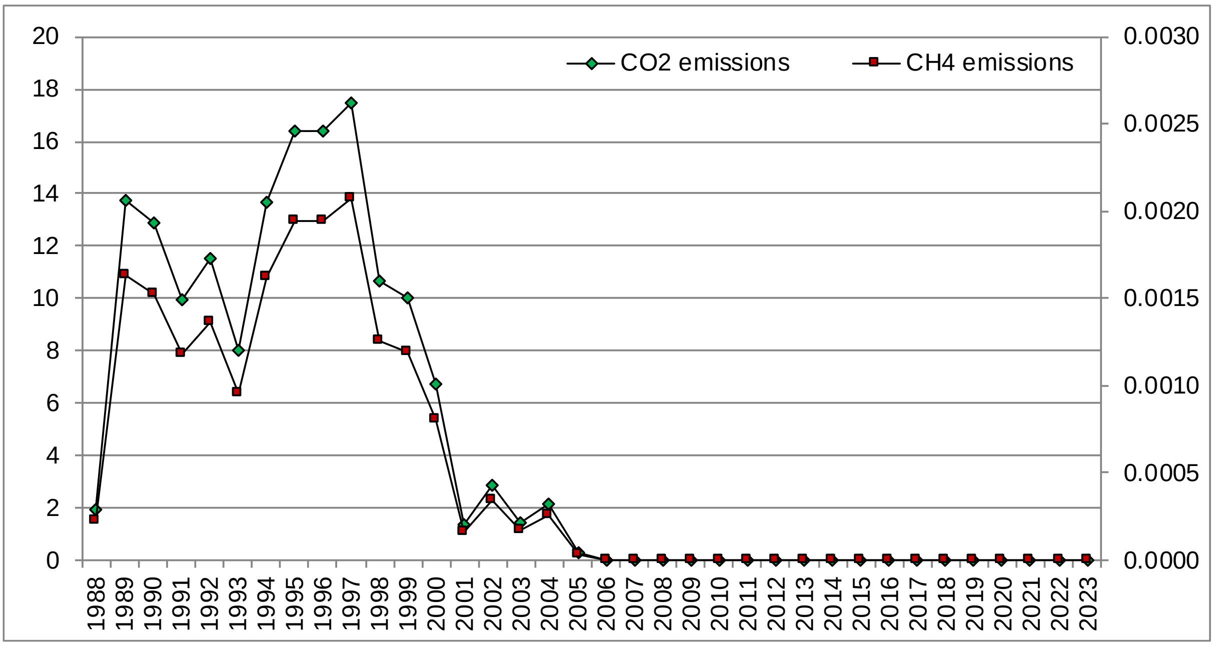


Figure 69 CO2 emissions in CRT 2.B.2.c Ethylene Dichloride production

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:

$$\text{TOTAL } CO_2/CH_4 = \sum(AD \cdot EF \cdot DGAF)$$

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:

$$\text{TOTAL } CO_2/CH_4 = \sum(AD \cdot EF)$$

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	30.41 %	11.18 %
AD	± 5 %	± 5 %
EF	± 30 %	± 10 %

Ethylene Dichloride (2.B.8.c)

	CO_2
Combined uncertainty	20.62 %
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, because of lack of activity in the moment.

4.3.9 FLUOROCHEMICAL PRODUCTION (2.B.9)

Fluorochemical production does not occur in Bulgaria.

4.4 METAL INDUSTRY (CRT 2.C)

4.4.1 IRON AND STEEL PRODUCTION (CRT 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. In Bulgaria in the beginning of the asesesment period

(1998), EU (15) steel production was based on the blast furnace/ basic-oxygen route (approximately 65%) and the electric arc furnace (EAF) route (approximately 35%).[23]

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.

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, is:

- to reduce the carbon content to a specified level (from approximately 4% to less than 1%, and often lower percent);
- 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;

[23] (ftp://ftp.jrc.es/pub/eippcb/doc/isp_bref_1201.pdf)

- 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%).

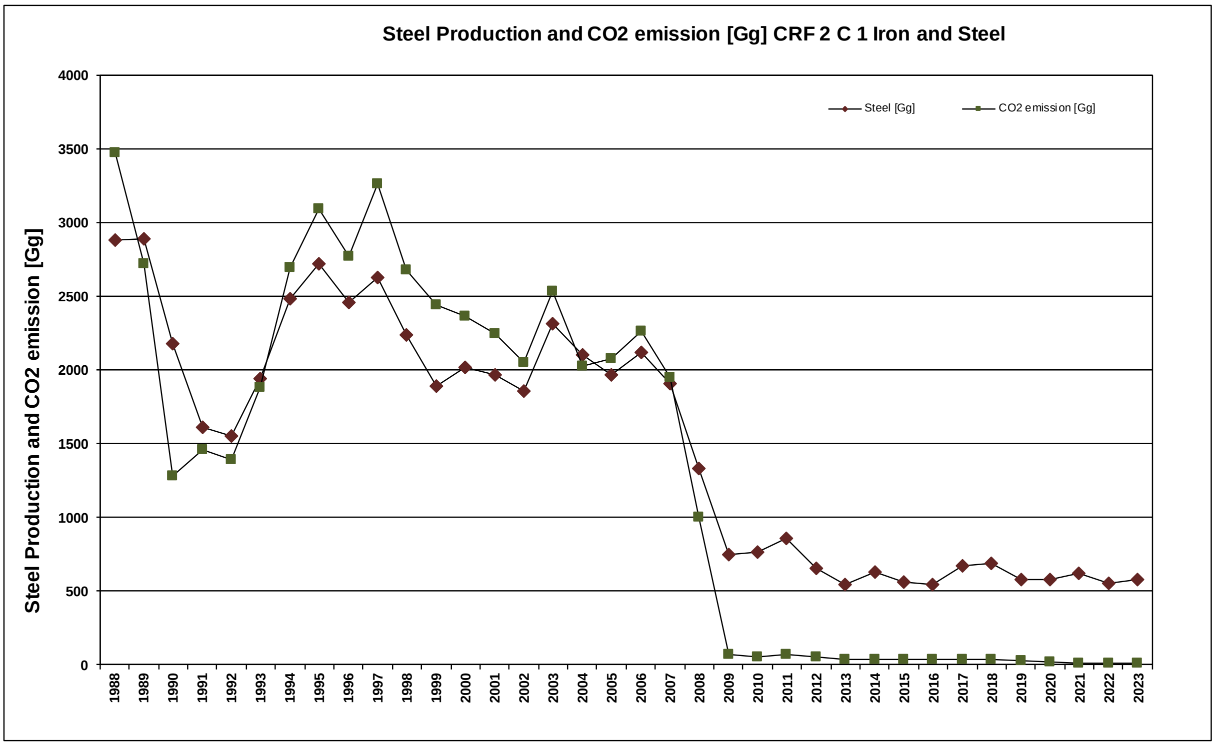


Figure 70 Iron and Steel Production and CO2 emission in CRT 2.C.1.a Iron and Steel production

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:

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	1,21	3481,44
1989	BAMI / WSA	2890,00	0,94	2724,87
1990	BAMI / WSA	2180,00	0,59	1283,24
1991	BAMI / WSA	1616,00	0,90	1460,58
1992	BAMI / WSA	1552,00	0,90	1392,13

Year	Steel Production	Steel Production [kt/y]	Emission Factor [kt CO_2/kt Steel]	CO_2 Emissions [kt CO_2]
1993	BAMI / WSA	1942,00	0,97	1883,71
1994	BAMI / WSA	2490,00	1,08	2697,12
1995	BAMI / WSA	2724,00	1,14	3095,68
1996	BAMI / WSA	2457,00	1,13	2771,76
1997	BAMI / WSA	2628,00	1,24	3268,68
1998	BAMI / WSA	2242,00	1,19	2676,82
1999	BAMI / WSA	1889,00	1,29	2444,83
2000	BAMI / WSA	2022,00	1,17	2368,01
2001	BAMI / WSA	1972,00	1,14	2247,66
2002	BAMI / WSA	1860,00	1,10	2055,21
2003	BAMI / WSA	2316,00	1,10	2537,47
2004	BAMI / WSA	2106,00	0,96	2031,37
2005	BAMI / WSA / ETS	1969,00	1,06	2078,16
2006	BAMI / WSA / ETS	2124,00	1,06	2261,72
2007	BAMI / WSA / ETS	1909,00	1,02	1953,25
2008	BAMI / WSA / ETS	1330,00	0,75	1003,16
2009	BAMI / WSA / ETS	744,53	0,10	74,17
2010	BAMI / WSA / ETS	761,41	0,07	53,47
2011	BAMI / WSA / ETS	858,92	0,08	67,96
2012	BAMI / WSA / ETS	653,88	0,08	50,33
2013	BAMI / WSA / ETS	541,23	0,06	32,65
2014	BAMI / WSA / ETS	634,03	0,06	40,22
2015	BAMI / WSA / ETS	563,76	0,07	37,22
2016	BAMI / WSA / ETS	549,04	0,07	35,86
2017	BAMI / WSA / ETS	673,47	0,05	35,17
2018	BAMI / WSA / ETS	686,91	0,05	35,38
2019	BAMI / WSA / ETS	579,17	0,05	31,58
2020	BAMI / WSA / ETS	579,43	0,04	21,98
2021	BAMI / WSA / ETS	617,57	0,02	10,76
2022	BAMI / WSA / ETS	551,75	0,02	10,55
2023	BAMI / WSA / ETS	574,99	0,02	11,90

As can be seen in Table 17 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 2009-2023, there is no BOF steel production in Bulgaria ceased 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

No recalculations were made.

4.4.1.7 Source specific planned improvements

No source specific improvements are planned.

4.4.2 PIG IRON PRODUCTION (CRT 2.C.1.B)

4.4.2.1 Source category description

There was one pig iron production plant in Bulgaria. Currently it has ceased operation (since November 2008) and has been under demolition.

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).

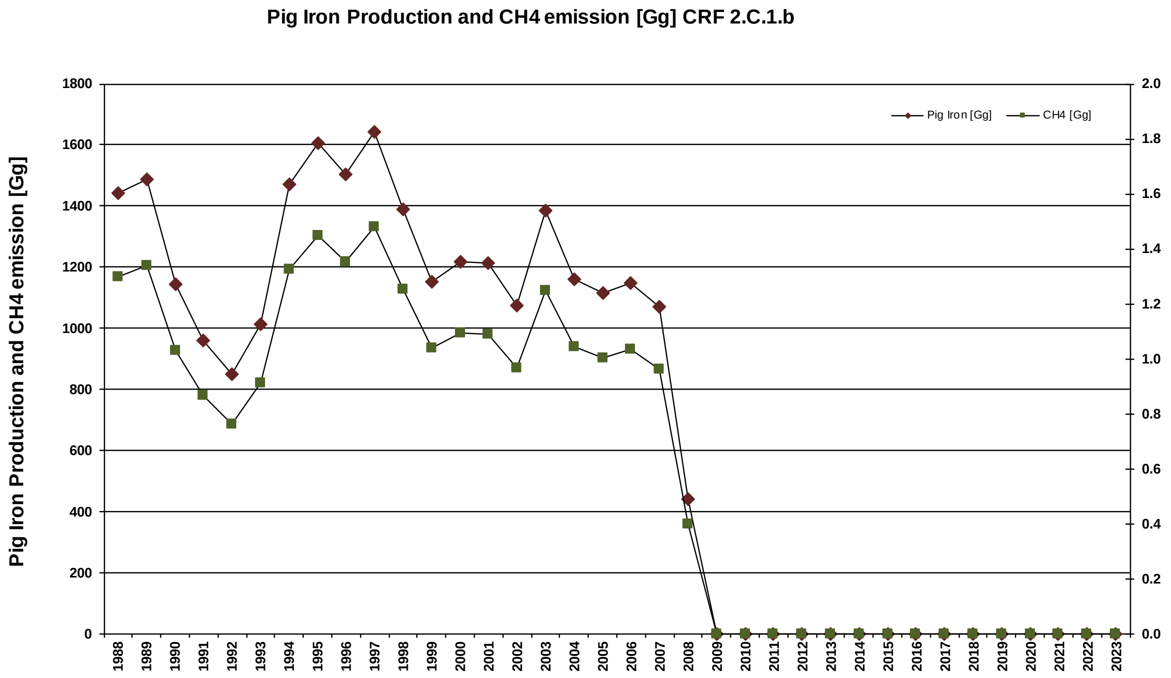


Figure 71 Pig iron Production and CH4 emission in CRT 2.C.1.b Pig iron production

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	0,9	1,30
1989	1487	0,9	1,34
1990	1143	0,9	1,03
1991	960	0,9	0,86
1992	848	0,9	0,76
1993	1013	0,9	0,91
1994	1470	0,9	1,32
1995	1607	0,9	1,45
1996	1504	0,9	1,35
1997	1643	0,9	1,48
1998	1390	0,9	1,25
1999	1152	0,9	1,04
2000	1216	0,9	1,09
2001	1211	0,9	1,09
2002	1072	0,9	0,96
2003	1386	0,9	1,25
2004	1158	0,9	1,04
2005	1115	0,9	1,00
2006	1147	0,9	1,03
2007	1069	0,9	0,96
2008	440	0,9	0,40
2009 – 2023	NO	0,9	NO

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 (CRT 2.C.1.C)

There is not direct reduced iron production In Bulgaria.

4.4.4 SINTER (CRT 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 (CRT 2.C.1.E)

There is not pellet co–production In Bulgaria.

4.4.6 FERROALLOYS PRODUCTION (CRT 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 2023.

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.

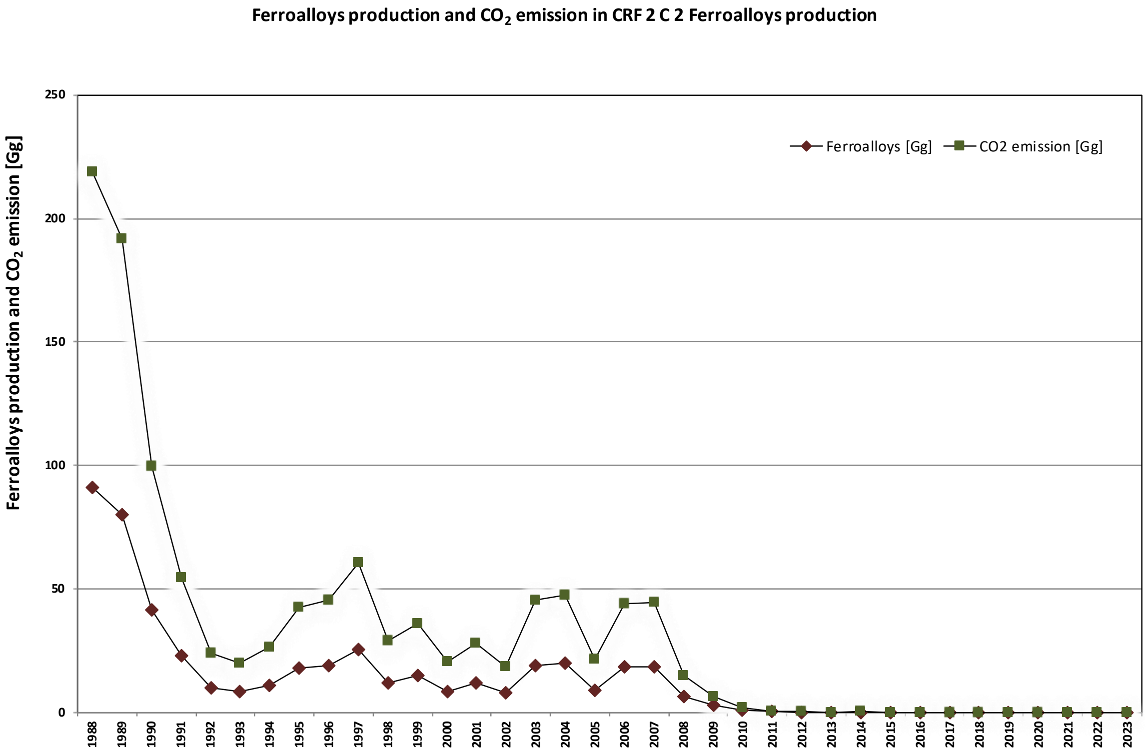


Figure 72 CO_2 and CH_4 emission in CRT 2.C.2 Ferroalloys production

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:

TOTAL $CO_2/CH_4 = \sum(AD_i \cdot EF_i)$

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
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 CRT 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
1989	C	0,07984	228,49
1990	C	0,04145	129,37
1991	C	0,02273	73,07
1992	C	0,00998	31,57
1993	C	0,00828	26,90
1994	C	0,01099	35,63
1995	C	0,01766	55,82
1996	C	0,01901	60,41
1997	C	0,02523	79,89
1998	C	0,01201	44,72
1999	C	0,01487	42,28
2000	C	0,00845	21,88
2001	C	0,01165	23,98
2002	C	0,00768	18,05
2003	C	0,01890	44,08
2004	C	0,01982	40,21
2005	C	0,00897	20,10
2006	C	0,01838	40,40
2007	C	0,01849	36,80
2008	C	0,00627	20,99
2009	C	0,00262	7,82
2010	C	0,00065	2,35
2011	C	0,00019	0,62
2012	C	0,00003	0,08
2013	C	0,00002	0,05
2014	C	0,00003	0,08
2015	C	0,00001	0,04

2016	C	0,00002	0,04
2017	C	0,00001	0,02
2018 – 2023	C	0,00000	0,00

In CRT 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 (CRT 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 (CRT 2.C.4)

In Bulgaria magnesium production does not occur.

4.4.9 LEAD PRODUCTION (CRT 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 was 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.

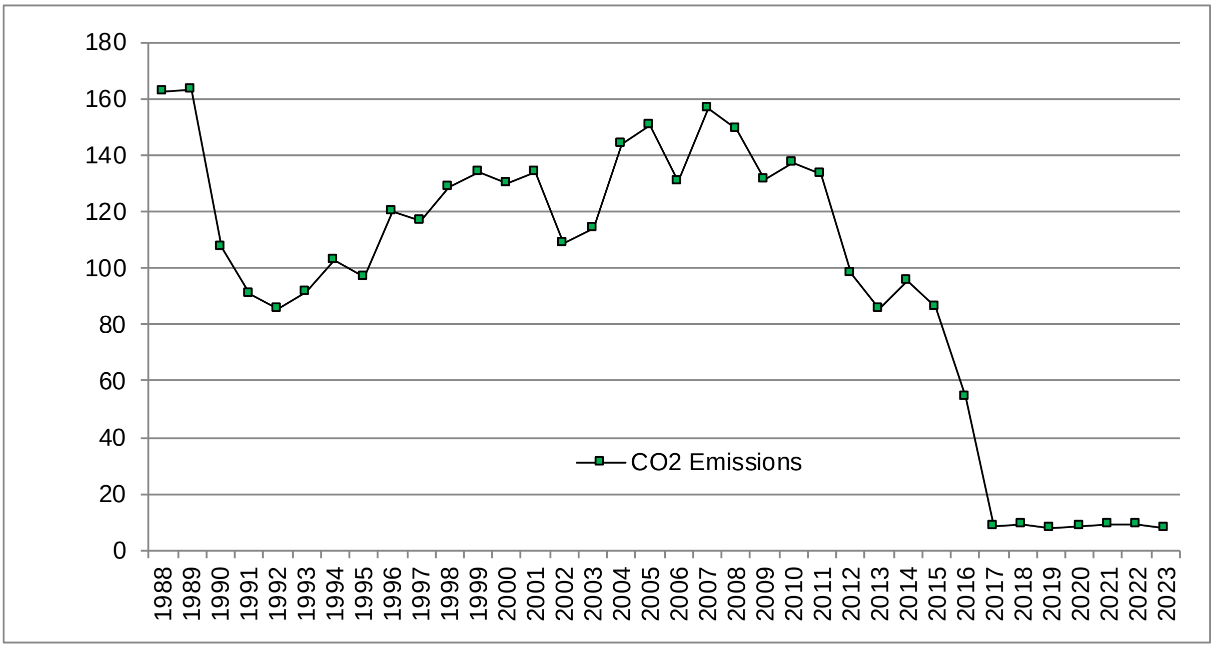


Figure 73 CO2 emissions in CRT 2.C.5 Lead production

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.

Activity 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 2005-2023 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 (2005-2023) 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 (CRT 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.

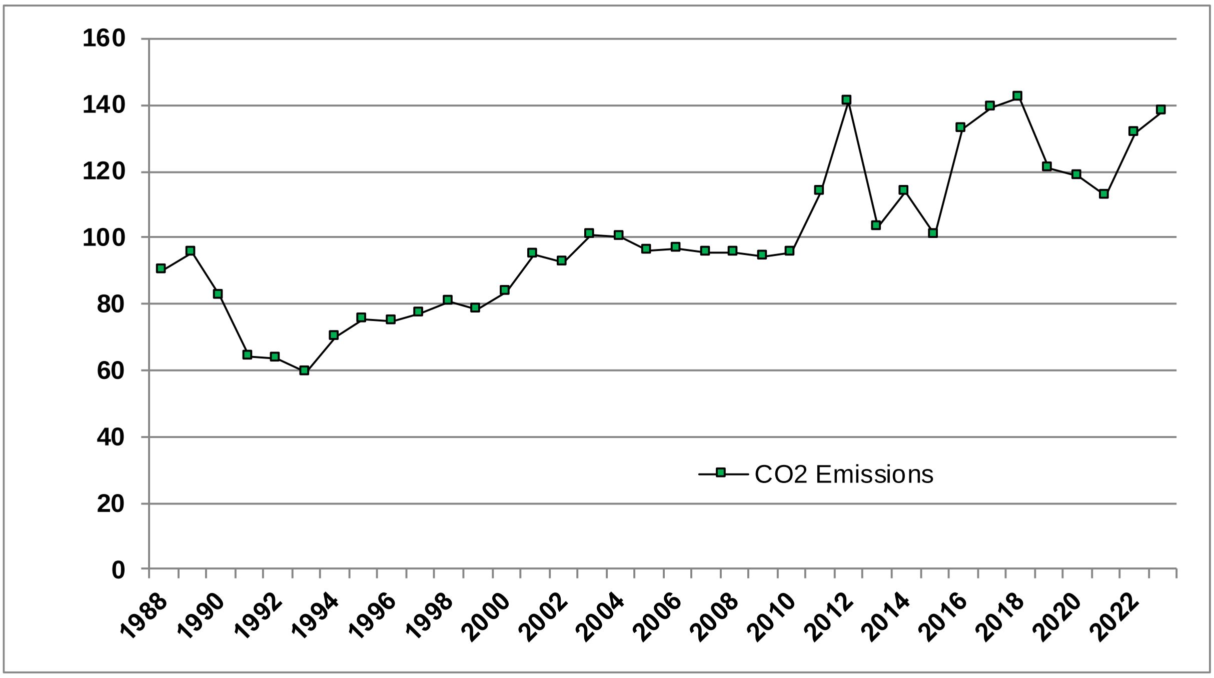


Figure 74 CO2 emissions in CRT 2.C.Zinc production

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 2005-2023 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 (2005-2023) from data, obtained by NSI and the enterprises.

4.4.10.4 Uncertainties and time series consistency

Combined uncertainty	15.81 %
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 (CRT 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 (CRT 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. In 2020 emissions have been decreased due to the Covid – 19 pandemic. Many bussines have remained closed and reduced their production.

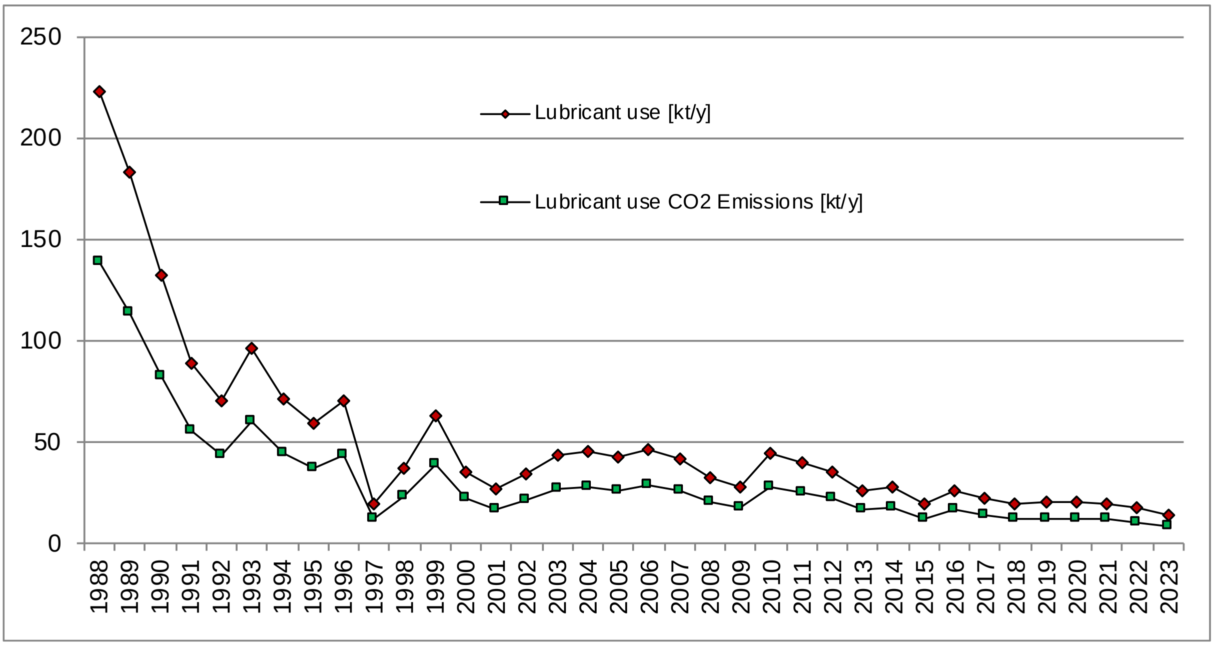


Figure 75 Lubricant use and CO2 emissions in CRT 2.D.1

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. In 2022 submission a recommendation from TERT was fulfilled and the lubricants used in four stroke engines only are included in this category. The emissions from two stroke engines are reported in the Energy sector.

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:

CO_2,Emissions = AD • EFlubricant, CO_2

EFlubricant, CO2 = NCVlubricant • CClubricant • ODUlubricant • 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 CRT 2.D.1.

CRT 2.D.1 - Lubricant use		
Year	**Lubricant use [kt/y]**	**CO2 Emissions [kt]**
1988	223,0	138,35
1989	183,0	113,53
1990	132,0	81,89
1991	89,0	55,22
1992	70,0	43,43
1993	96,0	59,56
1994	71,0	44,05
1995	59,0	36,60
1996	70,0	43,43
1997	19,0	11,79
1998	37,0	22,95
1999	63,0	39,09
2000	35,0	21,71
2001	27,0	16,75
2002	34,0	21,09
2003	43,0	26,68
2004	45,0	27,92
2005	42,0	26,06
2006	46,0	28,54
2007	41,0	25,44
2008	32,0	19,85
2009	28,0	17,37
2010	44,0	27,30
2011	40,0	24,82
2012	35,0	21,71
2013	26,0	16,13
2014	28,0	17,37
2015	19,0	11,79
2016	26,0	16,13
2017	22,2	13,77
2018	19,5	11,5
2019	20,2	11,9
2020	19,9	11,7
2021	19,6	11,6
2022	17,2	10,1
2023	13,6	8,0

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, %

CRT 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 NID, 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

In 2022 submission a recalculation provoked by recommendation from TERT was fulfilled and the lubricants used in four stroke engines only are included in this category. The emissions from two stroke engines are reported in the Energy sector.

4.5.1.8 Source specific planned improvements

No source specific improvements are planned.

4.5.2 PARAFFIN WAX USE (CRT 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.

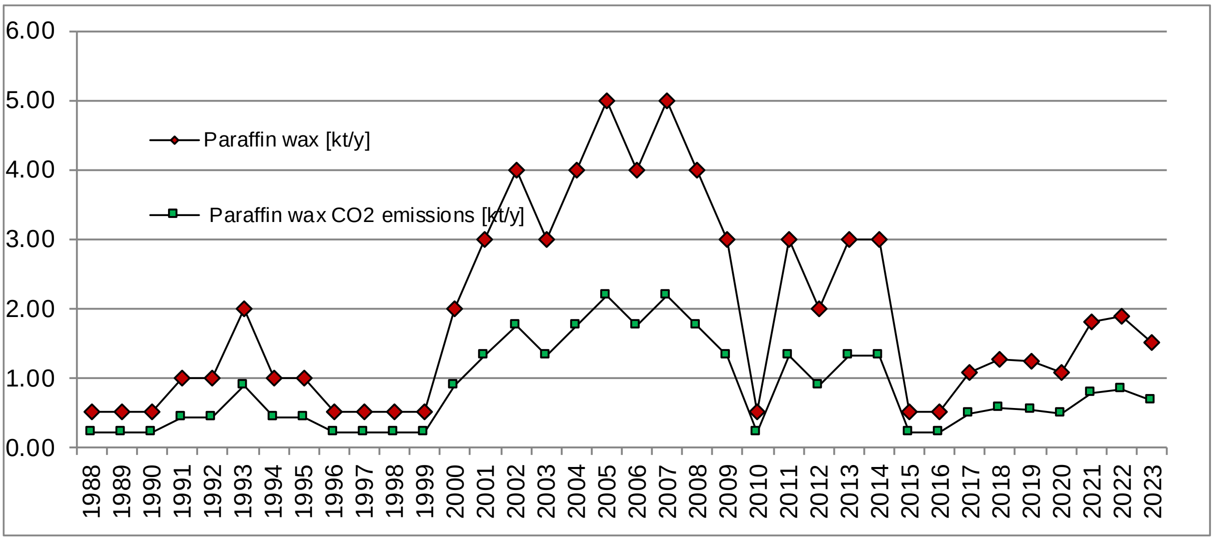


Figure 76 Paraffin wax use and CO2 emissions in CRT 2.D.2.

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:

CO_2 Emissions = PW •CCWax •ODUWax • 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 – CRT 2.D.2 [kt/1000]

***CRT 2.D.2* - PARAFFIN WAX USE**		
Year	**Paraffin wax [kt/year]**	**CO_2 Emissions [kt/year]**
1988	0,50	0,22
1989	0,50	0,22
1990	0,50	0,22
1991	1,00	0,44
1992	1,00	0,44
1993	2,00	0,88
1994	1,00	0,44
1995	1,00	0,44
1996	0,50	0,22
1997	0,50	0,22
1998	0,50	0,22
1999	0,50	0,22
2000	2,00	0,88
2001	3,00	1,32
2002	4,00	1,76
2003	3,00	1,32
2004	4,00	1,76

CRT 2.D.2 - PARAFFIN WAX USE		
Year	Paraffin wax [kt/year]	CO_2 Emissions [kt/year]
2005	5,00	2,2
2006	4,00	1,76
2007	5,00	2,2
2008	4,00	1,76
2009	3,00	1,32
2010	0,50	0,22
2011	3,00	1,32
2012	2,00	0,88
2013	3,00	1,32
2014	3,00	1,32
2015	0,50	0,22
2016	0,50	0,22
2017	1,09	0,48
2018	1,26	0,56
2019	1,24	0,55
2020	1,09	0,48
2021	1,80	0,79
2022	1,89	0,83
2023	1,52	0,67

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, %

CRT 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 NID, background documentation and archive;

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 (CRT 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.

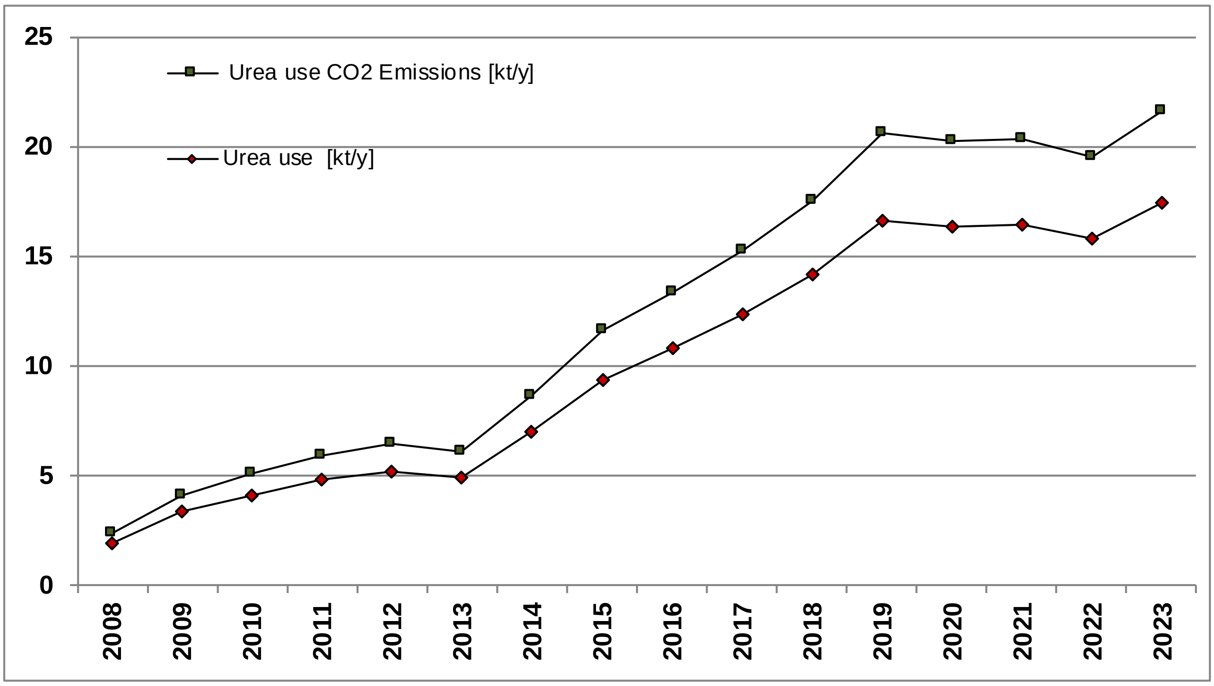


Figure 77 Urea use and CO2 emissions in CRT 2.D.3.d.

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:

CO_2 Emissions = EF • FC • Share of SCR vehicles mileage • 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 – CRT 1.A.3.b.

Table 136 Urea use and CO2 emissions in CRT 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	1,910	0,455
2009	3,300	0,786
2010	4,112	0,979
2011	4,783	1,138
2012	5,191	1,236
2013	4,912	1,169
2014	6,964	1,657
2015	9,379	2,232
2016	10,813	2,574
2017	12,326	2,934
2018	14,133	3,364
2019	16,642	3,961
2020	16,347	3,891
2021	16,408	3,905
2022	15,790	3,758
2023	17,459	4,155

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, %

CRT 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 NID, 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 model with the latest version.

4.5.3.6 Source specific planned improvements

No source specific improvements are planned.

4.5.4 OTHER – SOLVENT USE (CRT 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.

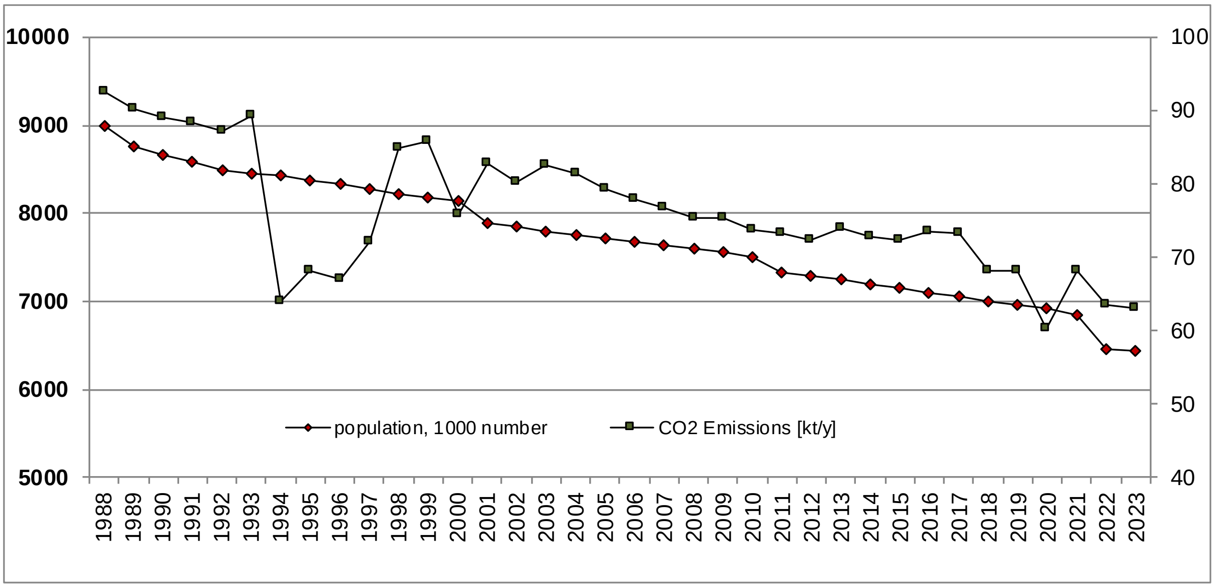


Figure 78 Population and CO2 emissions.

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>

$$\boldsymbol{All\ Emission_{CO2} = AR_{\mathbf{population}} \times IEF_{Averdge}}$$

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.

$$2D3b\ Emission_{CO2} = All\ Emission_{CO2} - 2G4\ Emission_{CO2}$$

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 CRT 2.D.3.b

***2D3b* – Other solvent used**			
Year	**Population [1000 number]**	**CO_2 Emissions [kt CO_2]**	**CO_2 Indirect Emissions [kt CO_2]**
1988	8986,6	92,672	26,726
1989	8767,3	90,286	26,198
1990	8669,3	89,220	25,962
1991	8595,5	88,417	25,784
1992	8484,9	87,214	25,517
1993	8459,8	89,440	22,958
1994	8427,4	63,932	48,036
1995	8384,7	68,077	43,324
1996	8340,9	67,131	43,688
1997	8283,2	72,163	37,889
1998	8230,4	84,952	24,398
1999	8190,9	85,904	22,921
2000	8149,5	75,895	32,381
2001	7891,1	82,917	21,925
2002	7845,8	80,250	23,991
2003	7801,3	82,621	21,028
2004	7761,0	81,503	21,611
2005	7718,8	79,259	23,294
2006	7679,3	78,013	24,015

2D3b – Other solvent used			
Year	Population [1000 number]	CO_2 Emissions [kt CO_2]	CO_2 Indirect Emissions [kt CO_2]
2007	7640,2	76,715	24,795
2008	7606,6	75,317	25,745
2009	7563,7	75,353	25,140
2010	7504,9	73,687	26,024
2011	7327,2	73,248	24,103
2012	7284,6	72,444	24,340
2013	7245,7	74,046	22,221
2014	7202,2	72,753	22,937
2015	7153,8	72,365	22,681
2016	7101,9	73,573	20,783
2017	7050,0	73,317	20,351
2018	7000,0	68,198	24,806
2019	6951,5	68,140	24,219
2020	6916,5	60,284	31,610
2021	6838,9	68,073	22,790
2022	6447,7	63,481	22,184
2023	6445,5	63,130	22,506

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, %

CRT 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 NID, 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

A recalculation was made for the whole time series conserning the indirect CO2 emissions. The Indirect emissions are calculated according to EMEP CORINAIR 2019 Guidebook.

4.5.4.7 Source specific planned improvements

No source specific improvements are planned.

4.6 ELECTRONICS INDUSTRY (CRT 2.E)

A recent research showed that this activity is not applicable for Bulgaria. In the country the operators declare that they do only final assembley of already manufactured parts.

4.7 PRODUCT USES AS SUBSTITUTES FOR ODS– SECTOR OVERVIEW (CRT 2.F)

The following table and figure summarize the results for CRT Sector 2.F for :

Table 140 Summary of the results for 2023.

Sector	Actual emission	Actual share
	Gg CO_2-eq.	%
Solvents	0.00	0.00%
Aerosols	11.01	0.64%
Foams	4.54	0.26%
Domestic refrigeration	3.43	0.20%
Commercial and industrial refrigeration	215.59	12.46%
Transport refrigeration	1.71	0.10%
Domestic AC	1021.47	59.02%
Commercial and industrial AC	23.67	1.37%
Mobile AC	438.47	25.33%
Fire protection	10.93	0.63%
Total	**1730.84**	**100.00%**

The following figure shows the emissions for CRT Sector 2.F during 2023 in logarithmic scale so that the small emissions could be visible.

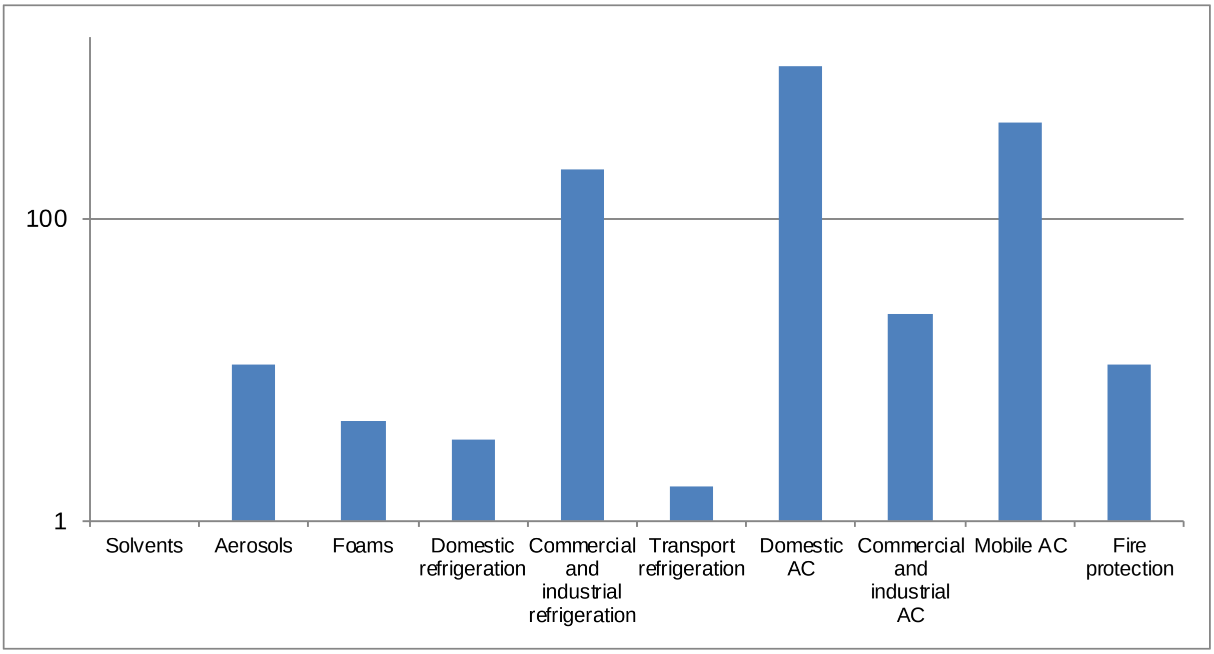


Figure 79 Actual emissions for 2023 [Gg CO2-eq.]

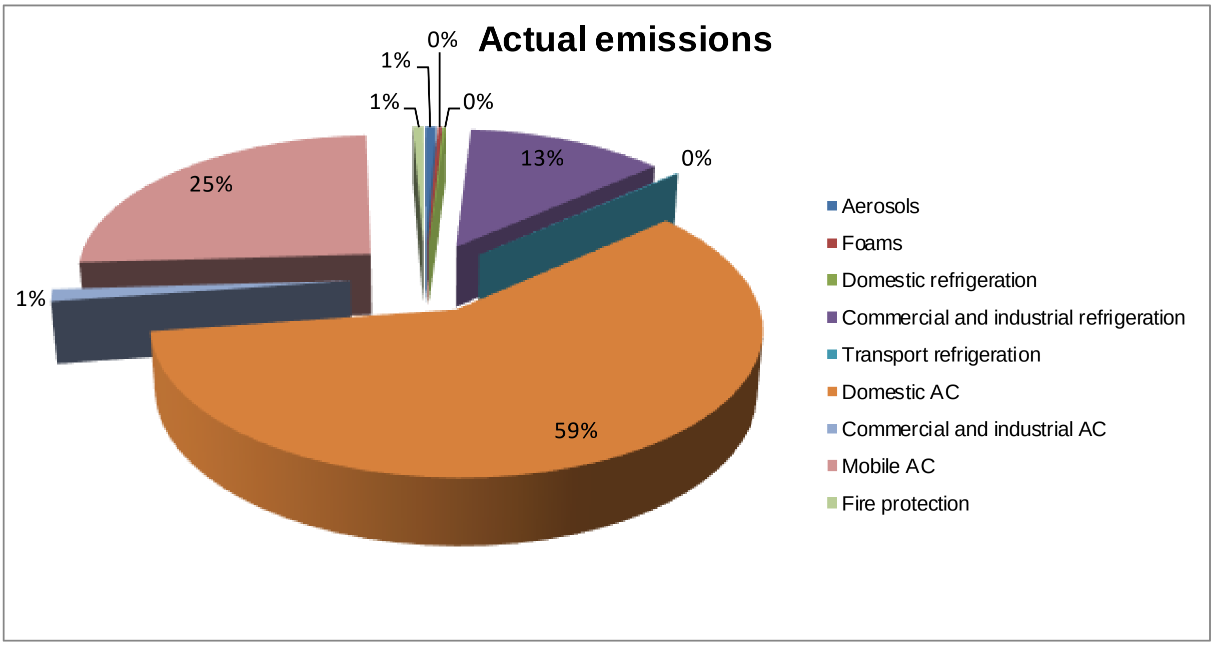


Figure 80 Actual emissions for 2023 [Gg CO2-eq.]

The following table and figures 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	Electrical equiopment
1988	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	0,003	NO	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	0,01	NO	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	0,02	NO	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	0,03	NO	NO	NO	NO	0,96	NO	NO
1995	NO	NO	NO	0,05	NO	NO	NO	NO	2,96	NO	NO
1996	NO	NO	NO	0,08	NO	0,04	NO	NO	5,19	NO	NO
1997	NO	NO	NO	0,10	NO	0,09	NO	NO	8,25	NO	NO
1998	NO	1,03	NO	0,15	NO	0,13	NO	NO	12,41	NO	NO
1999	NO	1,63	NO	0,21	NO	0,19	NO	NO	17,63	NO	NO
2000	NO	0,70	NO	0,24	13,83	0,31	NO	1,42	22,45	NO	NO
2001	NO	0,31	NO	0,27	14,33	0,48	0,85	2,71	27,58	0,54	NO
2002	NO	0,76	NO	0,30	21,10	0,69	3,03	3,99	33,47	0,67	NO
2003	NO	1,20	NO	0,32	27,86	0,99	9,25	5,28	41,45	0,83	NO
2004	NO	1,74	NO	0,34	34,62	1,34	18,20	6,57	59,05	1,04	NO
2005	NO	2,39	10,63	0,35	41,39	2,21	29,84	7,86	100,17	1,30	NO
2006	NO	6,55	30,99	1,27	48,15	2,69	50,17	9,14	144,94	1,62	NO
2007	NO	9,02	41,96	2,56	54,92	2,95	99,17	10,43	158,46	2,02	NO
2008	NO	9,40	116,80	3,96	61,68	3,13	177,12	11,72	216,53	2,51	NO
2009	NO	10,87	58,18	4,53	68,45	2,73	201,99	13,01	256,92	3,47	NO
2010	NO	9,94	37,88	6,88	75,21	2,40	228,04	14,30	264,13	3,47	NO
2011	NO	9,44	31,92	7,62	105,85	2,25	266,71	18,39	287,58	4,75	NO
2012	NO	9,11	26,07	9,29	114,62	2,21	318,87	23,30	293,64	4,77	NO
2013	NO	9,62	21,40	15,52	131,30	2,23	401,22	28,83	324,98	5,47	NO
2014	NO	8,68	21,96	18,37	143,60	2,44	464,49	33,71	374,61	5,69	NO
2015	NO	10,31	24,91	11,65	176,66	2,34	525,47	53,03	424,45	6,38	NO
2016	NO	13,33	24,29	9,90	176,29	2,27	667,57	53,06	455,19	6,75	NO
2017	NO	12,07	25,43	8,29	181,52	2,34	1055,15	57,72	447,05	7,14	NO
2018	NO	12,26	14,54	8,31	190,12	2,11	1452,48	64,77	446,89	7,75	NO
2019	NO	12,73	10,73	6,59	199,23	2,17	866,71	113,09	455,93	8,41	NO
2020	NO	12,64	8,47	3,78	198,16	2,58	900,26	113,36	457,28	12,18	NO
2021	NO	10,18	6,78	4,06	205,73	2,65	1010,60	112,85	453,55	12,96	NO
2022	NO	9,93	5,50	4,29	213,40	2,16	1024,37	64,65	449,00	13,35	NO
2023	NO	11,01	4,54	3,43	215,59	1,71	1021,47	23,67	438,47	10,93	NO

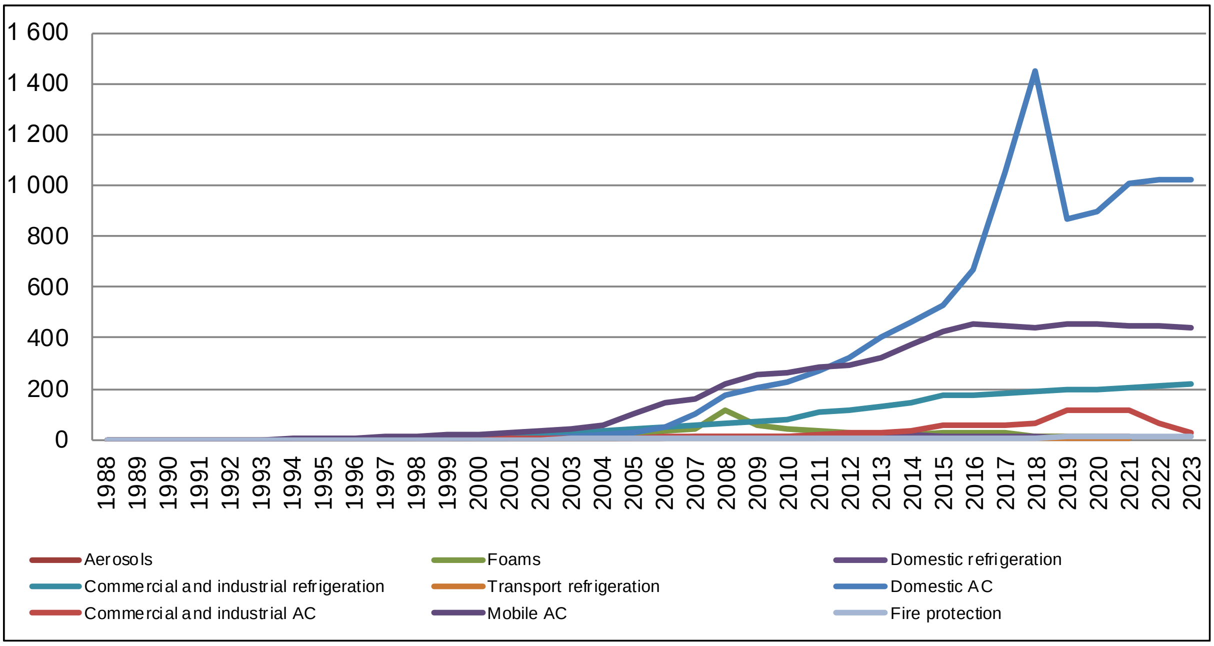


Figure 81 Actual emissions [Gg CO2-eq.]

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.

In 2024 the ExEA is starting an Informatianal system (IS) for collecting activity data conserning the air conditinig, refrigeration, fire protection agents. This will have major impact on the transperancy of the activity data collection and on the accuracy of the emission estimates. The IS is already under testing procedures and very soon it will be introduced for the people who are obliged to declare controlled substances uunder this category.

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 and other 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 entring into force of the Montreal Protocol, the use of CFCs and HCFCs (which were subsequently implemented in the European and national legislation) has been banned, 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.

In 2020,2021 and 2022 some preliminary data were used because of lack of validated statistical information (the NSI is upgrading an Information System) for some subsectors. That is the main reason for the fluctuation in the emissions series in some sub sectors.

The following figure shows the total emissions of HFC (by type) from the sub-sector in logarithmic scale so that all the data be visible and comparable:

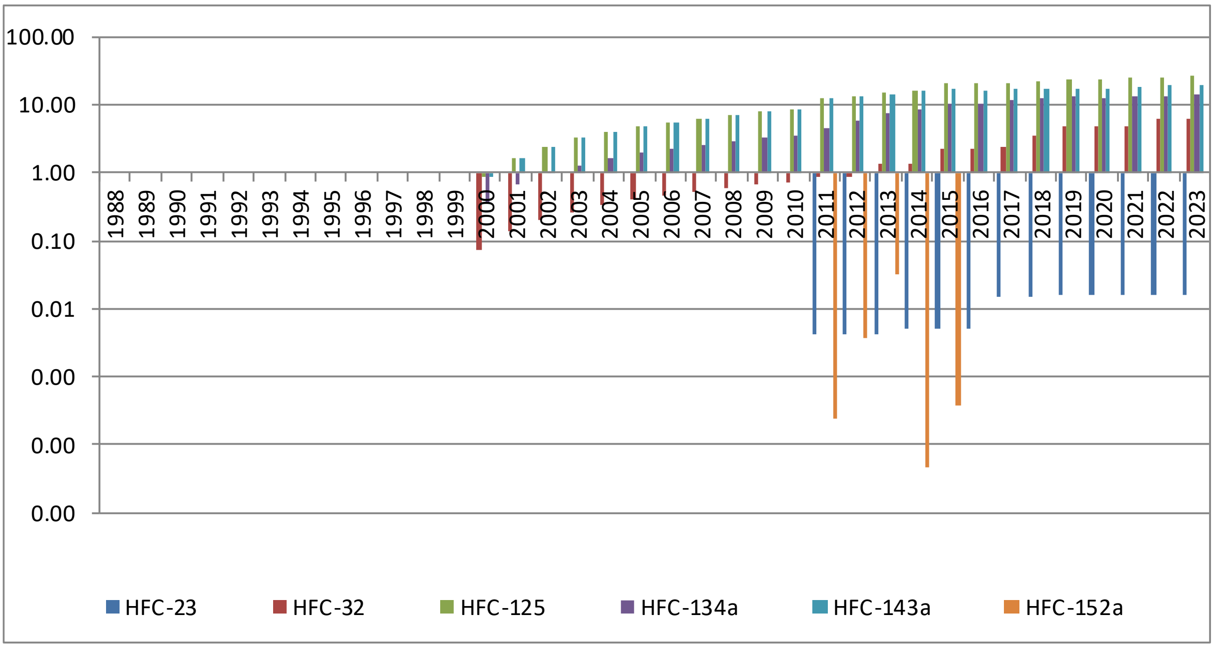


Figure 82 Total emissions by gasses of Commercial and industrial refrigeration in CRT 2.F.1.a and 2.F.1.c

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.

In 2020,2021 and 2022 some preliminary data were used because of lack of validated statistical information (the NSI is upgrading an Information System) for some subsectors. That is the main reason for the fluctuation in the emissions. The following figure shows the total emissions of HFC (by type) from the sub-sector:

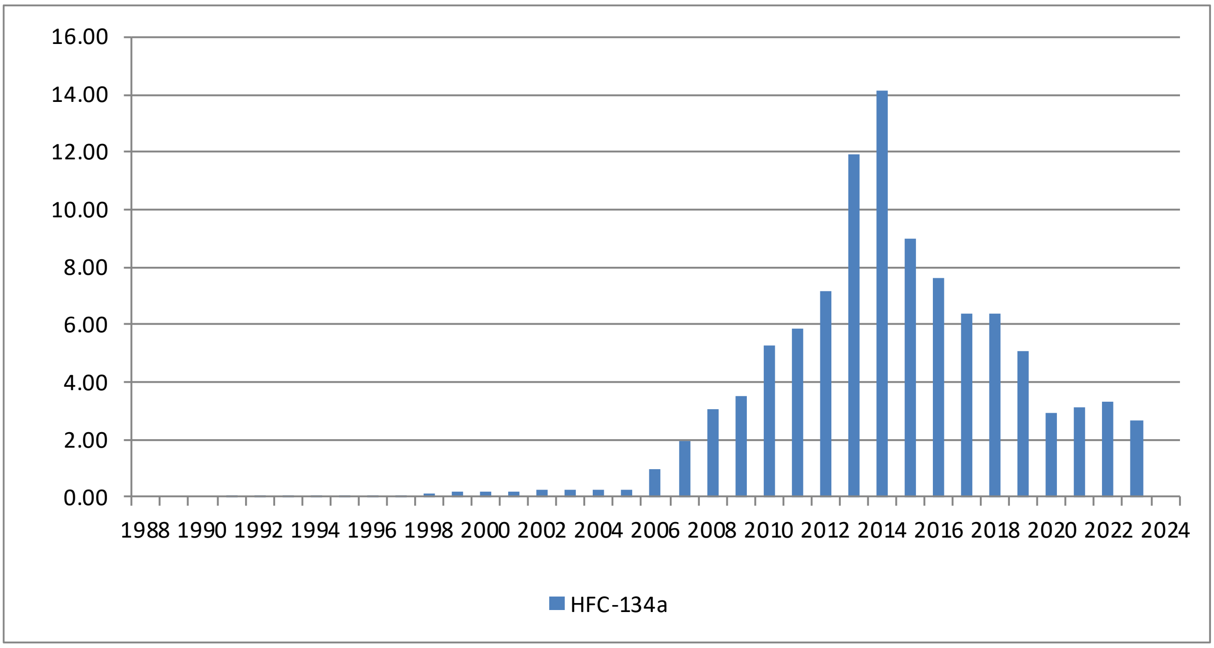


Figure 83 Total emissions of HFC – 134a in Domestic refrigeration in CRT 2.F.1.b

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, an attempted to contact and obtain information directly from some large transport companies, including ones operating outside Bulgaria was made. The 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 were 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 in logarithmic scale:

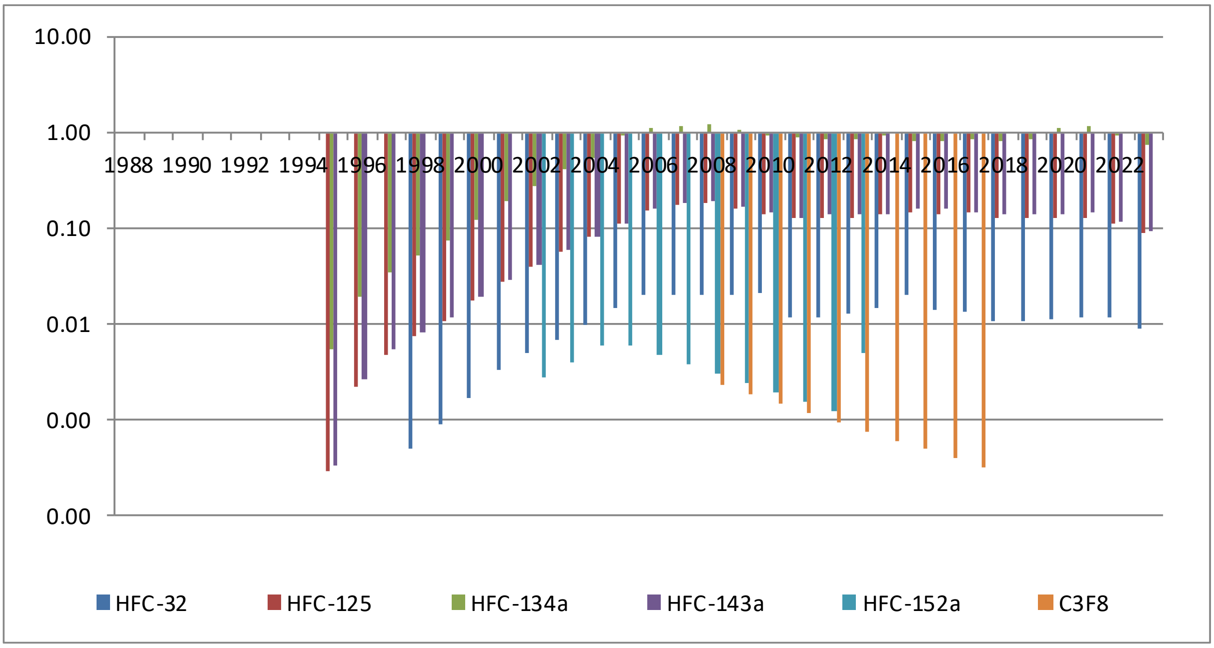


Figure 84 Total emissions by gasses of Transport refrigeration in CRT 2.F.1.d

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 in logarithmic scale:

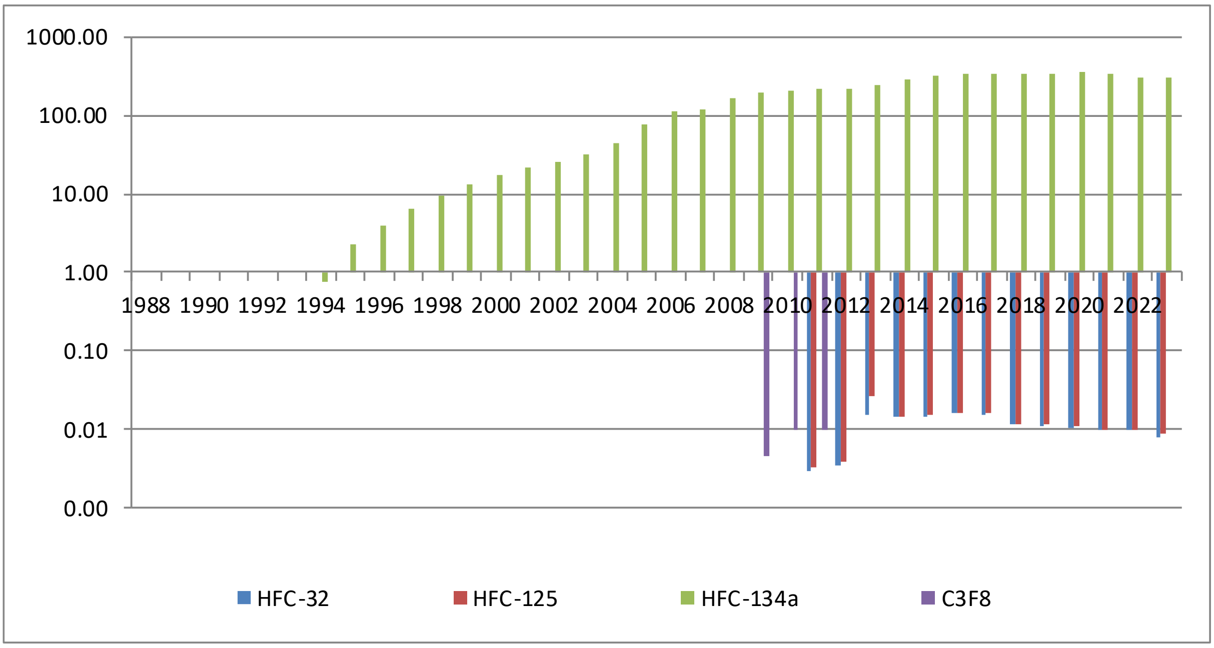


Figure 85 Total emissions by gasses of Mobile air conditioning in CRT 2.F.1.e

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. The product lifetime is considered to be 15 years. 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 in logarithmic scale:

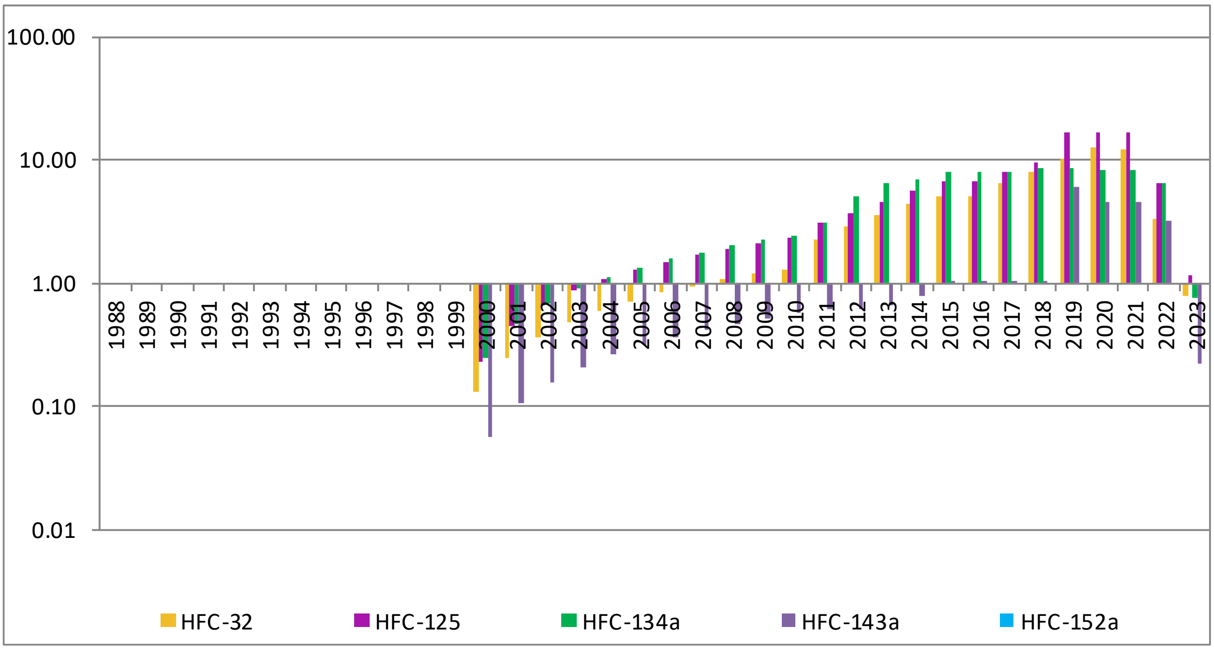


Figure 86 Total emissions by gasses of Stationary air conditioning in CRT 2.F.1.f

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 15 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 2023. 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 hass 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 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.

The difference in emmissions in the last submission comes from a technical mistake: in the CRF emmissions were reported despite the activity data for this sector are zero from 2012 (the activity was discontinued). Now the new ETF reperter corrected this mistake and this gives the difference in the Totals of the emissions.

4.7.1.2.5 Stationary air conditioning (2.F.1.f)

Data about domestic AC was received from the 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. In the newly introduced equipment the manufacturers give even longer terms of sevice. It will be hard to evaluate when new equipment is introduced in the country. In 2024 the Informational system for evaluating the F- gases was introduced. We hope that it will give a positive impact in the whole sector and help evaluate the new equipment and more accurate consideration on the product life factor. 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.

In 2024 a new Ordinance establishing measures to implementation of Regulation 517/2014 entered in force, and new Informational System started work (under this Ordinance). This will give more transparency on the activity data for the whole sector.

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). 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 – 2023. 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 import 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 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 (CRT 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

- There was a TC from TERT in 2020. Due to technical mistake in applying it, the ERT in 2022 gave us additional reccomendations.
- 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.
- In submission 2024 and 2025 some technical mistakes were corrected for years 2020,2021 and 2022.

4.7.1.6 Source-specific planned improvements

In 2024 the ExEA is starting an Informatianal system for collecting activity data conserning the air conditinig, refrigeration, fire protection agents. This will have major impact on the transperancy of the activity data collection and on the accuracy of the emission estimates. The IS is now in the phase of testing and will soon be introduced. There will be no transitional period to evaluate the wortk of the new IS in accordance to the nowadays approach in activity data collection. There in some possibility of uneven fluctuation in the first year of the IS.

4.7.2 FOAM BLOWING(CRT 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 is a significant change in the foam blowing – HFC – 152a amount for due to technological change in one operator`s manufacturing in the country. In 2018 the operator with major share started using izobutane instesd of HFC – 152a. This lead to a dramatical drop in the emissions series. The remaining quantities were reported in 2019 and 0 emissions from this subcategory in 2020/2021/2022/2023.

The following figures show the activity data for the subsector in CO_2 equivalent:

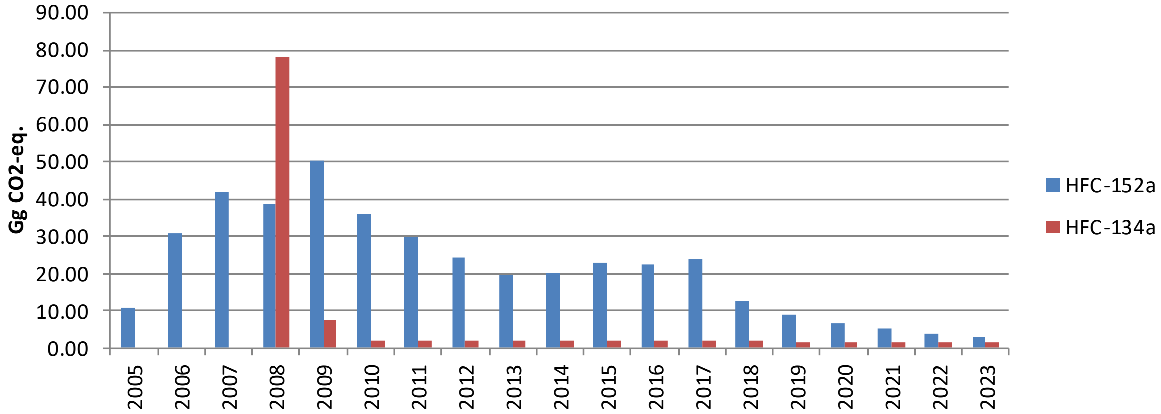


Figure 87 Total emissions Foam blowing CRT 2F2 – HFC 134a and HFC 152a

The following two tables represent the activity data 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**
1988-2007	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 – 2023	NO	C	NO	NO	NO	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 – 2004	NO	NO	NO	NO	NO	NO
2005	C	C	NO	77,01	NO	NO
2006	C	C	NO	205,28	19,25	NO
2007	C	C	NO	238,30	65,76	NO
2008	C	C	NO	170,61	108,89	NO
2009	C	C	NO	241,65	124,32	NO
2010	C	C	NO	107,20	153,65	NO
2011	C	C	NO	75,77	142,04	NO
2012	C	C	NO	50,04	125,47	NO
2013	C	C	NO	35,15	106,61	NO
2014	C	C	NO	57,13	88,75	NO
2015	C	C	NO	86,52	80,84	NO
2016	C	C	NO	80,75	82,26	NO
2017	C	C	NO	89,49	81,88	NO
2018	C	C	NO	8,76	83,78	NO
2019	C	C	NO	NO	260,11	NO
2020 – 2023	C	C	NO	NO	NO	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 was 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 performed.

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, because the use of ODS is declinining.

4.7.3 FIRE PROTECTION (CRT 2.F.3)

4.7.3.1 Source category description

According to experts from the industry, who have been consulted to, 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. There is fluctuation in the time series because of restricting the Fireprotection regulations in the countryfor the past several years and more strict requirements are applied in the sector, as long as some fire equipment need a renovation.

The following figure shows the summed activity data for the subsector.

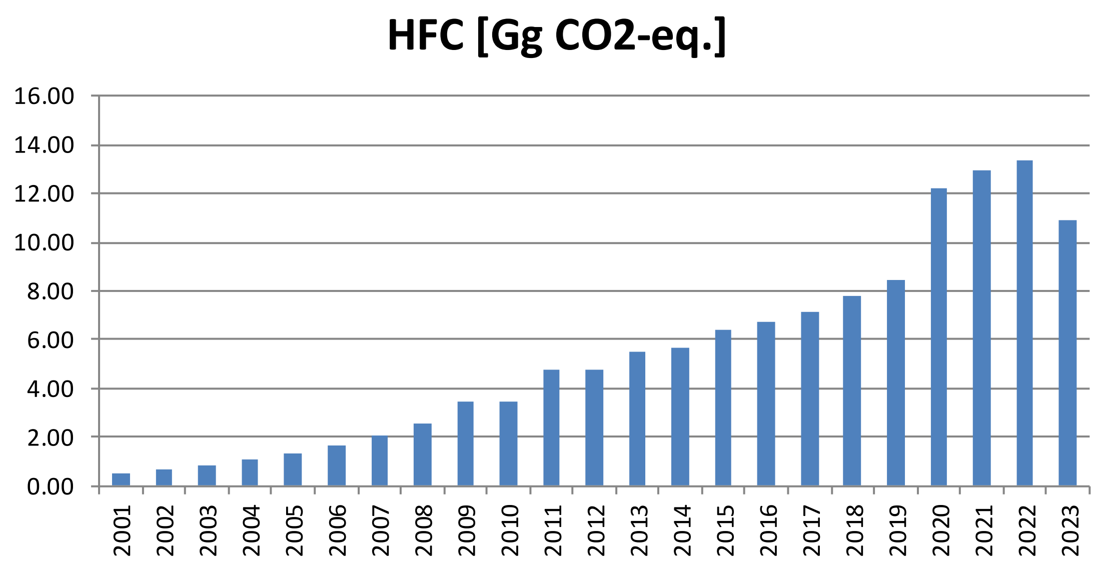


Figure 88 Fire protection CRT 2F3 – Sum of HFC 125 and HFC 227a

The following two tables represent the activity data 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 – 2000	NO	NO	NO	NO	NO	NO
2001	0,148	0,148	NO	NO	0,007	NO
2002	0,037	0,185	NO	NO	0,009	NO
2003	0,046	0,231	NO	NO	0,012	NO
2004	0,057	0,288	NO	NO	0,014	NO
2005	0,071	0,359	NO	NO	0,018	NO
2006	0,088	0,447	NO	NO	0,022	NO
2007	0,110	0,557	NO	NO	0,028	NO
2008	0,138	0,695	NO	NO	0,035	NO
2009	2,712	3,407	NO	NO	0,170	NO
2010	0,000	3,407	NO	NO	0,170	NO
2011	0,000	3,407	NO	NO	0,170	NO
2012	0,000	3,407	NO	NO	0,170	NO
2013	3,409	6,816	NO	NO	0,341	NO
2014	0,346	7,161	NO	NO	0,358	NO
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

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
2020	13,536	33,761	NO	NO	1,688	NO
2021	0,729	34,490	NO	NO	1,725	NO
2022	1,854	36,344	NO	NO	1,817	NO
2023	4,019	32,325	NO	NO	1,616	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 – 2000	NO	NO	NO	NO	NO	NO
2001	3,065	3,065	NO	NO	0,153	NO
2002	0,756	3,821	NO	NO	0,191	NO
2003	0,943	4,764	NO	NO	0,238	NO
2004	1,176	5,940	NO	NO	0,297	NO
2005	1,466	7,406	NO	NO	0,370	NO
2006	1,827	9,233	NO	NO	0,462	NO
2007	2,278	11,511	NO	NO	0,576	NO
2008	2,841	14,352	NO	NO	0,718	NO
2009	3,162	17,514	NO	NO	0,876	NO
2010	0,000	17,514	NO	NO	0,876	NO
2011	7,649	25,163	NO	NO	1,258	NO
2012	0,114	25,276	NO	NO	1,264	NO
2013	0,953	26,229	NO	NO	1,311	NO
2014	0,977	27,206	NO	NO	1,360	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
2020	9,731	40,778	NO	NO	2,039	NO
2021	3,961	44,739	NO	NO	2,237	NO
2022	0,597	45,337	NO	NO	2,267	NO
2023	10,674	34,662	NO	NO	1,733	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

In 2024 the ExEA is starting an Informatianal system for collecting activity data conserning the air conditinig, refrigeration, fire protection agents. This will have major impact on the transperancy of the activity data collection and on the accuracy of the emission estimates.

4.7.4 AEROSOLS (CRT 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 conserning 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 research 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 in their work.

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 figure represents the activity data for the subsector in the period 1988 – 2023.

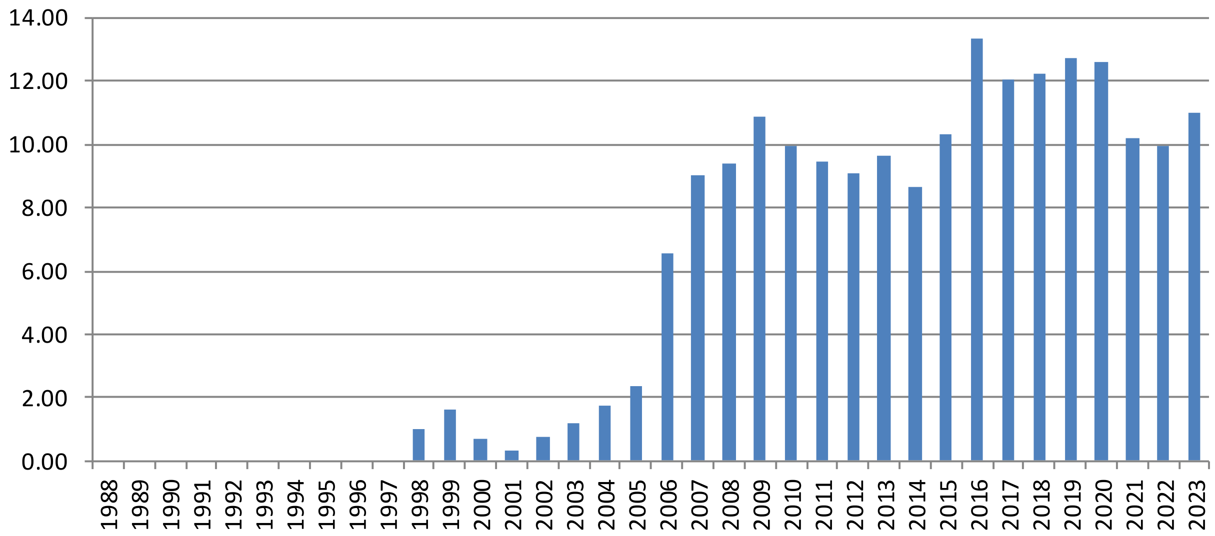


Figure 89 Aerosols CRT 2F4 – HFC 134a

The following table represents the activity data 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 – 1997	NO	NO	NO	NO	NO	NO
1998	1,579	0,790	NO	0,021	0,790	NO
1999	0,935	0,467	NO	0,010	1,257	NO
2000	0,138	0,069	NO	0,004	0,536	NO
2001	0,333	0,167	NO	0,010	0,236	NO
2002	0,828	0,414	NO	0,012	0,581	NO
2003	1,017	0,508	NO	0,021	0,923	NO
2004	1,661	0,830	NO	0,021	1,339	NO
2005	2,015	1,007	NO	0,025	1,838	NO
2006	8,061	4,031	NO	0,022	5,038	NO
2007	5,809	2,905	NO	0,016	6,935	NO
2008	8,653	4,326	NO	0,023	7,231	NO
2009	8,064	4,032	NO	0,028	8,359	NO
2010	7,224	3,612	NO	0,027	7,644	NO
2011	7,306	3,653	NO	0,024	7,265	NO
2012	6,712	3,356	NO	0,030	7,009	NO
2013	8,092	4,046	NO	0,029	7,402	NO
2014	5,269	2,634	NO	0,024	6,681	NO
2015	10,586	5,293	NO	0,020	7,928	NO
2016	9,924	4,962	NO	0,010	10,255	NO
2017	8,641	4,320	NO	0,013	9,283	NO
2018	10,218	5,109	NO	0,024	9,429	NO
2019	9,363	4,682	NO	0,007	9,790	NO
2020	10,083	5,041	NO	0,010	9,723	NO
2021	5,583	2,792	NO	0,010	7,833	NO
2022	9,693	4,846	NO	0,009	7,638	NO
2023	7,242	3,621	NO	0,003	8,467	NO

4.7.4.2 Methodological Issues

According to the 2006 IPCC Guidelines, aerosol emissions are considered to be immediately, occurring during the first year of production. Using data on quantities of HFC-134a consumed by the company for the period 1988-2022, 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.

In the reviw in 2022 submission was suggested a different emission estimatetion approach for production.. The emissions from import of meter dose inhaler from import so far were estimated as from Manufacture emissions instead of in operation emissions which was corrected.

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

In the reviw in 2022 submission was suggested a different emission estimatetion approach for production.. The emissions from import of meter dose inhaler from import so far were estimated as from Manufacture emissions instead of in operation emissions which was corrected.

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 CRT SOURCE CATEGORY NUMBER)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

4.7.7 SEMICONDUCTOR MANUFACTURING (CRT SOURCE CATEGORY NUMBER)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

REFERENCES

AEAT, 2003. Emissions and Projections of HFCs, PFCs and SF_6 for the UK and Constituent Countries, Haydock H., Adams M., Bates J., Passant N., Pye S., Salway G., Smith A. Publisher: AEA Technology

Eurostat, 2011. online database, available at: http://epp.eurostat.ec.europa.eu/

F-gases, Germany, 2005. Emissions, Activity Data, and Emission Factors of Fluorinated Greenhouse Gases (F-Gases) in Germany 1995-2002, Schwarz W., Publisher: Federal Environmental Agency (Umweltbundesamt), Berlin

F-gases, Germany, 2011. Preparatory study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases

ICF, 2008. Analysis on the Recovery of Fluorinated Greenhouse Gases in EU-27 in the Period 2004-2007 and Determination of Options for Further Progress. Prepared by ICF International, 2008.

ICF, 2010. Identifying and Assessing Policy Options for Promoting the Recovery and Destruction of Ozone Depleting Substances (ODS) and Certain Fluorinated Greenhouse Gases (F-Gases) Banked in Products and Equipment. Prepared by ICF International, 2010

IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

IPCC Third Assessment Report - Climate Change 2001 - online versions, available at: http://www.grida.no/publications/other/ipcc_tar/?src=/climate/ipcc_tar/wg1/248.htm

J.P. van der Sluijs et al., 2004. RIVM/MNP Guidance for Uncertainty Assessment and Communication: Tool Catalogue for Uncertainty Assessment, Copernicus Institute & RIVM, 2004

Kyoto Protocol to the United Nations Framework Convention on Climate Change, United Nations, 1998. Online version, available at: http://unfccc.int/resource/docs/convkp/kpeng.pdf

NID, Austria, 2010. Austria's National inventory document 2010, Pazdernik K. et al., Publisher : Umweltbundesamp GmbH, Vienna

National Survey and Development of a National Strategy Outline of HCFC Phase-out for Consumption Sectors in Republic of Bulgaria. Lambrev Y., Fikiin K., Sofia, 2010.

Reductions of SF_6 Emissions from High and Medium Voltage Electrical Equipment in Europe, Ecofys, 2005

Schwarz W., 2007a. Establishment of Leakage Rates of Mobile Air Conditioners in Heavy Duty Vehicles, Part 1: Trucks, prepared for the European Commission

Schwarz W., 2007b. Establishment of Leakage Rates of Mobile Air Conditioners in Heavy Duty Vehicles, Part 2: Buses and Coaches, prepared for the European Commission

Bulgarian inventory of the additional greenhouse gases (HFC, PFC and SF_6), included in the Kyoto Protocol for 1995

Regulation establishing measures for the implementation of Regulation (EC) № 842/2006 on certain fluorinated greenhouse gases

NSI, 2011. National Statistical Institute, Bulgaria, online database: http://www.nsi.bg/index.php; http://ftrade.nsi.bg/portal/page?_pageid=34, 34826 & _dad = portal & _schema = PORTAL

World Bank, 2011. Online database of the World Bank: http://databank.worldbank.org/ddp/home.do

Regulation (EC) № 842/2006 of the European Parliament and the Council of 17 May 2006 on certain fluorinated greenhouse gases

Strategy for phase-out of hydrochlorofluorocarbons in Bulgaria, MEW, Danish Agency for Environmental Protection, 2003

4.8 OTHER PRODUCT MANUFACTURE AND USE (CRT 2.G)

4.8.1 ELECTRICAL EQUIPMENT (CRT 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 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 SF_6-containing equipment are required to report annually data on their available equipment. Additionally, companies are sent reminders to provide information about used equipment containing SF_6.

In Bulgaria there is no production of SF_6 and switchgear containing SF_6, it is only imported. The main share (85-90%) of the use of SF_6 in switching equipment belongs to a state-owned companies 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 SF_6 equipment is serviced by thermal power plants and companies with their own substations.

The trend of the emissions in this sector can be seen in the following Figure:

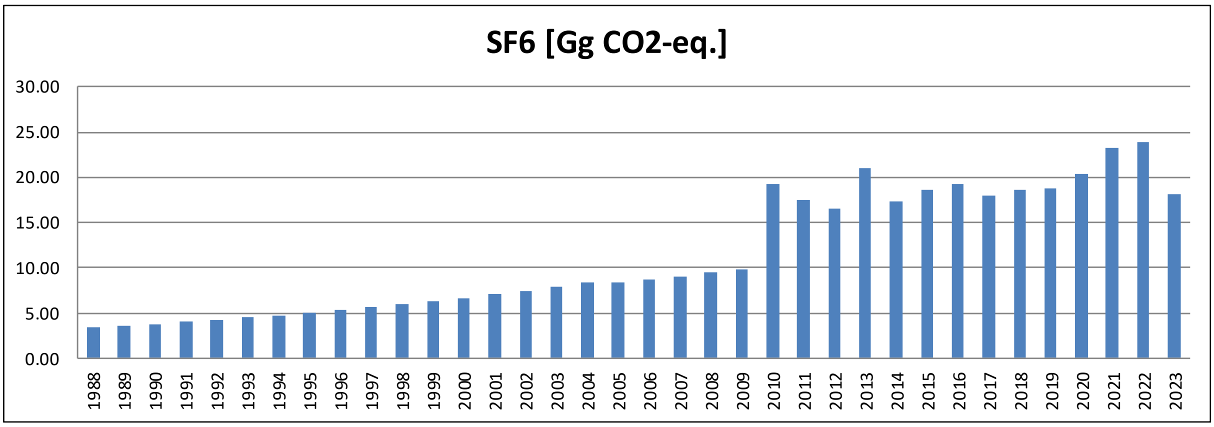


Figure 90 Sulfur hexafluoride (SF6) – in CO_2 equivalent emissions.

The following table represents the activity data 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	0,471	5,957	NO	0,033	0,112	NO
1989	0,499	6,303	NO	0,035	0,118	NO
1990	0,528	6,668	NO	0,037	0,125	NO
1991	0,558	7,055	NO	0,039	0,133	NO
1992	0,591	7,464	NO	0,041	0,140	NO
1993	0,625	7,897	NO	0,043	0,148	NO
1994	0,661	8,355	NO	0,046	0,157	NO
1995	0,699	8,840	NO	0,049	0,166	NO
1996	0,740	9,352	NO	0,051	0,176	NO
1997	0,783	9,895	NO	0,054	0,186	NO
1998	0,828	10,469	NO	0,058	0,197	NO
1999	0,876	11,076	NO	0,061	0,208	NO
2000	0,927	11,718	NO	0,064	0,220	NO
2001	0,981	12,398	NO	0,068	0,233	NO
2002	1,038	13,117	NO	0,072	0,247	NO
2003	1,098	13,878	NO	0,076	0,261	NO
2004	1,162	14,683	NO	0,081	0,276	NO
2005	0,931	15,255	NO	0,066	0,292	NO
2006	0,967	15,850	NO	0,069	0,303	NO
2007	1,005	16,469	NO	0,071	0,315	NO
2008	1,044	17,111	NO	0,074	0,328	NO
2009	1,085	17,778	NO	0,077	0,340	NO
2010	8,062	25,017	NO	0,469	0,354	NO
2011	3,059	27,332	NO	0,263	0,481	NO
2012	2,008	28,634	NO	0,164	0,542	NO
2013	4,593	32,331	NO	0,321	0,575	NO
2014	1,344	32,935	NO	0,089	0,651	NO
2015	2,001	34,144	NO	0,132	0,660	NO
2016	2,089	35,410	NO	0,141	0,681	NO
2017	0,768	35,410	NO	0,064	0,704	NO
2018	1,014	35,635	NO	0,085	0,704	NO
2019	1,085	35,919	NO	0,091	0,710	NO
2020	1,824	36,873	NO	0,153	0,718	NO
2021	2,974	38,857	NO	0,248	0,742	NO
2022	2,446	40,283	NO	0,227	0,793	NO
2023	NO	31,350	NO	NO	0,836	NO

4.8.1.2 Methodological Issues

Emission data is based on annual reports from companies on available equipment in the relevant reported year.

The data obtained are 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 (CRT 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 (CRT 2.G.3A)

4.8.3.1 Source category description

N_2O emissions in this category 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 – 2023.

The trend of N_2O emissions is presented in the following figure.

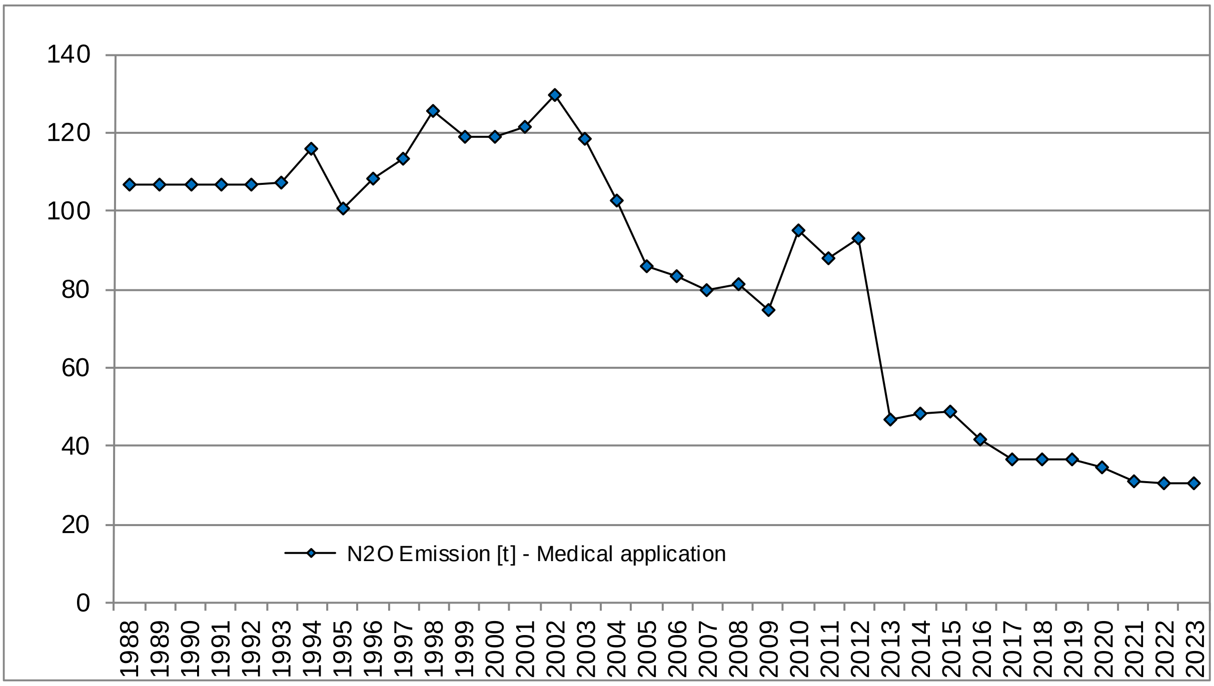


Figure 91 Medical application (Anaesthesia) – N2O emissions.

4.8.3.3 Methodological issues.

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.

Emission Factor

The default emission factors used for assessment of emissions of N2O from 2G3a Medical application are presented inTable 36.

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

4.8.3.3.1 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 working as it is not possible to meet the additional requirements for 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 every year 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 – 1992 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
1989	106,95
1990	106,95
1991	106,95
1992	106,95
1993	107,38
1994	115,87
1995	100,95
1996	108,32
1997	113,44
1998	125,73
1999	118,84
2000	119,30
2001	121,82
2002	129,62
2003	118,53
2004	103,01
2005	86,17
2006	83,39
2007	80,08
2008	81,31
2009	74,83
2010	95,36
2011	87,76
2012	93,12
2013	46,66
2014	48,47
2015	48,56
2016	41,83
2017	36,77
2018	36,74
2019	36,74
2020	34,42
2021	30,95
2022	30,38
2023	30,38

4.8.3.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 38 .

Table 150 Uncertainty of subcategory 2G3 N2O emissions from product uses (2G3a Medical application), %

CRT 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 NID, 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 (CRT 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 – 2023. The rate of use is not a steady one because of various factors (and probably some quantities remained in stock from the previous year).

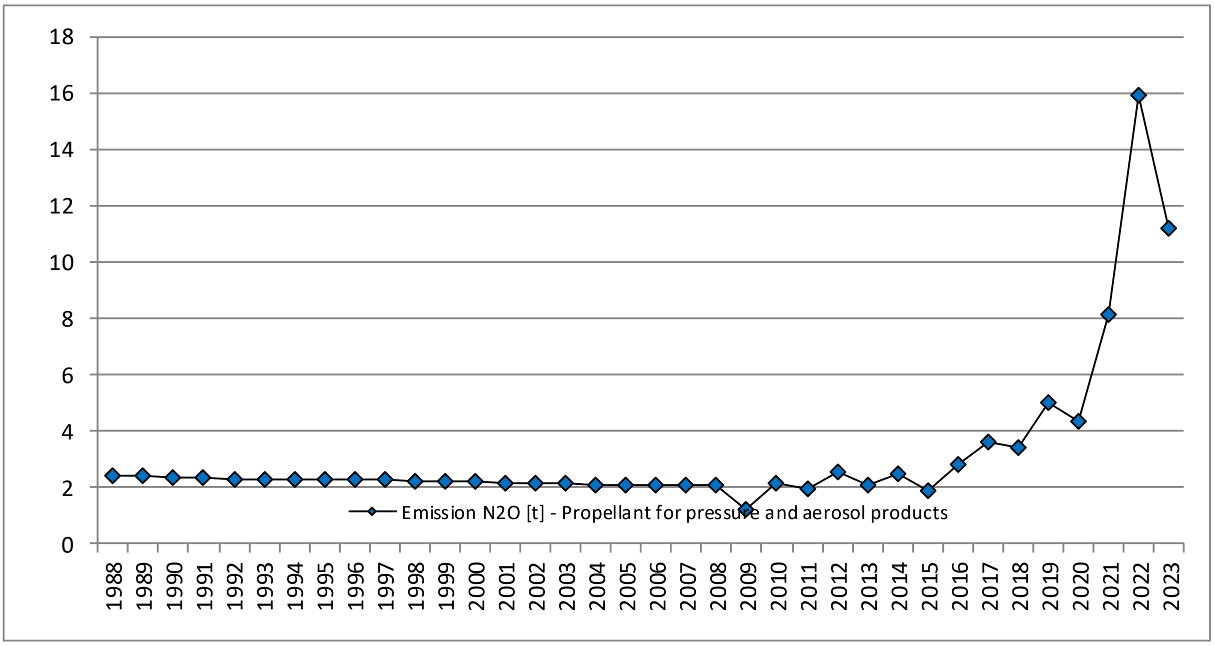


Figure 92 Propellants for pressure and aerosol product - N2O emissions.

4.8.4.3 Methodological issues.

Method

The activity data are provided from the importing companies in the cream spray. Available data on the amount of cream sprayed are for the period 2009-2023 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.

Emission Factor

The default emission factors used for assessment of emissions of N2O from 2G3b – 100% of the quantity of N2O contained in the cans of cream spray imported to the country.

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	2,453	8986,636
1989	2,393	8767,308
1990	2,366	8669,269
1991	2,346	8595,465
1992	2,316	8484,863
1993	2,309	8459,763
1994	2,300	8427,418
1995	2,289	8384,715
1996	2,277	8340,936
1997	2,261	8283,200
1998	2,246	8230,371
1999	2,236	8190,876
2000	2,224	8149,468
2001	2,154	7891,095
2002	2,141	7845,841
2003	2,129	7801,273
2004	2,118	7761,049
2005	2,107	7718,75
2006	2,096	7679,29
2007	2,085	7640,238
2008	2,076	7606,551
2009	1,254	7563,71
2010	2,168	7504,868
2011	1,978	7327,224
2012	2,549	7284,552
2013	2,102	7245,677
2014	2,506	7202,198
2015	1,912	7153,784
2016	2,809	7101,859
2017	3,624	7050,034
2018	3,391	7000,039
2019	5,027	6951,482
2020	4,354	6916,548
2021	8,166	6838,937
2022	15,907	6447,710

2023	11,201	6445,48

4.8.4.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 40

Table 152 Uncertainty of subcategory 2G3 - N_2O emissions from product uses (2G3b Propellant for pressure and aerosol products), %

CRT 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 NID, 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 (CRT 2G4I)

4.8.5.1 Source category description

This category deals with the following activities:

- Domestic solvent use (other than paint application)
- 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

In order to have consistency between the GHG inventory and the Air Quality inventory under CLRTAP, a revision wes performed for the whole time series. Activity data from the national statistical institute is used for the manufactured, imported and exported quantities of solvents. The trend of emissions for sector 2.G.4.i Domestic solvent use is presented in the following chart.

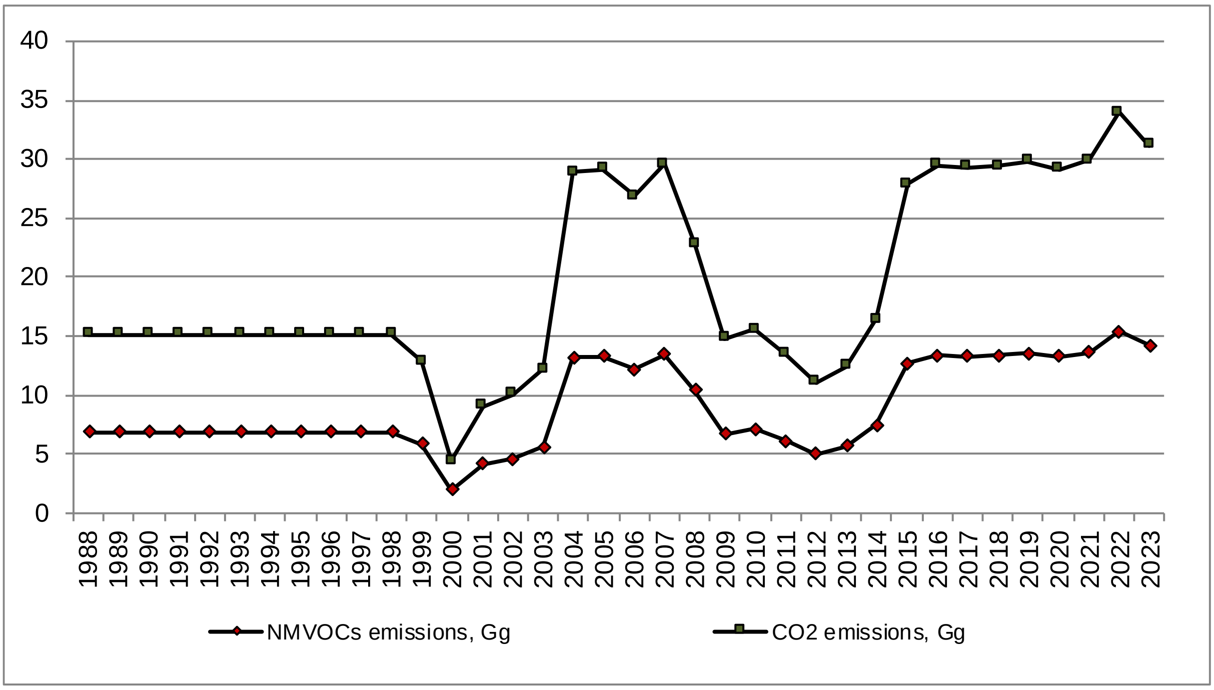


Figure 93 Trend of CO2 and NMVOC emissions in sector 2.G.4.i Domestic solvent.

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 2019.

The calculation of $\boldsymbol{Emissions_{NMVOC}}$ activity data from the National Statistical Institute were used.

$$\boldsymbol{Emissions_{NMVOC} = AD \times EFsubcategory}$$

Where AD is the activity data,

And EF subcategory is the emission factor from the Guidebook for each subcategoryfrom Table 154. Import, export, and manufacture data of solvent containing products were provided by the National Statistical Institute. These data were used to calculate consumption data (assuming that consumption = import + manufacture – export). The data were then formatted to match the product categories used in the 2019 EMEP/EEA Guidebook. Emissions inventory best practice techniques were used to address some outlier data points, and further work is planned to discuss the accuracy of the data with the National Statistical Institute.
The finalised activity data for selected years is shown in Table 153.

Table 153 **Consumption of solvent containing products**

	Units	2000	2005	2010	2015	2020	2021	2022	2023
Cosmetics and toiletries, Hair sprays	t	4462	4189	7269	17429	10578	9926	10108	12441

Car care products, Antifreeze agents in windscreen wiper systems	t	5500	10369	8615	9215	13029	13114	14303	9084
Cosmetics and toiletries, Toilet waters	t	629	970	758	2742	597	845	948	0
Pharma, domestic use of pharmaceutical products	t	353	58066	34206	68844	70832	72946	84653	96628
Household products, Soaps (liquid, paste)	t	63960	116545	108892	115508	136212	115682	181453	83445
Household products, Polishes and creams for floors	t	1730	1089	2509	1208	175	0	771	1722
Cosmetics and toiletries, After shave	t	0	0	204	267	252	322	347	0
Cosmetics and toiletries, Perfumes	t	0	121	189	437	147	470	677	216
Cosmetics and toiletries, Face care	t	2430	3370	234	353	0	0	114	0
Cosmetics and toiletries, Personal deodorants and antiperspirants	t	1449	1662	1780	2018	1562	1695	1862	37
Cosmetics and toiletries, Body care	t	257	1991	1943	2529	16325	8189	9997	13160
Household products, Shoe polishes and creams	t	0	45	59	0	0	0	30	41
DIY/buildings, Application of glues and adhesives — DIY	t	11902	89152	18137	17119	36857	40297	44071	2335
DIY/buildings, Thinners	t	132	134	141	153	172	236	243	0

The names of the sectors are following the EMEP Guidebook 2023 division, and for some subcategories many different products are included.

Table 154 **Consumption of solvent containing products**

	Contents of products by Prodprom code
Cosmetics and toiletries, Hair sprays	3305; 330510; 33051000; 330520; 33052000; 330530; 33053000; 330590; 33059000
Car care products, Antifreeze agents in windscreen wiper systems	3819;381900; 38190000; 3820; 382000; 38200000; 340530; 34053000
Cosmetics and toiletries, Toilet waters	30030090
Pharma, domestic use of pharmaceutical products	3306;330610;33061000;330690;33069000
Household products, Soaps (liquid, paste)	34;3401;340111;34011100;340119;34011900;340120;34012010; 34012090;340130;34013000;3402;34025;90;340290
Household products, Polishes and creams for floors	34052000;340540;34054000;340590;34059010;34059090
Cosmetics and toiletries, After shave	3307;330710;33071000
Cosmetics and toiletries, Perfumes	3303;330300;33030010
Cosmetics and toiletries, Face care	330410;33041000;330420;33042000;330491;33049100;330499; 33049900
Cosmetics and toiletries, Personal deodorants and antiperspirants	330720;33072000
Cosmetics and toiletries, Body care	330790;33079000;330430;33043000
Household products, Shoe polishes and creams	3405;340510;34051000
DIY/buildings, Application of glues and adhesives — DIY	3214;321410;32141010;3506;350610;35061000;350691;35069110; 35069190;350699;35069900
DIY/buildings, Thinners	3213;321310;32131000;321390;32139000

Emission Factors

Default solvent contents and emission factors were taken from the 2023 EMEP/EEA Guidebook (see Tables 3-3, 3-4 in chapter 2D3a Domestic solvent use).

4.8.5.3.2 Activity Data

The emissions related to domestic use of solvents given in Table 155

Table 155 Activity data of 2G4i Domestic solvent

Years	NMVOCs emissions, Gg	CO_2 emissions, Gg
1988	6,86	15,12
1989	6,86	15,12
1990	6,86	15,12
1991	6,86	15,12
1992	6,86	15,12
1993	6,86	15,12
1994	6,86	15,12
1995	6,86	15,12
1996	6,86	15,12
1997	6,86	15,12
1998	6,86	15,12
1999	5,83	12,85
2000	1,98	4,36
2001	4,11	9,05
2002	4,57	10,05
2003	5,53	12,19
2004	13,13	28,92
2005	13,25	29,17
2006	12,18	26,83
2007	13,42	29,54
2008	10,37	22,82
2009	6,71	14,78
2010	7,07	15,57
2011	6,08	13,40
2012	5,01	11,02
2013	5,65	12,43
2014	7,43	16,35
2015	12,64	27,84
2016	13,38	29,47
2017	13,29	29,26
2018	13,34	29,38
2019	13,53	29,79
2020	13,23	29,13
2021	13,58	29,90
2022	15,41	33,93
2023	14,15	31,15

4.8.5.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in theTable 156.

Table 156 Uncertainty of subcategory 2G4i Domestic solvent use, %

CRT 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 NID, 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

Improvements have been made for the sector in 2024 (inventory year 2022) to the emissions inventory calculation methodology, and a Tier 2 approach is now used to calculate emissions (see above). As a result, all emissions from this source sector have been recalculated.

4.8.5.7 Source specific planned improvements

Further work will be undertaken to review the reliability and accuracy of the activity data, because some of the trends in the data are not easily explained/understood. However, the focus of this is on data prior to 2000, and hence there are not expected to be any major recalculations that impact on the projected compliance with emission reduction commitments.

4.8.6 OTHER PRODUCT USE (CRT 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)

The emissions from subcategory 2H3 Vegetable Oil Production are included in the current subsector because of the source of AD. The NSI does not separate these snap codes for SNAP activity 060404 production.

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. In 2020 many bussines remained closed due to the pandemic and the restrictions and reduced their production rates.

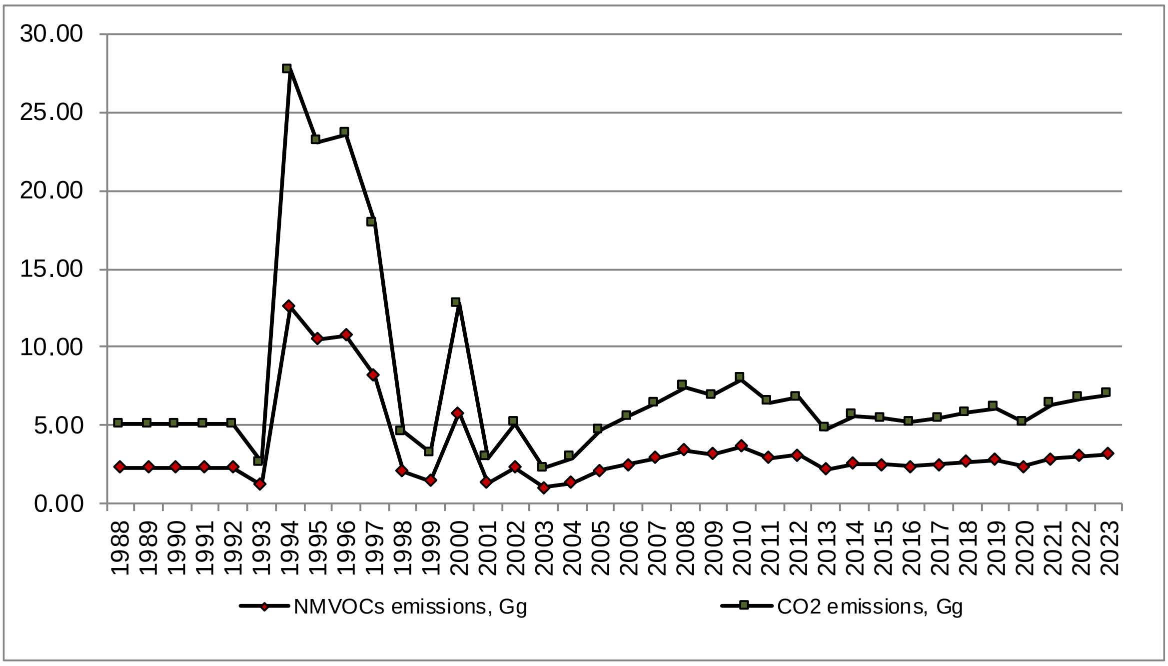


Figure 94 Trend of NMVOC and CO2 emissions in sector 2.G.4.I Other product use.

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 157 Emission factors used for Other product use (CRT 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 2019
060405	Application of glues and adhesives	522	g/kg adhesives	EMEP/EEA guidebook 2019
060406	Preservation of wood: Creosote preservative type Waterborne preservative	945 105 0,5	g/kg preservative	EMEP/EEA guidebook 2019
060403	Printing	730	g/kg ink	EMEP/EEA guidebook 2019

** The other SNAP activities under CRT 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:

$$Inputs_{CO_2} = Emissions_{NMVOC} \times C \times \frac{44}{12}$$

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 PRODPROM 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 158 Activity data for sector 2.G.4.i – Other product use

2.G.4.i – Other product use			
Year	*Other product use*	*NMVOC Emissions [kt NMVOC]*	*CO2 Emissions [kt CO2]*
	[kt]	*[kt]*	*[kt]*
1988	11,14	2,30	5,07
1989	11,14	2,30	5,07
1990	11,14	2,30	5,07
1991	11,14	2,30	5,07
1992	11,14	2,30	5,07
1993	3,90	1,17	2,57
1994	27,16	12,60	27,73
1995	20,91	10,51	23,12
1996	60,14	10,72	23,59
1997	91,61	8,15	17,93
1998	66,16	2,07	4,56
1999	70,37	1,45	3,18
2000	121,36	5,79	12,74
2001	92,01	1,32	2,91
2002	46,14	2,31	5,08
2003	54,00	1,01	2,23
2004	47,69	1,32	2,91
2005	53,95	2,13	4,69
2006	68,75	2,50	5,51
2007	134,05	2,90	6,38
2008	165,40	3,37	7,41
2009	378,18	3,14	6,91
2010	355,48	3,61	7,94
2011	374,73	2,93	6,44
2012	354,40	3,08	6,78
2013	518,70	2,16	4,76
2014	724,33	2,54	5,58

2.G.4.i – Other product use			
Year	**Other product use**	**NMVOC Emissions [kt NMVOC]**	**CO2 Emissions [kt CO2]**
	[kt]	**[kt]**	**[kt]**
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
2020	818,40	2,35	5,17
2021	1234,17	2,87	6,31
2022	1218,74	3,02	6,65
2023	1035,67	3,17	6,97

4.8.6.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in in the Table 159.

Table 159 Uncertainty of subcategory 2G4i Other product use, %

CRT 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 CRT 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 NID,
- 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.

4.9 OTHER: (CRT 2.H)

4.9.1 VEGETABLE OIL PRODUCTION (CRT 2.H.3.I)

4.9.1.1 Source category description

This chapter describes the methodology used for calculating greenhouse gas emissions from vegetable oil production in Bulgaria. Solvents are used also in vegetable oil production.

4.9.1.2 Trend description

Trend for NMVOC and CO_2 emissions from subcategory – 2H3i Other (vegetable oil production)

NMVOC emissions in Vegetable oil production 2H3i have been calculated for the period 1988 - 2023. The emission factor are in accordance with the EMEP/EEA air pollutant emission inventory guidebook –2006 and 2013[24]. The activity data are provided mainly by the National Statistics Institute – NSI.

The trend of NMVOC and CO_2 emissions is presented in the following figure. The trend is not steady because of changes in the market demands and some quantities remaining from pevious years or lack of such quantities.

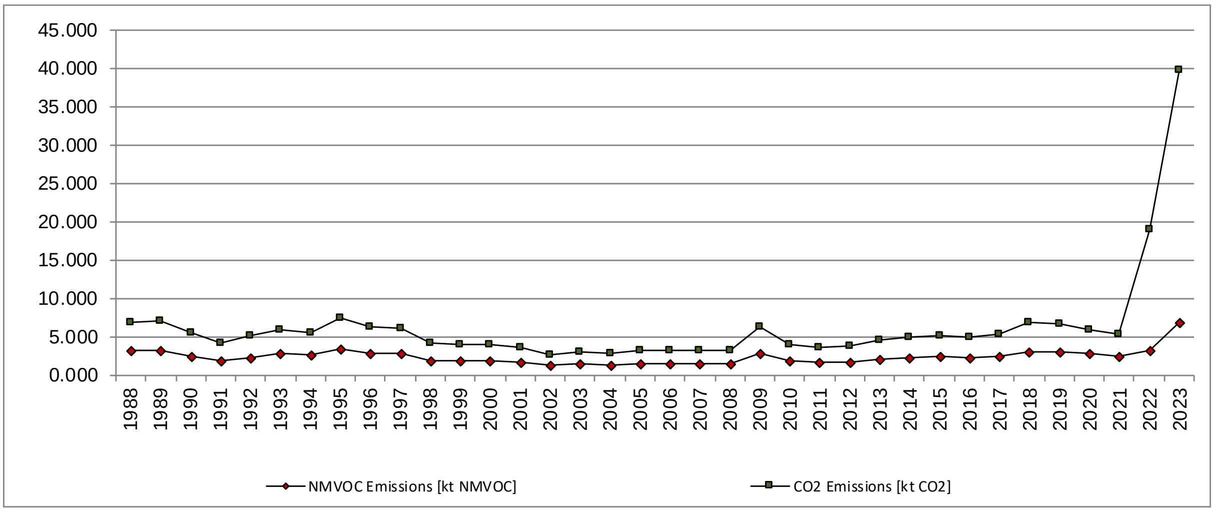


Figure 95 NMVOC and CO2 emissions in Vegateble oil production.

4.9.1.3 Methodological issues

Methods

The emissions of NMVOC from *2H3* Other (Vegetable oil production), are estimated based on the emission factor are in accordance with the EMEP/EEA air pollutant emission inventory guidebook – 2006 and 2019[i]. The activity data are provided mainly by the National Statistics Institute – NSI.

Because of country specific way of activity data aggregation currently the emissions are reported in 2G4I.

CO_2 emissions from *2H3* Other (Vegetable oil production)

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, 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

[24] In the following referred as EMEP/EEA Guidebook (2023)

Emission Factor

The default emission factors used for assessment of emissions of NMVOC from 2H3 are presented in Table 46.

Table 160 Emission factor used for estimation of NMVOC emissions from 2H3 Other (Vegetable oil production)

SNAP activity	Name of activity	Emission factor	Unit	Reference
2H3	Vegetable oil production	18	kg/t	CORINAIR

4.9.1.3.1 Activity Data

The activity data for estimation of emissions in 2H3,_are provided by the NSI. Because of the way the AD is presented by the NSI the emissions from this subcategory are reported under the subsector 2G4i in order to avoid double counting.

Table 161 AD for NMVOC and CO2 emissions from 2H3 - Other (Vegetable oil production),Gg.

2H3 Other - Vegetable Oil Production		
Year	**NMVOC Emissions [kt NMVOC]**	**CO_2 Emissions [kt CO_2]**
1988	3,115	6,852
1989	3,198	7,035
1990	2,512	5,527
1991	1,917	4,218
1992	2,323	5,110
1993	2,721	5,986
1994	2,543	5,596
1995	3,428	7,541
1996	2,878	6,332
1997	2,798	6,156
1998	1,876	4,128
1999	1,830	4,027
2000	1,845	4,059
2001	1,607	3,535
2002	1,222	2,688
2003	1,393	3,064
2004	1,236	2,719
2005	1,487	3,271
2006	1,491	3,280
2007	1,480	3,255
2008	1,442	3,172
2009	2,840	6,247
2010	1,766	3,885
2011	1,616	3,554
2012	1,736	3,819
2013	2,103	4,627
2014	2,242	4,933
2015	2,339	5,146
2016	2,207	4,854
2017	2,446	5,381
2018	3,093	6,804
2019	2,997	6,593

2H3 Other - Vegetable Oil Production		
Year	NMVOC Emissions [kt NMVOC]	CO_2 Emissions [kt CO_2]
2020	2,724	5,994
2021	2,393	5,266
2022	3,240	19,011
2023	6,799	39,887

4.9.1.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented inTable 48 .

Table 162 Uncertainty of subcategory 2H3 Vegetable oil production, %

CRT categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2.H.3.I	NO	CO_2	10	30	31.62

4.9.1.5 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 NID, 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).

4.9.1.6 Source specific recalculation

No source specific recalculation.

4.9.1.7 Source specific planned improvements

No source specific improvements are planned.

5 AGRICULTURE (CRT 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 tables. The following sources exist in Bulgaria:

- domestic livestock activities with enteric fermentation and manure management,
- rice cultivation,
- agricultural soils,
- agricultural residue burning, and
- liming;
- urea fertilisation.

5.2 EMISSION TRENDS

In the year 2023 the sector agriculture contributed 13.10% to the total of Bulgaria's greenhouse gas emissions (without LULUCF). The trend of GHG emissions from 1988 to 2023 shows a decrease of 56.34 % for this sector due to decrease in activity data. (Figure 96)

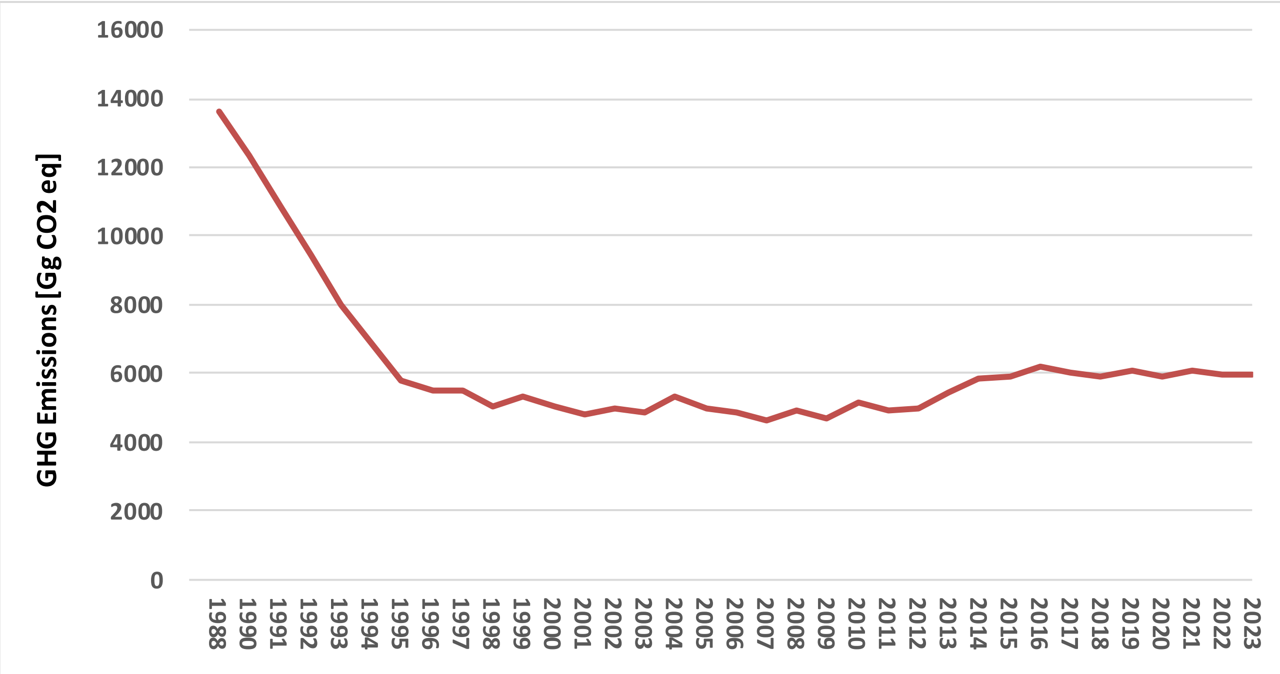


Figure 96 Trend of GHG Emissions from agriculture

5.3 EMISSION TRENDS PER GAS

CH_4 emissions are 35% from of the total emissions in the sector in CO_2-eq in 2023. 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 63% for the year 2023. The biggest share in these emissions has the Agricultural soils category with 93%. 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 38%. The trend is presented in Table 163.
CH_4 emissions were 75,30 Gg in the year 2023. The decrease for the year 2023 is 2,81% compared to 2022. In 2023 the N_2O emissions increased by 1,61% compared to 2022.

Table 163 Emissions of greenhouse gases from agriculture 1988 – 2023.

Year	GHG emissions [Gg]		
	CH_4	N_2O	CO_2
1988	252.47	24.34	89.67
1990	240.45	20.86	88.19
1995	111.94	9.90	59.44
2000	96.39	8.72	41.51
2005	88.16	9.20	47.89
2010	78.78	10.95	59.55
2015	79.48	13.62	66.23
2016	79.11	14.82	68.74
2017	77.98	14.22	74.44
2018	76.82	13.83	76.14
2019	74.41	14.78	80.46
2020	76.82	13.92	79.04
2021	79.50	14.23	77.14
2022	77.48	13.93	80.08
2023	75.30	14.12	91.29

5.3.1 EMISSION TRENDS PER SUB CATEGORY

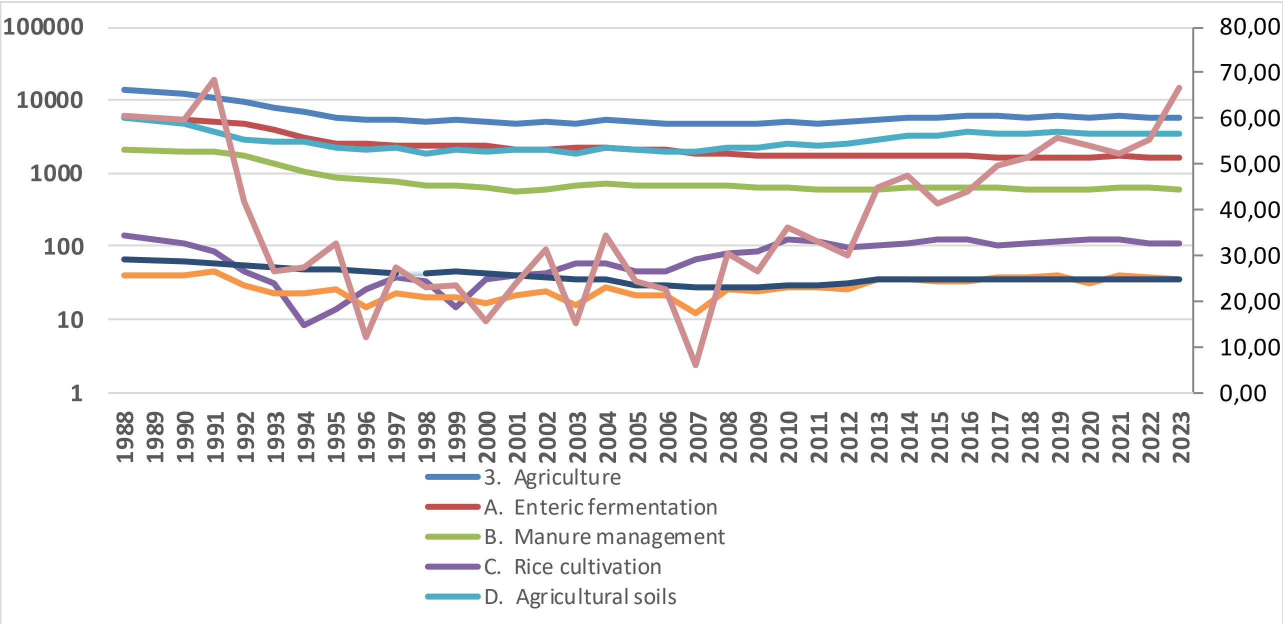


Figure 97 GHG emission trends 1988–2023 of agriculture by categories (Gg CO2-eq)

Table 164 and Figure 97 present total GHG emissions and trend 1988–2023 from agriculture by sub-categories as well as the contribution to the overall inventory emissions. Important categories are 3.D Agricultural soils (59%) and 3.A Enteric Fermentation (27%) followed by 3.B Manure management (10%).

Table 164 GHG emissions 1988–2023 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.G	3.H
1988	13607.95	5680.27	2056.45	142.22	5599.38	39.97	29.19	60.47
1990	12348.87	5379.43	2003.21	106.82	4730.94	40.29	28.66	59.53
1995	5817.73	2608.53	1931.51	13.92	3624.67	25.28	28.39	32.61
2000	5051.72	2366.62	1694.73	36.02	2952.47	16.46	28.06	15.56
2005	4955.52	2064.43	1350.93	45.40	2687.95	21.79	27.58	24.21
2010	5166.52	1718.34	1061.06	120.81	2676.39	27.94	27.16	36.11
2015	5901.72	1710.48	630.25	125.18	3337.16	32.42	24.84	41.39
2016	6211.97	1699.59	629.02	120.92	3659.74	33.95	24.81	43.94
2017	6026.51	1685.61	618.86	105.25	3505.48	36.89	24.81	49.63
2018	5879.69	1641.91	613.81	111.00	3399.71	37.13	24.77	51.37
2019	6081.45	1593.22	595.06	119.25	3654.27	39.19	24.74	55.72
2020	5918.02	1652.47	599.74	124.56	3430.44	31.77	24.83	54.22
2021	6074.12	1704.26	622.56	121.58	3507.63	40.95	24.87	52.28
2022	5940.04	1669.26	621.21	106.69	3426.06	36.75	24.63	55.45
2023	5941.62	1607.77	611.84	113.00	3481.26	36.46	24.73	66.56
Share in Total 2023	-	27.06%	10.30%	1.90%	58.59%	0.61%	0.42%	1.12%

As can be seen in Table 164 and Figure 97, 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 165 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 166 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 166 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

IPCC Category		CH_4		N_2O	CO_2
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 + 3.B.2.1	Young cattle	Calves .and heifers	✓	✓	NO
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	✓
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 NID, background documentation and archive.

5.3.5 RECALCULATIONS AND TIME-SERIES CONSISTENCY

For each subsector please refer to the text in the NID for further details.

5.4 ENTERIC FERMENTATION (CRT 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 2023, this source category was responsible for 27% of the total GHG emissions from the agriculture sector.

5.4.1 SOURCE CATEGORY DESCRIPTION

CH4 emissions in CO2-eq. were 1 607, 77 in the year 2023. Compared to base year a decrease of 72% is observed.
CH_4 emissions from the enteric fermentation of domestic livestock are given in Table 167**.**

Table 167 Greenhouse gas emissions from enteric fermentation 1988–2023.

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	202.87	66.18	12.11	44.79	1.66	64,07	2.17	5.82	6.06
1990	192.12	64.80	11.40	42.10	1.53	58,10	2.17	5.68	6.34
1995	93.16	38.69	3.63	13.39	1.02	24,44	3.68	5.27	3.04
2000	84.52	42.36	2.86	11.85	0.64	15,66	4.47	4.77	1.91
2005	73.73	38.27	3.24	12.99	0.53	11,58	3.32	2.40	1.41
2010	61.37	32.74	3.51	10.13	0.58	9,88	1.79	1.69	1.05
2015	61.09	30.50	6.86	9.77	0.67	9,82	1.42	1.19	0.86
2016	60.70	29.66	8.15	9.33	0.76	9.92	1.29	0.69	0.91
2017	60.20	28.29	8.94	9.20	0.82	9.86	1.24	0.94	0.91
2018	58.64	26.24	9.79	8.73	0.93	9.87	1.32	0.81	0.94
2019	56.90	24.20	10.39	8.47	1.06	9.79	1.25	0.87	0.86
2020	59.02	24.65	11.67	9.26	1.21	9.70	1.20	0.51	0.81
2021	60.87	24.05	13.60	9.54	1.37	9.47	1.17	0.69	0.97
2022	59.62	22.38	14.54	9.92	1.38	8.82	1.00	0.60	0.97
2023	57.42	20.97	14.69	9.40	1.35	8.42	0.90	0.69	0.99
Share 2023	-	37%	26%	16%	2%	15%	2%	1%	2%
Trend 1988–2023	-72%	-68%	21%	-79%	-19%	-87%	-59%	-88%	-84%

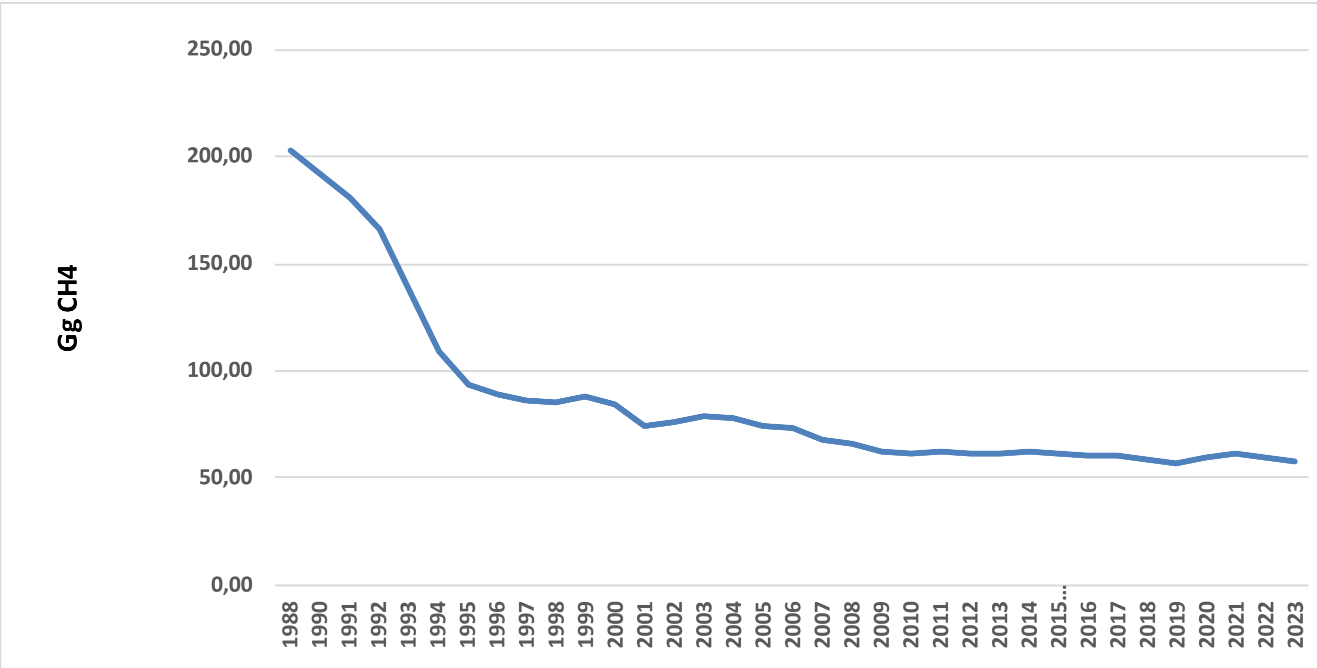


Figure 98 CH_4 emissions from enteric fermentation

Figure 98 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 168 Activity data and parameters used for IPCC Sub-category 3A1 – Cattle – Mature Dairy CattleTable 168.
For **dairy cattle**, the EF has been calculated by combining activity data, coefficients and parameters shown in Table 168. 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"[25] published in *Bulgarian Journal of Agricultural Science, 15 (No 2) 2009, 168-176, Agricultural Academy.*

Table 168 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 177)
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 175)
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 175)
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

[25] 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
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 169.

Table 169 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 177)
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
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 170 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 177)
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 171 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	50.81	6.95
1989	104.70	78.94	50.69	6.93
1990	104.67	78.94	50.69	6.94
1991	99.61	78.94	50.69	6.87
1992	97.30	78.94	50.69	6.86
1993	95.26	78.94	50.69	6.87
1994	96.53	78.94	50.69	6.89
1995	100.73	78.94	50.69	6.82
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	6.85
1999	105.10	78.94	50.66	6.85
2000	108.07	78.55	51.77	7.03
2001	104.68	78.25	49.01	7.10
2002	107.38	78.77	50.10	7.04
2003	107.29	78.98	51.04	7.01
2004	107.79	79.14	48.76	6.98

	Emission Factor [kg CH_4/head*yr]			
Year	**Mature Diary Cattle**	**Mature Non-Diary Cattle**	**Young Cattle**	**Sheep**
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	7.15
2009	105.69	79.28	49.85	7.18
2010	108.25	7864	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	55.17	7.37
2016	108.34	76.95	53.50	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
2020	111.29	76.85	5568	7.49
2021	108.65	76.94	52.69	7.56
2022	108.42	7678	55.53	7.68
2023	108.92	76.73	54.52	7.76

.
For mature dairy cattle, over the period 1988-2023, the milk yield has increased by 8% (see Table 175). 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 178), 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 172 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 177) - Executive Agency for Selection and Reproduction in Animal Breeding

Table 173 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 NID 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 174 Domestic livestock populations 1988–2023(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
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
2020	221.51	144.73	7.11	103.21	63.04	240.95	18.46
2021	221.37	167.89	8.87	113.86	67.14	234.20	20.93
2022	206.47	181.33	8.40	111.95	66.69	199.51	21.00
2023	192.55	183.26	8.14	105.18	67.33	179.49	20.63

Domestic livestock populations 1988–2023(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	126.32	1 014.39	143.65	17 673.16	1 849.54
2004	104.48	1 210.50	39.47	291.08	135.91	981.85	164.71	18 239.40	1 970.25
2005	99.63	1 233.17	36.14	278.44	90.38	937.20	76.99	17 182.20	2 331.35
2006	97.55	1 207.74	36.87	276.68	113.14	977.82	120.85	17 582.00	2 254.00
2007	106.91	1 157.90	36.48	279.61	80.43	950.63	58.24	17 192.50	2 235.00
2008	102.40	1 113.38	35.54	249.31	96.79	836.13	89.55	16 095.50	2 028.00
2009	79.07	1 087.72	33.64	237.11	88.61	756.72	73.89	15 883.50	1 591.50
2010	72.49	1 041.76	27.20	242.67	69.97	696.90	43.26	15 032.50	1 635.00
2011	78.62	1 054.48	27.19	251.01	79.29	636.13	58.58	13 606.00	1 688.50
2012	80.94	1 048.25	30.61	248.28	74.63	569.61	50.92	13 493.00	1 464.50
2013	87.48	1 031.56	30.59	215.93	42.14	558.68	20.40	12 751.50	1 485.50
2014	84.63	1 046.34	31.76	189.69	58.39	569.77	35.66	12 318.00	1 593.50
2015	86.21	1 026.82	32.39	188.18	50.26	576.59	28.03	13 614.00	1 490.50
2016	97.55	1 025.39	31.79	191.26	32.94	608.25	9.38	13 353.00	1 297.00
2017	103.49	1 009.15	32.29	193.51	41.60	604.79	18.71	12 656.00	1 572.00
2018	117.91	990.23	33.92	191.35	37.27	623.85	14.05	13 368.00	1 770.00
2019	128.06	969.20	32.62	185.63	39.44	573.18	16.38	13 807.00	1 735.00
2020	127.44	962.78	30.85	173.32	26.37	541.96	3.75	13 077.00	1 614.20
2021	141.46	918.05	29.45	164.71	32.90	643.38	10.06	12 293.50	1 698.70
2022	161.35	809.69	26.09	150.84	29.63	648.18	6.91	12 994.00	1 843.50
2023	176.47	738.56	24.55	145.00	37.32	663.22	2.17	13 171.00	1 843.50

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 (MAF), to provide activity data for the preparation of the NGHGI, and this is the official source of agricultural statistics.
MAF 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 MAF.
Every year there are agrostatistics bulletins with information on livestock (number of agricultural animals, milk production, meat production, live weight) and crops productions.
(see https://www.mzh.government.bg/bg/statistika-i-analizi/izsledvane-zhivotnovdstvo/danni/)
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.

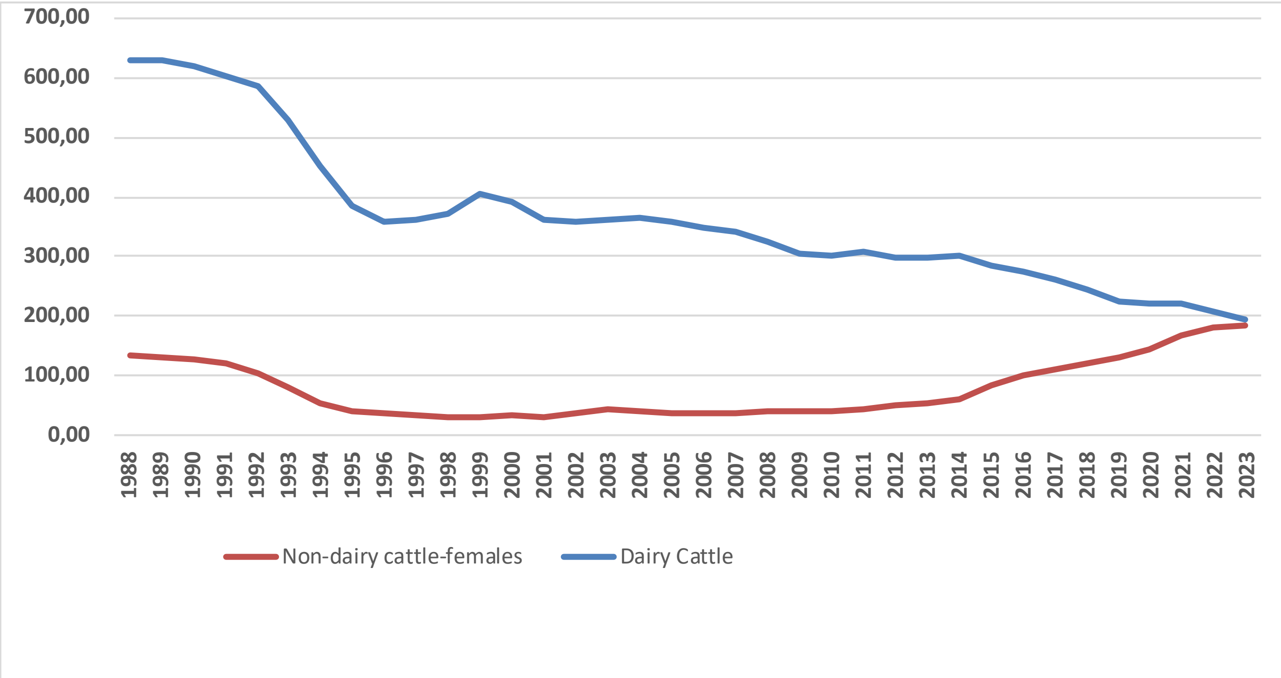


Figure 99 Domestic livestock populations (I)

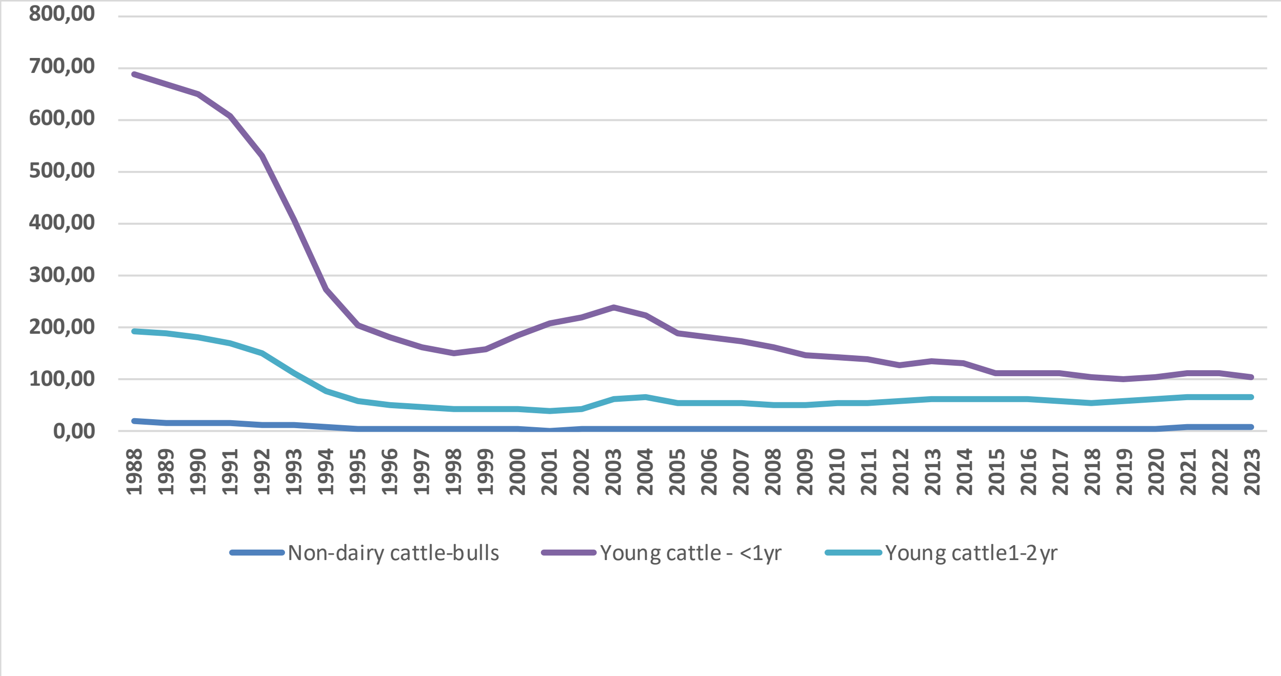


Figure 100 Domestic livestock populations (II)

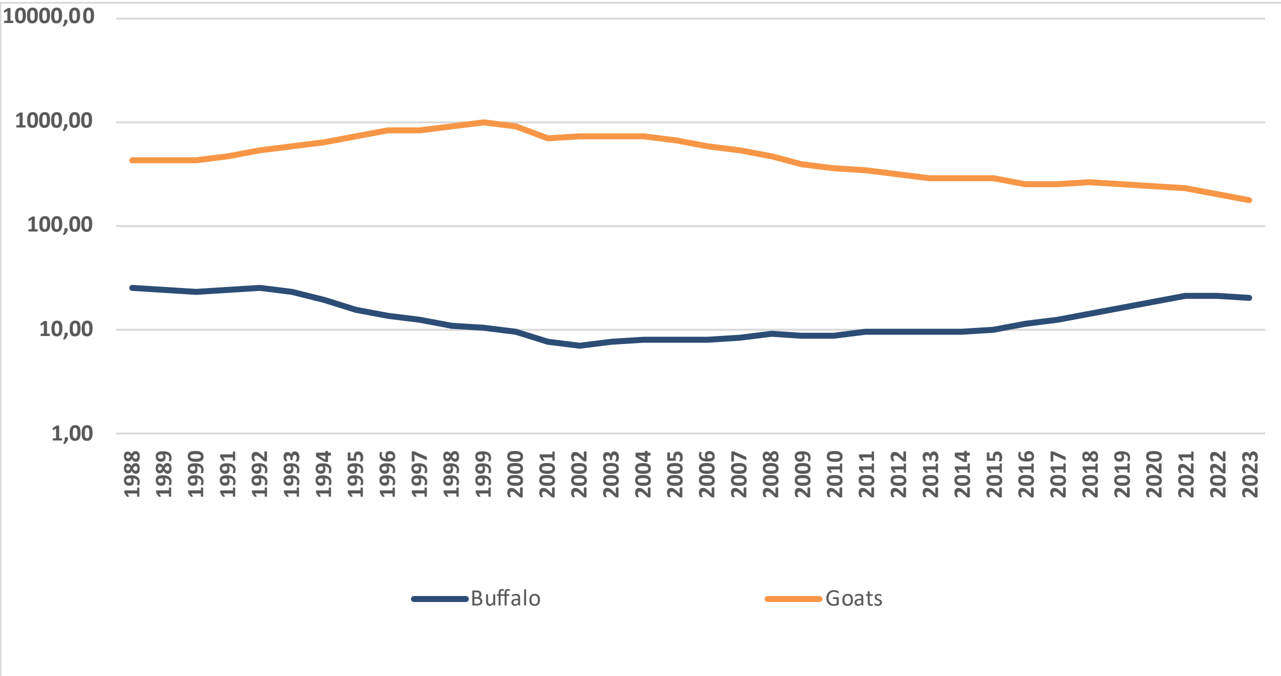


Figure 101 Domestic livestock populations (III)

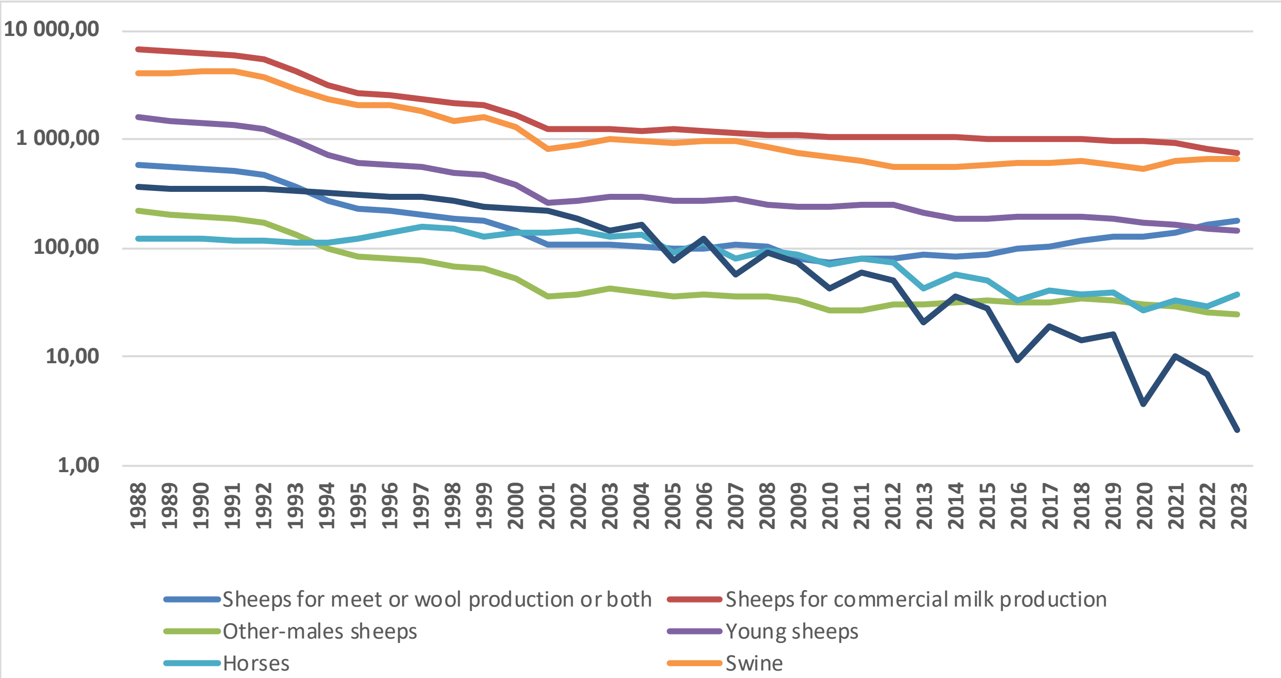


Figure 102 Domestic livestock populations (IV)

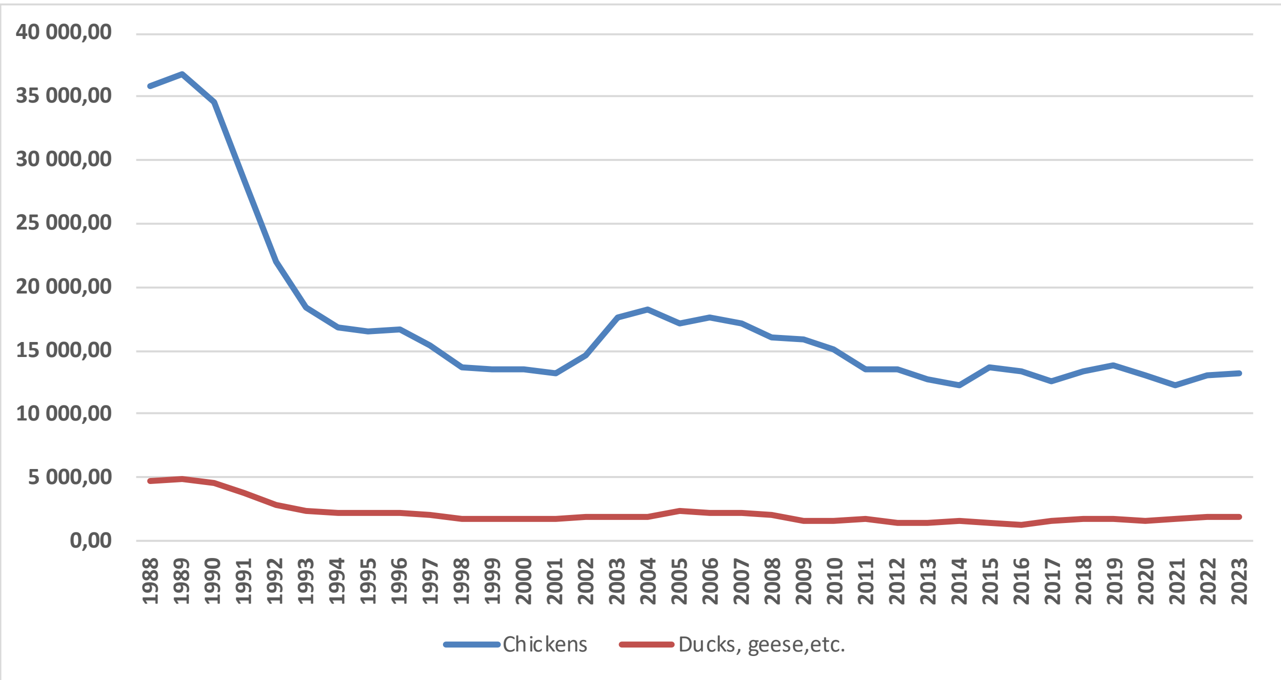


Figure 103 Domestic livestock populations (V)

(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 2023 is 3,67 %. Data on the fat content of milk is available in EUROSTAT.

Table 175 Milk yield, gross energy intake for dairy cattle: 1988 – 2023:

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
2020	4763.85	261.03
2021	4518.30	254.86
2022	4467.30	254.30
2023	4517.16	255.50

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. MAF provided the data on the fat content. It's constant over the time – 6,5 %.

Table 176 Milk yield, gross energy intake for sheep: 1988 – 2023

Year	Milk Yield	Gross Energy Intake
	[kg/sheep*yr]	[MJ/head*day]
1988	44.54	16.62
1990	43.86	16.61
1995	46.63	16.34
2000	58.72	16.81
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
2020	79.44	17.83
2021	76.65	17.98
2022	69.97	18.27
2023	70.43	18.46

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 177. 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 177 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 purpose	61.00	
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 178). Due to lack of data, for the period 1988 – 1999 average value have been used.

Table 178 Live-weight for young cattle 1988 – 2023:

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	211.25	396.15
2016	203.75	379.50
2017	207.15	381.55
2018	204.20	384.35
2019	206.55	370.40
2020	220.10	380.50
2021	201.85	361.65

Year	Live-weight Cattle – Young Cattle – Calves	Live-weight Cattle – Young Cattle – Growing Heifers
2022	218.05	383.60
2023	209.30	377.40

5.4.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty from methane emissions from this source is 50%.

Table 179 Uncertainty of sub-sector Enteric Fermentation for 2023, %

CRT 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 MAF.
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 NID, national statistic of agriculture and food provided by MAF, background documentation and archive.

5.4.5 SOURCE-SPECIFIC RECALCULATIONS

- In submission 2025 there is revised avtivity data for livestock population mature non-dairy cattle female (female cattle over 2 years) for 2022 due to a technical mistake.

- In submission 2025 there is revised avtivity data for live body weight of Young Cattle - Calves (calves for slaughtering & other calves) for 2015 and 2016 due to a technical mistake
- In submission 2025 there is revised avtivity data for live body weight of Young Cattle - Growing Heifers (cattle from 1 to 2 years (male/female) for 2002, 2015 and 2016 due to a technical mistake.
- In submission 2025 there is revised avtivity data for annual wool production from sheep for the period 1988-2016 due to a technical mistake
- In submission 2025 there is revised avtivity data for annual milk yield from sheeps for the period 1988-2001 due to a technical mistake

5.4.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

Bulgaria makes great efforts to improve the estimations, using year-specific values for the digestibility of feed in its emissions calculations for 3A1 Enteric Fermentation Dairy Cattle.

5.5 MANURE MANAGEMENT (CRT 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 2023, this source category was responsible for 10,30% 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 180 and
Table 181

Table 180 CH4 emissions from Manure management 1988 –2023, 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	6.68	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	7.99	0.57
2000	10.10	4.68	0.30	1.24	0.05	0.46	0.12	0.39	2.45	0.43
2005	12.17	5.74	0.46	1.84	0.04	0.34	0.09	0.20	2.96	0.50
2010	12.28	5.93	0.60	1.73	0.04	0.29	0.05	0.14	3.09	0.40
2015	12.97	6.34	1.35	1.92	0.05	0.29	0.04	0.10	2.55	0.34
2016	13.10	6.17	1.60	1.83	0.06	0.29	0.03	0.06	2.72	0.33
2017	12.94	5.88	1.76	1.81	0.06	0.29	0.03	0.08	2.70	0.33
2018	12.65	5.46	1.92	1.71	0.07	0.29	0.03	0.07	2.74	0.35
2019	12.09	5.03	2.04	1.66	0.08	0.28	0.03	0.07	2.53	0.35
2020	12.43	5.13	2.29	1.82	0.09	0.28	0.03	0.04	2.40	0.34
2021	13.08	5.00	2.67	1.87	0.10	0.27	0.03	0.06	2.73	0.33
2022	12.97	4.66	2.86	1.95	0.11	0.26	0,03	0.05	2.72	0.34
2023	12.76	4.36	2.88	1.85	0.10	0.24	0.02	0.06	2.89	0.35
Share 2023		**34,18%**	**22,61%**	**14,48%**	**0,81%**	**1,91%**	**0,18%**	**0,47%**	**22,65%**	**2,71%**

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
Trend 1988–2023	-70,58%	-58,27%	59,77%	-72,35%	-18,51%	-86,94%	-58,71%	-87,15%	-86,11%	-68,88%

Code 3.B.1 indicates **CH_4 from Manure management*

Table 181 N_2O emissions from Manure management 1988 –2023, 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	1.83	0.39	0.06	0.29	0.003	0.36	0.02	0.032	0.032	0.65
1990	1.69	0.38	0.06	0.27	0.003	0.32	0.02	0.031	0.033	0.56
1995	0.88	0.23	0.02	0.08	0.002	0.14	0.04	0.030	0.064	0.27
2000	0.80	0.22	0.01	0.07	0.001	0.09	0.05	0.028	0.091	0.23
2005	0.79	0.23	0.02	0.08	0.001	0.06	0.04	0.015	0.042	0.30
2010	0.63	0.19	0.02	0.07	0.001	0.05	0.02	0.011	0.015	0.26
2015	0.61	0.19	0.04	0.06	0.001	0.05	0.02	0.008	0.004	0.24
2016	0.60	0.18	0.05	0.06	0.001	0.05	0.01	0.005	0.005	0.23
2017	0.58	0.17	0.05	0.06	0.001	0.05	0.01	0.006	0.005	0.22
2018	0.59	0.16	0.06	0.06	0.002	0.05	0.01	0.005	0.005	0.23
2019	0.59	0.15	0.06	0.06	0.002	0.05	0.01	0.006	0.004	0.24
2020	0.57	0.15	0.07	0.06	0.002	0.05	0.01	0.004	0.004	0.23
2021	0.58	0.15	0.08	0.07	0.002	0.05	0.01	0.005	0.005	0.21
2022	0.58	0.14	0.08	0.06	0.002	0.05	0.01	0.004	0.005	0.21
2023	0.57	0.13	0.08	0.06	0.002	0.04	0.01	0.005	0.005	0.23
Share 2023		22.38%	14.24%	11.04%	0.42%	7.74%	1.78%	0.01%	0.009%	40.65%
Trend 1988–2023	-68.91%	-67.09%	28.42%	-78.22%	-18.51%	-87.58%	-58.72%	-84.59%	-84,19%	-64.18%

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 189.

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):

$$EF_i = VS_i * 365 \text{ [days yr}^{-1}\text{]} * B_{0i} * 0.67 \text{ [kg m}^{-3}\text{]} * \Sigma_{jK}\, MCF_{jK} * MS\%_{ijK}$$

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.

$$\boldsymbol{VS = [GE * (1 - \frac{DE\%}{100}) + (UE * GE)] * [(\frac{1 - ASH}{18.45})]}$$

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 189), 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).

The emission factor of CH4 from manure management of swine is according Equation 4.17 from Good practice Guidence and Uncertainty Management in National Greenhouse Gas Inventories.

$$\boldsymbol{EF_i = (VS_i \cdot 365) \cdot \left[B_{oi} \cdot 0,67kg/m^3 \cdot \sum\nolimits_{(Jk)} MCF_{jk} \cdot MS_{ijk}\right]}$$

VS = volatile solid excretion per day on a dry-organic matter basis, kg VS day-1
B_0i= CH4 Producing Potential according Table 10A-8 - IPCC 2006
MCF- based on Table 10,17 - IPCC_2006
MS-please see Table 184

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 182, and are based on cool allocation by climate.

Table 182 Methane conversion factors

AWMS	Allocation by climate	MCF
Liquid system	Cool	20%
Solid storage	Cool	2%
Dry lot	Cool	1%
Other	Cool	1%

Table 183 Average value of air temperature (for regions with altitude up to 800 m) for the period 1988 – 2022 [Cº]

1988	1989	1990	1991	1992	1993	1994	
11.90	12.40	11.80	10.60	11.70	11.60	12.90	
1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	
11.20	11.00	11.30	12.10	12.10	12.40	12.30	
2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	
11.90	11.40	11.60	11.10	11.50	12.60	12.50	
2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	
12.30	12.10	11.30	12.40	12.50	12.30	12.70	
2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
12.60	12.30	12.60	13.30	13.00	12.30	12.80	13.06

The average annual temperature for the country for the whole time series is provided by National Institute of Meteorology and Hydrology.

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 184.

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 (MAF). 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 – 2023 provided in Table 184 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 184 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%
2020	20.00%	66.50%	13.50%	91.74%	8.26%	0.00%	35%	65%
2021	20.00%	66.50%	13.50%	91.74%	8.26%	0.00%	35%	65%
2022	20.00%	66.50%	13.50%	91.74%	8.26%	0.00%	35%	65%
2023	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).

N excretion per animal waste management system:

$$Nex_{(AWMS)} = \sum_{(T)}[N_{(T)} \times Nex_{(T)} \times AWMS_{(T)}]$$

$Nex_{(AWMS)}$ = 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

N₂O 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 184).

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 185 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 186 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	267.2	153338	178.6	688059	135.5	193448	165.46
1990	619145		144465		648247		182255	165.46
1995	384111		45965		206253		57988	165.46
2000	392017		36362		183503		45418	165.21
2005	358237		40811		190675		56967	166.03
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
2020	221507		151840		103212		63035	165.21
2021	221366		176755		113863		67136	165.16
2022	206 466		189424		111952		66687	165.41
2023	192 546		191399		105179		67331	165.37

- **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 187 Undigested N (swine)

Animal weight/condition	Undigested N(%)
<20 kg	50%
20-50 kg	60%
50-80 kg	60%
80-110 kg	60%

Animal weight/condition	Undigested N(%)
>110 kg and boars	60%
Pregnant	70%
lactating	65%

The amount of N the animals receive with the food is as follows:

Table 188 Amount of nitrogen per day in swine food

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 189 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
2020	111433	131218	121433	113148	6411	58314
2021	143078	163095	157420	105739	8290	65760
2022	140086	179646	146849	113341	5461	62801
2023	144471	166605	139995	138149	4291	69714
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 190). Data have been provided by Agriculture university of Plovdiv.[26]

Table 190 Activity data for estimating nitrogen excretion from poultry

Layer hen		Broilers		Turkey		Ducks and others	
TAM	Kg N in 1000 Kg manure	TAM	Kg N in 1000 Kg manure	TAM	Kg N in 1000 Kg manure	TAM	Kg N in 1000 Kg manure
2.03	0,82	2.57	1.10	9.00	0.74	5	0.83

[26] D. PENKOV, V. GERZILOV et all, 2012 Data on the chemical content and management of waste from industrial poultry breeding

- **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):

$$\mathbf{Nex_{(T)} = Nrate_{(T)} \times TAM/1000 \times 365}$$

$Nex_{(T)}$ = *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 177, chapter Enteric fermentation)*

Values of nitrogen excretion of animal of type are present in
Table 191.

Table 191 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)	11.66
- Pigs <20 kg	7.30
- Pigs20-50 kg	10.42
- Pigs 50-80 kg	12.03
- Pigs 80-110 kg	13.01
- Pigs >110 kg and boars	16.19
- Breeding pigs	19.88
Layer hen	0.61
Broilers	1.03
Turkey	2.43
Ducks & other	1.51

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 192 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 193 Indirect N2O emissions from Manure Management

Year	Total N volatilised as NH_3 and NOx (kg N/year)	N_2O emissions (Gg)
1988	85557673	1.34
1990	82363192	1.29
1995	39427420	0.62
2000	31313418	0.49
2005	31921154	0.50
2010	26280488	0.41
2015	25328683	0.40
2016	25049796	0.39
2017	24608111	0.39
2018	24818342	0.39
2019	24254614	0.38
2020	23874613	0.38
2021	24769536	0.39
2022	24919672	0.39
2023	24620155	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:

$$N_2O_{G(mm)} = (N_{volatilization-MMS} \times EF_4) \times \frac{44}{28}$$

$N_2O_{G(mm)}$ – 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);

$$N_{volatilization-MMS} = \sum_S [\sum_T [(N \times Nex \times MS) \times (\frac{FracGasMS}{100})]]$$

$N_{volatilization-MMS}$ - 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 191*);*
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 194 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 195 Uncertainty of sub-sector Manure Management for 2023, %

CRT 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
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 2025 there is no source specific recalculations. Please refer to Chapter 3.A Enteric fermentation.

Source-specific planned improvements

Bulgaria makes great efforts to improve the estimations, using year-specific values for the nitrogen excretion rate in this emissions calculation for 3.B.1 Manure Management, Dairy Cattle.

.

5.6 RICE CULTIVATION (CRT 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 11 203 ha in 2023.

113.00 Gg CH4 CO2-eq. has been emitted in 2023. Emission increase by 1.06% compared to the year 2022 (106.69 Gg CH4 CO2-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[27];
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 196 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.

5.7 AGRICULTURAL SOILS (CRT SECTOR 3D)

Microbial processes of nitrification and denitrification in agricultural soils produce nitrous oxide emissions. In 2023 this category generates 93,05% of N_2O emissions from Agricultural sector.

[27] According NAAS (National Agricultural Advisory Service)

There is a decrease of 37,83 % for this category from 1988 to 2023 (Figure 104). The reasons are structural changes in agricultural holdings and decrease in arable land area.

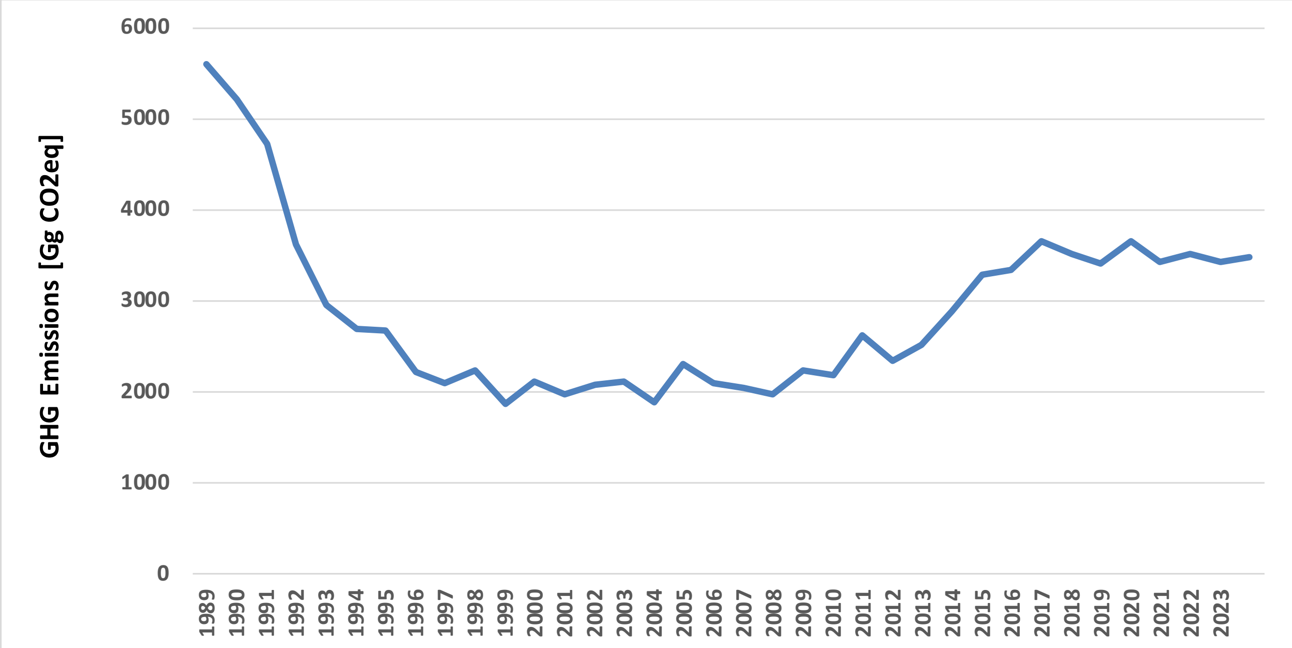


Figure 104 Trend of GHG Emissions from agricultural soils

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 2023.

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 3 481,26Gg CO_2-eq. in 2023.

Indirect N_2O emissions are 775.21 Gg CO_2-eq. in 2023.

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 198

- 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 (CRT 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 2019, 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 2019). Furthermore, the NH_3 emission factor for each fertiliser is given, based on the values from the EMEP/EEA Guidebook 2023. 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 2019.

Table 197 Activity data for the estimations of $Frac_{GASF}$ for 2022.

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%	106408	0.064
Ammonium nitrate (AN)	0.015	55%	188790	
CAN	0.008	1%	3433	
Ammonium sulphate (AS)	0.09	4%	13730	
Ammoniun phosphate (AP)	005	9%	30893	

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 198.

Table 198 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 200) (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
https://ec.europa.eu/eurostat/databrowser/view/aei_fm_usefert/default/table?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). „IE" is reported for sludge under wastewater treatment and discharge in CRT table 5.D to avoid double counting.

- **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.
MAF 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 MAF published the information on their website.

- **Area of organic soils**

Data is provided by Institute of Soil, Agrotechnology and Plant Protection "Nikola Pushkarov"

Table 199 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 - MAF
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 200 Area of crop land (ha)

	1990	1995	2005	2010	2017	2018	2019	2020	2021	2022	2023
Wheat	1162775	1181115	1101807	1131565	1144519	1212012	1198682	1200175	1206187	1206580	1220906
Barley	359950	369211	264519	245328	128365	103570	112029	130757	126310	122411	149980
Maize	424428	475256	298713	327525	398152	444623	560911	581532	573023	520461	534637
Oats	35225	35715	30571	24353	13266	11339	12153	13397	9937	11442	13005
Rye	24499	14183	8782	10795	8237	8316	6097	5352	7633	8326	7655
Rice	10590	1380	4501	11977	10434	11004	11822	12349	12053	10577	11203

Maize for silage	424317	64081	32211	20314	29930	27242	27500	30439	30108	27346	28233
Bean	39381	42747	8552	1410	2749	1809	1396	2254	2524	1366	1312
Peas	38138	6723	1402	1981	766	479	919	870	699	734	529
Soya	16816	15113	272	725	11530	2315	3862	4510	1986	9501	3671
Chick peas	4600	3794	593	911	22564	59841	11373	4076	3335	3472	3688
Lentils	7720	2301	2064	2879	4471	3179	1273	1432	1791	1386	1117
Potatoes	41000	56000	23999	13805	12806	14096	9291	9946	10902	9159	7019
Sugar beet	36479	9378	1294	0	0	0	0	0	0	0	0
Cotton	8995	11482	1119	558	4805	3157	3461	3280	2354	1299	1300
Feet beet	310000	286000	87302	337313	172723	183218	165052	138988	124504	108596	135546
Peanuts	11738	12167	1094,3	519	443	605	471	636	676	463	530
Sunflower	280203	586009	635003	729889	898844	788656	815561	821922	836469	916959	869907
Tobacco	52897	14254	40869	24518	7721	5812	3536	3186	3782	2415	2393
Alfalfa	399576	172818	64851	74832	88182	91592	69361	92075	92745	86673	81865

Table 201 Parameters for estimating N_2O emissions in Crop Residues returned to Soils

Parameter description	Parameter Source
Area	Input of Ministry of Agricultural
Crop	Eq. 11.7, IPCC 2006 GB
Yield fresh	Input of Ministry of Agricultural
Dry matter fraction	CS (University of Plovdiv)
Above-ground residue dry matter	Table 11.2 IPCC 2006 GB
Slope	Table 11.2 IPCC 2006 GB
Intercept	Table 11.2 IPCC 2006 GB
Ratio of above-ground redues	Above-ground residue dry matter x 1000/Crop
N content of above-ground residue for crops	Table 11.2 IPCC 2006 GB
Ratio of below-ground residues TO above-ground biomass	Table 11.2 IPCC 2006 GB
Ratio of below-ground residues	RBG-BIO * (AGDM x 1000 + Crop)/Crop
N content of below-ground residue for crops	Table 11.2 IPCC 2006 GB
Annual amount of N in crop residue (Fcr)	Eq. 11.7A, IPCC 2006 GB
Emission Factor - N2O-N	Table. 11.1 IPCC 2006 GB
N2O-N emissions	(Fcr x EF1) / 1000000 GB

Table 202 Total emissions from N_2O [Gg] in Crop Residues returned to Soils 1990-2023

	1990	2000	2005	2010	2015	2018	2019	2020	2021	2022	2023
Total emissions from N_2O in Crop Residues Returned to Soils [Gg]	**3.18**	**1.52**	**2.07**	**3.37**	**3.30**	**4.05**	**3.98**	**3.50**	**4.02**	**3.63**	**3.87**

Table 203 Consumption of synthetic fertilizers for the period 1988 – 2023

	1988	1990	1995	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Amount of synthetic fertilizers (kt N/year)	**541**	**396**	**130**	**160**	**199**	**342**	**366**	**321**	**310**	**363**	**352**	**333**	**343**	**341**

Table 204 Sewage sludge spreading, 2008 – 2023:

	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**	**25665**
	2020	**2021**	**2022**	**2023**		
	16929	**18490**	**18616**	**21554**		

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 205 Uncertainty of sub-sector Agricultural soils for 2022, %

CRT 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

- There is a revised activity data for consumption of synthetic fertilizers for the period 2017-2021.
- There is a revised parameters of soil C after 20 years of LUC and soil C stock before LUC for the whole time series.

Source-specific planned improvements
To conduct a study on the parameter Frac remove (currently: assuming no removal)

5.8 FIELD BURNING OF AGRICULTURAL RESIDUES (CRT 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.
36.46Gg CO_2-eq. aggregated GHGs were emitted in 2023 (0.61% 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 206.

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 206 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 MAF. Specific parameters used for calculations of the emissions are provided from the Agricultural University of Plovdiv (see Table 207).

Table 207 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 (CRT sector 3G)

CO2 emission`s estimations are based on expert judgement of percent cultivated area and grasland area which need potentialy liming. The activity data for Grassland and Cropland are reported under Chapter Land use Land use change and forestry.
According expert judgement 10% of grassland and 17% of cropland are potentionaly liming.
The recommended lime application is 0,15 t/ha.
The emissions from liming are estimated according 2006 IPCC Guidelines, Volume 3 AFOLU, Chapter 11: N2O Emissions from Managed Soils, and CO2 Emissions from Lime and Urea Application sub-chapter 11.3.2.The chosen emission factors is on page 11.28.

Table 208 CO2 emissions from Liming 1988-2023

	1988	1990	1995	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total amount of Lime used in agriculture [t]	66346	65651	65130	64533	63763	62685	61727	60987	60237	59565	59458	59927	58961	58099
CO2 emission from 3.(II).G Liming [Gg]	29,19	28,89	28,66	28,39	28,06	27,58	27,16	26,83	26,50	26,21	26,16	26,37	25,94	25,56

5.10 CO_2 EMISSIONS FROM UREA FERTILIZATION (CRT 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 1,12% of the CO_2 emission from the agricultural sector. The recommended lime

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 209 Consumption of urea fertilizers (t/year) for the period 2006 – 2023

	2006	2007	2008	2009	2010	2011	2016	2017	2018	2019	2020	2021	2022	2023
Urea (t/year)	31018	8432	41286	36053	49239	45028	59912	67678	70048	75981	73933	71286	75617	90769

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 210 CO_2 emissions from urea fertilisation

	2006	2007	2008	2009	2010	2011	2012
CO_2 emissions (Gg)	22.75	6.18	30.28	26.44	36.11	33.02	29.95
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
	44.70	47.45	41.39	43.94	49.63	51.37	55.72
	2020	**2021**	**2022**	**2023**			
	54.22	52.28	55.45	66.56			

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 revised activity data for the whole time series.

5.10.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements in this category.

6 LULUCF

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.

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 2025 Inventory submission Bulgaria reports carbon stock changes, as well as greenhouse gas emissions and removals from Forest Land (CRT 4.A), Cropland (CRT 4.B) and Grassland (CRT 4.C), Wetlands (CRT 4.D), Settlements (CRT 4.E) and Other land (CRT 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 211 Overview of subcategories of CRT Sector 4 – LULUCF: status of emission estimates for CO_2, CH_4 and N_2O

Land-Use Categories	Net CO_2 emissions/removalc	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
G Harvested Wood Products (HWP)	x		

Land-Use Categories	Net CO_2 emissions/removalc	CH_4	N_2O
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 212 Key sources of LULUCF sector (T1)

Land-Use Categories	Gas	Level assessment	Trend assessment
4.A.1 Forest Land Remaining Forest Land	CO_2	x	x
4.A.2 Land Converted to Forest Land	CO_2		x
4.B.1 Cropland Remaining Cropland	CO_2		
4.B.2 Land Converted to Cropland	CO_2	x	x
4.C.1 Grassland remaining Grassland	CO_2		
4.C.2 Land Converted to Grassland	CO_2	x	x
4.D.2 Land Converted to Wetlands	CO_2		
4.E.2 Land Converted to Settlements	CO_2	x	x
4.G Harvested Wood Products	CO_2	x	x

6.1.3 EMISSION TRENDS

The emissions and removals in the different categories are presented in Table 213

Table 213 Total net emissions and removals of greenhouse gases from land use, land use changes and forestry by categories in CO_2 eq.

Year	4 Total	4 A Forest land	4 B Cropland	4 C Grassland	4 D Wetlands	4 E Settlements	4 F Other land	4 G HWP
1988	-17138.30	-16246.35	297.76	-776.43	51.34	118.67	NO	-583.29
1989	-17253.73	-16289.06	289.91	-838.03	48.62	118.12	NO	-583.29
1990	-17246.09	-16327.94	291.03	-785.61	45.92	113.80	NO	-583.29
1991	-17203.23	-16348.98	285.32	-876.64	43.22	132.06	NO	-438.22
1992	-16596.26	-16352.55	287.63	-1037.94	40.52	151.69	NO	314.40
1993	-16769.50	-16334.47	298.98	-1291.03	37.82	113.18	NO	406.02
1994	-16801.47	-16361.05	340.87	-1312.32	35.12	119.35	NO	376.57
1995	-16835.23	-16459.48	380.72	-1256.33	53.45	102.45	NO	343.96
1996	-16108.53	-15554.96	376.76	-1323.62	56.97	102.10	NO	234.22
1997	-16231.25	-15615.45	378.22	-1327.76	58.19	114.75	NO	160.79
1998	-15970.71	-15644.39	312.90	-1053.27	61.12	118.63	NO	234.29
1999	-15772.50	-15682.50	714.79	-1011.40	64.05	141.02	NO	1.55
2000	-16746.32	-15500.79	299.92	-1482.02	67.51	137.54	NO	-268.49
2001	-14005.98	-12679.53	350.01	-1502.97	70.92	89.94	NO	-334.35
2002	-14254.39	-12699.30	359.68	-1645.47	74.40	117.56	NO	-461.25
2003	-13916.16	-12685.56	400.72	-1388.48	77.56	106.95	NO	-427.36
2004	-14573.99	-12671.85	352.44	-1586.86	80.90	105.32	NO	-853.94
2005	-15606.92	-12672.35	271.64	-2506.53	84.21	177.17	NO	-961.06
2006	-12551.08	-10607.19	368.55	-1673.64	87.59	175.32	NO	-901.72
2007	-13391.06	-10440.82	327.94	-1897.83	91.05	230.67	NO	-1702.07
2008	-11891.63	-10576.54	537.09	-1451.66	97.00	394.82	NO	-892.32
2009	-12068.37	-10606.11	480.80	-1369.75	103.21	170.55	NO	-847.08

Year	4 Total	4 A Forest land	4 B Cropland	4 C Grassland	4 D Wetlands	4 E Settlements	4 F Other land	4 G HWP
2010	-11508.35	-10538.72	908.47	-1310.43	109.17	280.23	NO	-957.07
2011	-8248.69	-6916.44	902.98	-1244.53	115.17	188.96	NO	-1294.84
2012	-7808.74	-6848.94	1152.04	-1157.91	121.13	195.86	NO	-1270.91
2013	-6818.15	-6841.84	1872.89	-1041.56	129.60	251.53	NO	-1188.77
2014	-8086.52	-6819.21	745.57	-1029.81	117.64	157.36	NO	-1258.08
2015	-7642.97	-6668.06	1032.41	-901.81	113.00	311.33	NO	-1529.84
2016	-9447.99	-8571.31	762.14	-868.69	108.34	257.52	NO	-1136.00
2017	-9426.97	-8542.06	844.44	-741.07	103.98	263.18	NO	-1355.44
2018	-9507.50	-8527.70	819.02	-827.47	99.66	161.68	NO	-1232.69
2019	-9227.14	-8461.22	739.85	-892.61	95.36	319.09	NO	-1027.61
2020	-9269.06	-8438.28	883.37	-789.12	91.00	178.95	NO	-1194.99
2021	-9201.70	-8467.55	805.96	-609.23	86.58	152.24	NO	-1169.70
2022	-9153.93	-8341.83	664.17	-763.26	82.11	177.19	NO	-972.31
2023	-8601.07	-8220.83	936.40	-494.16	77.64	342.07	NO	-1242.19
2023-1988	**-49.81 %**	**-49.40%**	**214.48%**	**-43.21%**	**51.28%**	**188.25%**	**-**	**112.96%**

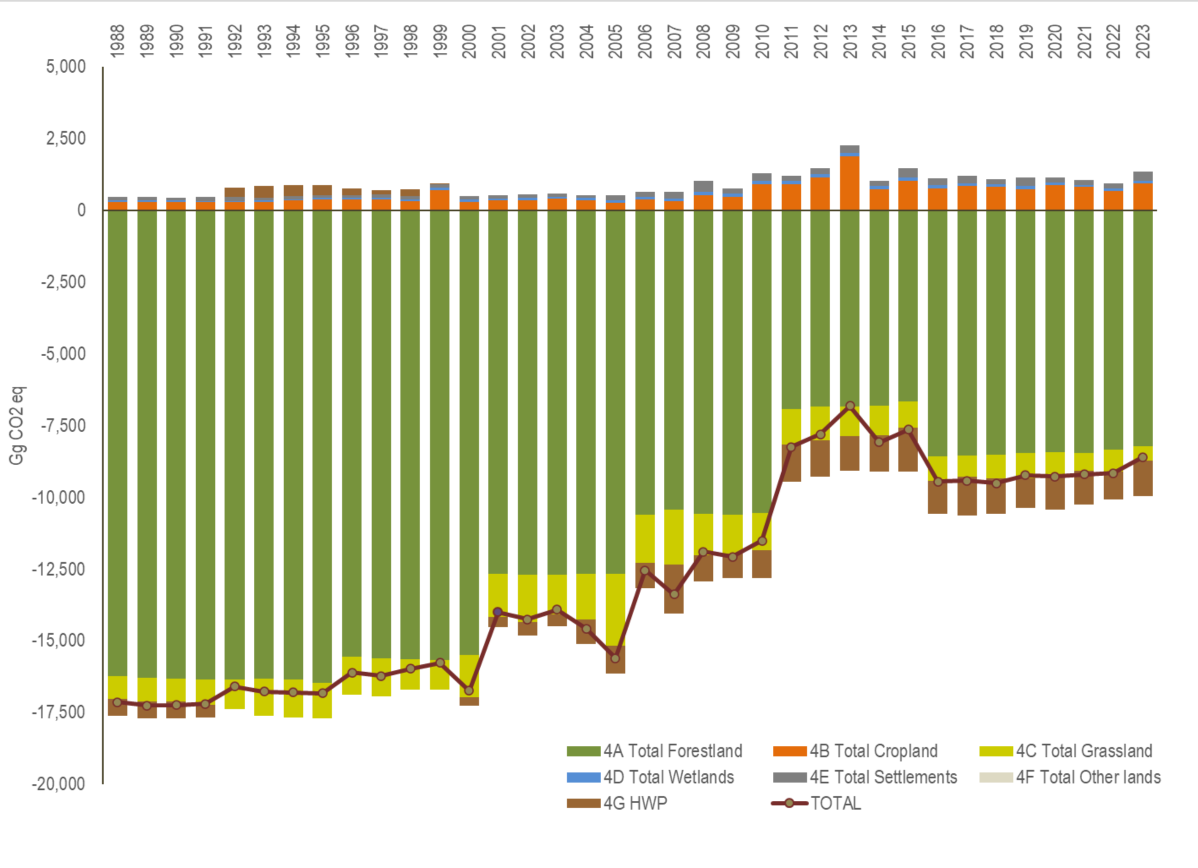


Figure 105 LULUCF emissions and removals 1988 – 2023 CO_2 eq.

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 46% 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 – 15.5% from the total GHG emissions in CO_2eq, while in the inventoried year the share is – 16.3%.
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 2024, 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 and Wetlands Supplements. 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 214 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, Tier 2
4A2 LUC to FL	Tier 2	Tier 2	Tier 2	Tier 2	NO	Tier 1	Tier 1, Tier 2
4B1 CLrCL	Tier 1, Tier 2	Tier 1		Tier 2	Tier 1		Tier 2
4B1.1 aCLraCL	Tier 1	Tier 1		Tier 2	Tier 1		Tier 2
4B1.2 pCLrpCL	Tier 2	Tier 1		Tier 2	Tier 1		Tier 2
4B2 LUC to CL	Tier 1, Tier 2	Tier 1		Tier 2	NO	NO	Tier 2
4C1 GLrGL	Tier 1	Tier 1		Tier 1	Tier 1	NO	Tier 2
4C2 LUC to GL	Tier 1, Tier 2	Tier 1		Tier 2	NO	NO	
4D1 WLrWL	NO	NO		NO	NO	NO	
4D2 LUC to WL	Tier 1, Tier 2	Tier 1, Tier 2	Tier 1, Tier 2	Tier 2	NO	NO	Tier 2
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 2
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 mostly follows 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 215 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

Activity/Emission factor	Uncertainty %	Source of information
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 (shrubs and grasslands), tonnes Cyr^{-1}	50	default, MediNet Project
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 grassland, tonnes C	1.54	empirical data
Organic soils in grassland, tonnes C	30.20	default, 2019 Refinement to the IPCC GNGGI
Soil C stock in annual cropland, tonnes C	0.04	empirical data

Activity/Emission factor	Uncertainty %	Source of information
Organic soils in cropland, tonnes C	18.35	default, 2019 Refinement to the IPCC GNGGI
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 NIDs 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 MAF together with the Regional Directorates "Agriculture and forestry" and Municipal Services on agriculture and forestry at MAF 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 MAF. 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

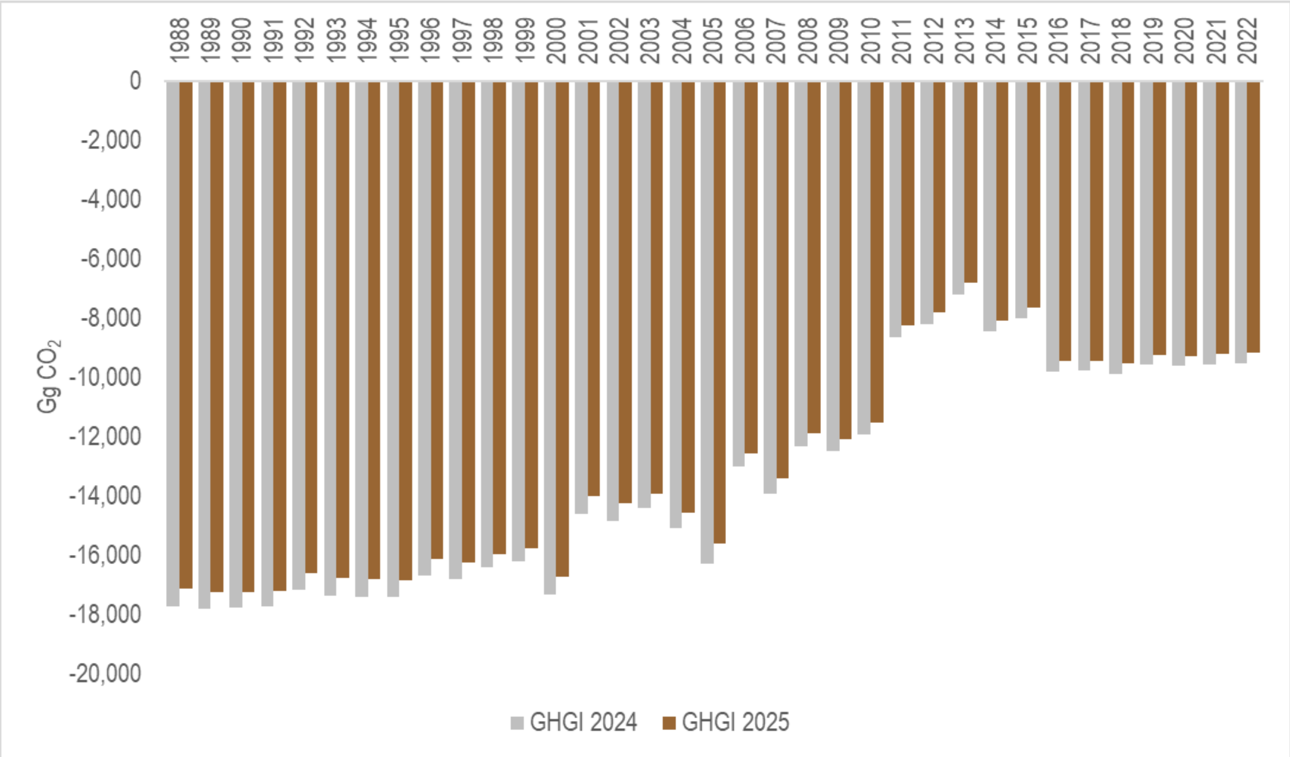


Figure 106 Recalculations in LULUCF sector

The main changes occur in 4.B Cropland, where the recalculations are related to changes in area representations, and more specifically – improved estimates of LUC conversions between annual and perennial crops and vice versa over the time series, and recalculations in carbon stock changes in living biomass and soils of perennials remaining perennials. The introduced changes in estimation of the carbon stock of biomass in perennials crops lead also to small recalculations in other categories, where conversions from perennials to other land-uses are reported. In addition, there are small recalculations in direct and indirect N_2O emissions associated with N mineralization due to land use changes, because of refinement of the C/N ratio data.

6.1.8 PLANNED IMPROVEMENTS

1. Improving the new approach in estimating the CSC in soils by adding more information to the dataset used now by including data from LUCAS monitoring sites as well as data from forest monitoring plots.
2. Gain more information for the soil improvements/management methods in CL and GL categories
3. Derive country specific data on soil carbon stock under coniferous and deciduous species.
4. Continuation of improvements in reporting DOM pool in FL category

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 12.03.2021, SG №21):
"***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 (fruit trees and berry plantations), walnuts and viticulture. 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 orchards and walnut's 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, wetlands areas and bogs.

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.

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 № 18/2015 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 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 216). 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 216 Information on data sources and providers

<table>
<tr><th rowspan="2">Land use category</th><th colspan="2">Main data source</th><th colspan="2">Data provider</th></tr>
<tr><th>1988-1997</th><th>1998-2020</th><th>1988-1997</th><th>1998-2020</th></tr>
<tr><td>4A Forest land</td><td colspan="2" rowspan="4">Forest Inventory, Forestry Management Plans and their Forestry fund reporting forms</td><td colspan="2" rowspan="4">Executive Forest Agency (ExFA)</td></tr>
<tr><td>Coniferous</td></tr>
<tr><td>Deciduous</td></tr>
<tr><td>forests out of yield</td></tr>
<tr><td>4B Cropland</td><td rowspan="3">National Statistical Yearbooks</td><td rowspan="3">BANCIK and LPIS</td><td rowspan="3">National Statistical Institute (NSI)</td><td rowspan="3">Ministry of agriculture, food and forestry (MAF)</td></tr>
<tr><td>annual cropland</td></tr>
<tr><td>perennial cropland</td></tr>
<tr><td>4C Grassland</td><td>National Statistical Yearbooks</td><td>BANCIK and LPIS</td><td>National Statistical Institute (NSI)</td><td>Ministry of agriculture, food and forestry (MAF)</td></tr>
<tr><td>4D Wetlands</td><td colspan="2" rowspan="2">Cadastral maps of the agricultural fund for single years 1994 and 1996; LPIS, CLC</td><td colspan="2" rowspan="2">Cadastre Agency, MAF, Executive Environment Agency</td></tr>
<tr><td>4E Settlement</td></tr>
<tr><td>4D Other land</td><td colspan="2">Forest Inventory</td><td colspan="2">Executive Forest Agency (ExFA)</td></tr>
</table>

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 the approaches 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 in general 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 spatially-explicit study, performed in 2021, for identification of the afforestation/reforestation units according to KP definitions. 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 (*Figure 137*). 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 the previous submissions 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 2020. 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 2020. 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 2020 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.

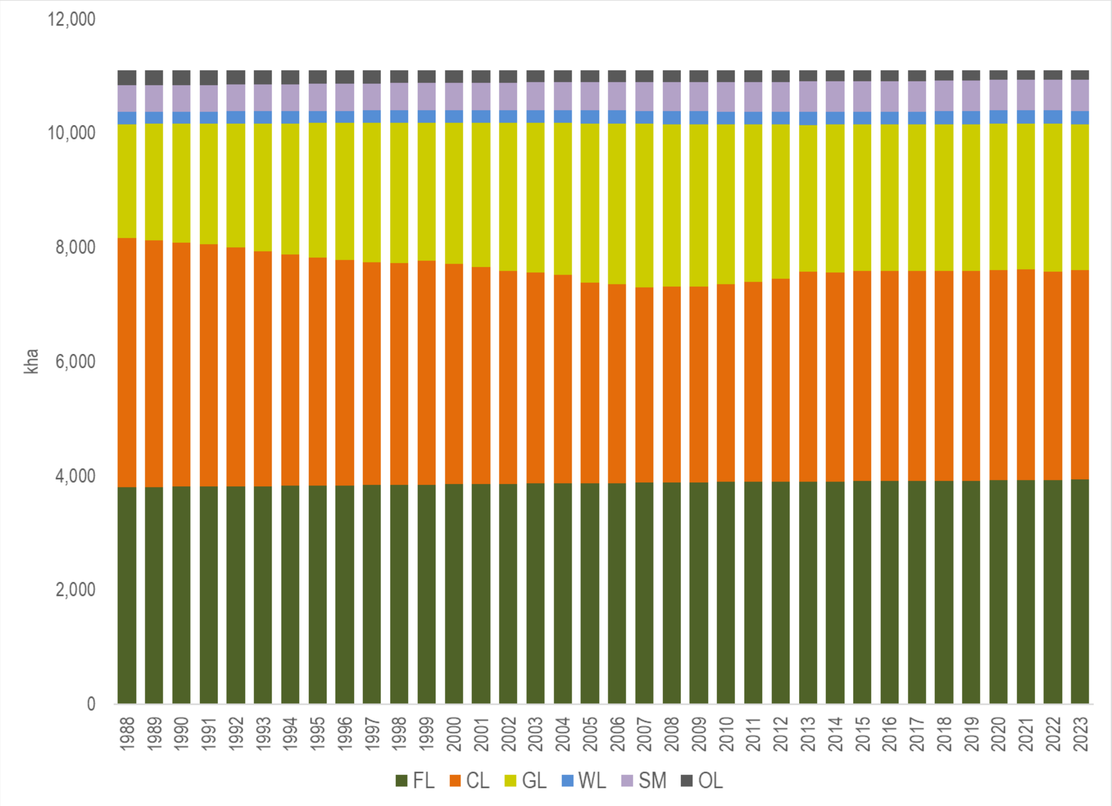


Figure 107 Annual land representation by land-use categories

Table 217 Land use and LUC data for Bulgaria for the years 1988 and 2023

Area in kha	1988	2023	2023 -1988
4.A Forest Land - Total	**3800.93**	**3933.46**	**132.53**
Forest land - coniferous - Total	1175.93	1021.81	-154.12
Forest land - deciduous - Total	2603.35	2887.77	284.42
Forest land - out of yield - Total	21.65	23.88	2.23
4A1. Forest land remaining forest land	***3339.00***	***3857.12***	***518.11***
4A1. Forest land remaining forest land - coniferous	762.83	997.61	234.78
4A1. Forest land remaining forest land - deciduous	2554.53	2835.63	281.10
4A1. Forest land remaining forest land - out of yield	21.65	23.88	2.23
4A2. LUC in forest land	***461.93***	***76.34***	***-385.59***
4A2. LUC in forest land - coniferous	*413.11*	*24.20*	*-388.91*
4A2.1.a Annual CL to FL	4.70	4.68	-0.01
4A2.1.b Perennial CL to FL	0.32	0.24	-0.08
4A2.2.a Pastures and meadows to forest land	100.01	10.74	-89.27
4A2.2.b Shrubs and grasslands to forest land	298.51	8.22	-290.29
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	9.57	0.32	-9.25

Area in kha	1988	2023	2023 -1988
4A2. LUC in forest land - deciduous	*48.82*	*52.14*	*3.32*
4A2.1.a Annual CL to FL	1.01	8.77	7.77
4A2.1.b Perennial CL to FL	0.07	0.42	0.35
4A2.2.a Pastures and meadows to forest land	12.62	23.60	10.97
4A2.2.b Shrubs and grasslands to forest land	34.00	18.87	-15.12
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	1.12	0.48	-0.64
4.B Cropland - Total	**4363.20**	**3669.76**	**-693.44**
Cropland annual – Total	*4067.40*	*3532.73*	-534.67
Cropland perennial – Total	*295.80*	*137.03*	-158.77
4B1. Cropland remaining cropland - total	***4312.37***	***3328.87***	***-983.50***
4B1a annual cropland remaining annual cropland	3969.61	3153.35	-816.26
4B1b perennial cropland remaining perennial cropland	260.96	67.32	-193.63
4B1c LUC perennial cropland in annual cropland	50.60	52.62	2.02
4B1d LUC annual cropland in perennial cropland	31.20	55.58	24.38
4B2. LUC in cropland	***50.83***	***340.89***	***290.06***
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	32.36	177.99	145.63
4B2.2b Pastures and meadows in perennial cropland	2.50	7.71	5.21
4B2.2a Shrubs and grasslands in annual cropland	14.83	148.77	133.94
4B2.2b Shrubs and grasslands in perennial cropland	1.14	6.42	5.27
4B2.3a Wetlands in annual cropland	0.00	0.00	0.00
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	**1995.37**	**2555.32**	**559.95**
Pastures and meadows total	*1717.53*	*1382.41*	-335.12
Shrubs and grasslands total	*277.84*	*1172.92*	895.07
4C1. Grassland remaining grassland	***1747.70***	***2186.51***	***438.82***
4C1.a Pastures and meadows remaining pastures and meadows	1448.93	1097.47	-351.46
4C1.b Shrubs and grasslands remaining shrubs and grasslands	163.57	929.18	765.61
4C1.c LUC Shrubs and grasslands to Pastures and meadows	101.35	89.37	-11.98
4C1.d LUC Pastures and meadows to Shrubs and grasslands	33.85	70.49	36.64
4C2. LUC in grassland	***247.68***	***368.81***	***121.14***
4C2.1 Forest land in grassland	0.00	0.00	0.00
4C2.2.a Annual cropland in Pastures and meadows	150.53	176.01	25.48
4C2.2.b Perennial cropland in pastures and meadows	16.73	19.56	2.83
4C2.2.a Annual cropland in Shrubs and grasslands	24.35	117.78	93.43
4C2.2.b Perennial cropland in Shrubs and grasslands	2.71	13.09	10.38
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	53.37	42.38	-10.99
4 D Wetlands - Total	**213.50**	**232.84**	**19.33**
4D1. Wetlands remaining wetlands	***205.55***	***221.66***	***16.11***
4D2. LUC in wetlands	***7.95***	***0.00***	***-7.95***
4D2.1 Forest land in wetlands	0.00	0.00	0.00
4D2.2.a Annual Cropland in wetlands	0.00	11.17	11.17
4D2.2.b Perennial Cropland in wetlands	0.00	0.00	0.00
4D2.3.a Grassland in wetlands, PMG	0.00	0.00	0.00

Area in kha	1988	2023	2023 -1988
4D2.3.b Grassland in wetlands, MGL	6.33	0.00	-6.33
4D2.4 Settlement in wetlands	0.00	0.00	0.00
4D2.4 Other land in wetlands	1.62	9.53	7.91
4 E Settlements - Total	**461.71**	**545.06**	**83.35**
4E1. Settlements remaining settlements	***421.79***	***489.26***	***67.47***
4E2. LUC in settlements	***39.92***	***55.80***	***15.87***
4E2.1 Forest land in settlements	1.43	6.28	4.86
4E2.2.a Annual Cropland in settlements	22.29	30.26	7.96
4E2.2.b Perennial Cropland in settlements	1.50	1.59	0.09
4E2.3.a Grassland in settlements, PMG	9.84	9.55	-0.29
4E2.3.b Grassland in settlements, MGL	3.47	6.37	2.90
4E2.4 Wetlands in settlements	0.00	0.00	0.00
4E2.4 Other land in settlements	1.39	1.74	0.35
4 F Other land- Total	**265.477**	**163.76**	**-101.72**
4F1. Other land remaining other land	***265.48***	***163.76***	***-101.72***
4F2. LUC in other land	***0.00***	***0.00***	***0.00***
Total area Bulgaria	**11100.19**	**11100.19**	**0.00**

The data shows that over the period 1988-2023 the areas in the categories "Forest land", "Grassland", "Wetlands", "Settlements" have increased by 132.53, 559.95, 19.33, 83.35 kha respectively, while they have decreased in the categories "Croplands" and "Other land" by 693.44 kha and 101.72 kha, respectively.

6.3 FOREST LAND (4.A)

6.3.1 DESCRIPTION OF THE CATEGORY

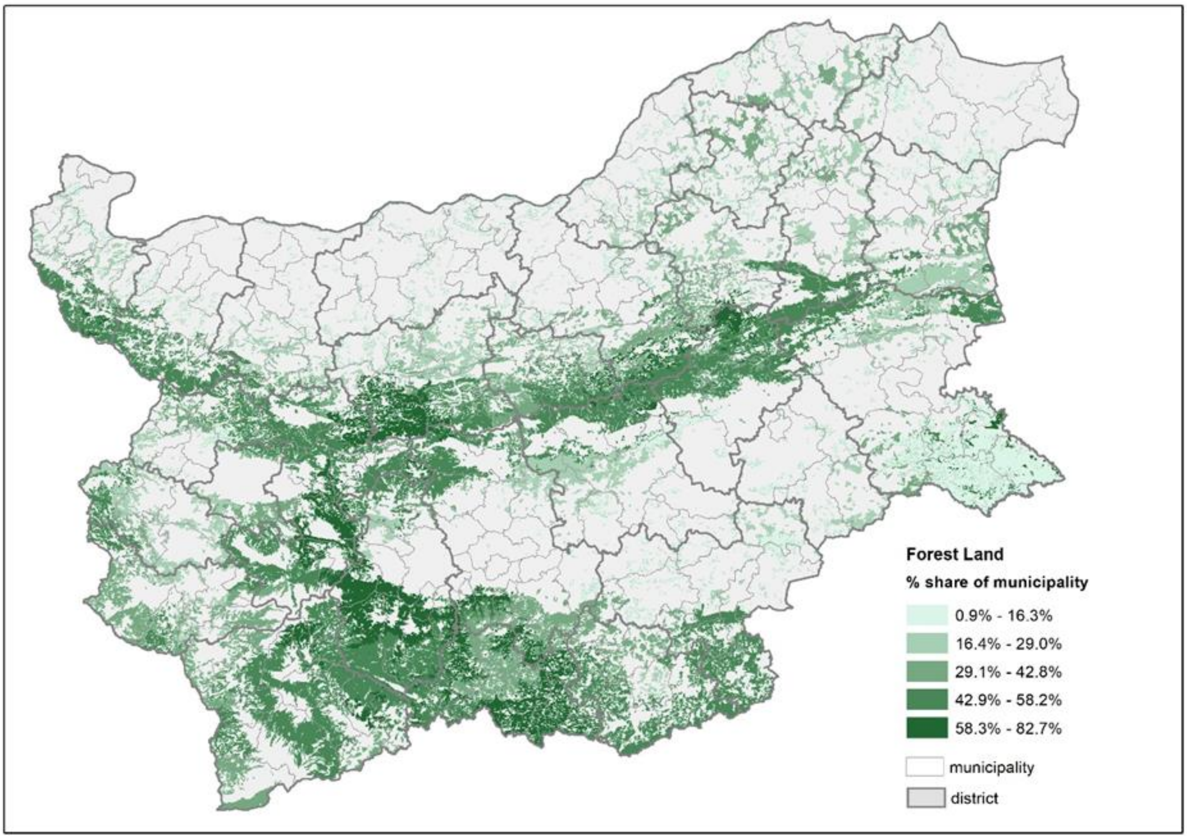


Figure 108 Share of municipality area occupied by Forest land.

The map is elaborated based on CLC, 2018

In 2023, forest territories in Bulgaria cover an area of 4280 kha. Forested areas are 3933 kha which represents 35.44 % of the country's territory. There is a constant increase in forested area since the base year, nevertheless the trend of LUC to FL has decrease substantially in the past 20 years. As a result, the total forested area is 3.47 % higher, comparing to the base year 1988 - 3801 kha. The figure below presents data on the area of Forest land for the reporting period.

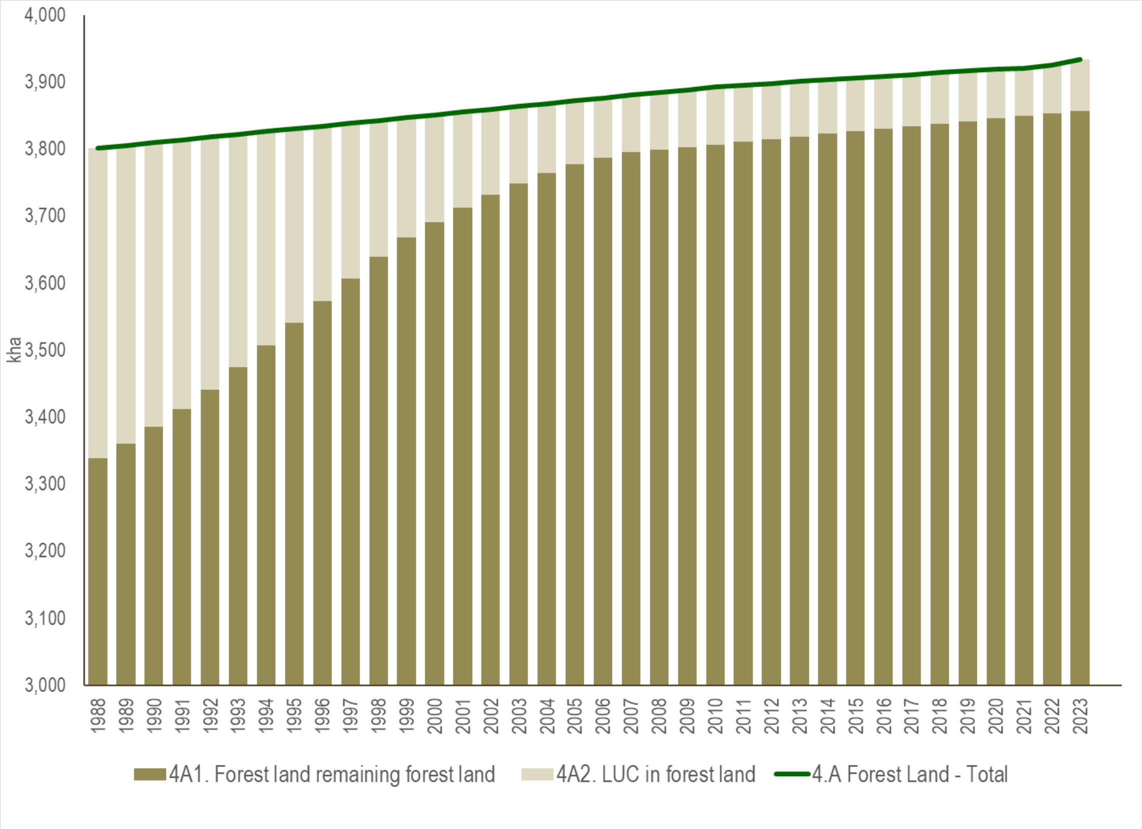


Figure 109 Trends in forested area in Forest land category 1988-2023

For the reporting year Forest land category includes 1022 kha coniferous forests, which represent 25.99 % of these lands, 73.43 % of the category or 2888 kha represent deciduous forests and the rest 0.58 %, or 24 kha are forests out of yield – presented in the following figure.

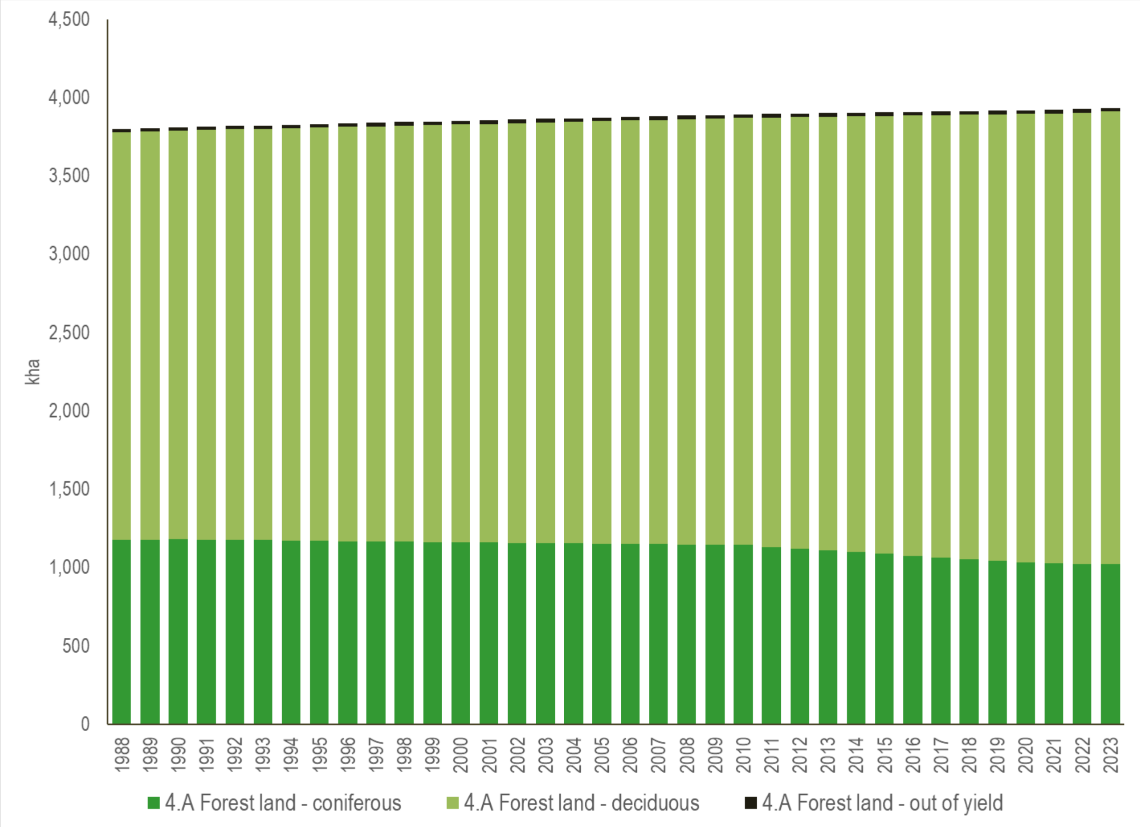


Figure 110 Forest type distribution under FL category

Most of the forest territory in Bulgaria is state's own – almost 78 % (according to data from 2023). The municipalities and religious organizations own around 12.67 % of the forests. The share of the private forests in Bulgaria has increased in recent years up to nearly 10 % from the total forest area. More than 90% of these private forests are properties with an area below 2 ha.

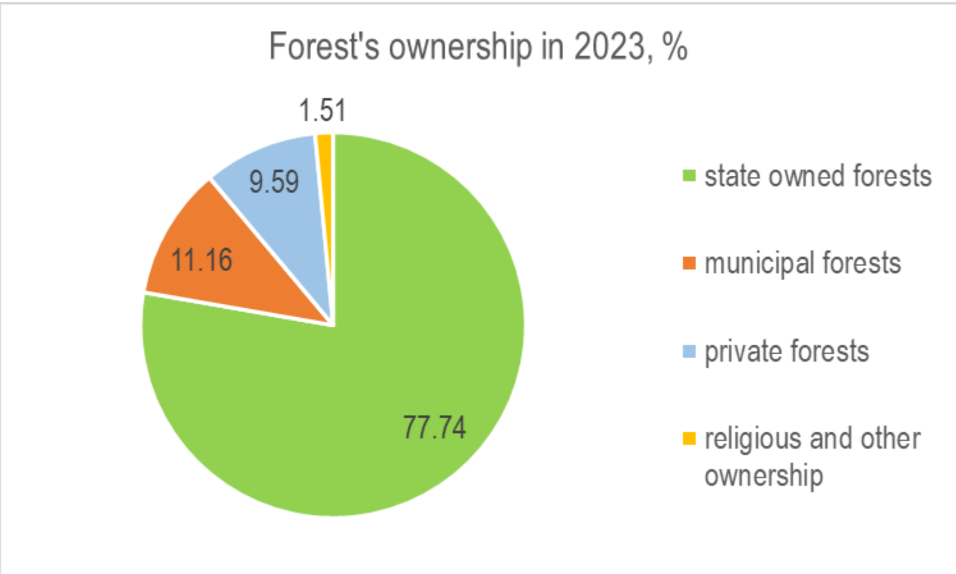


Figure 111 Breakdown of forest ownership in 2023, Source: EFA

The forest territories are managed according to the provisions of the Forest Law whatever their ownership. 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 land area up to 50 hectares a forestry programmes shall be developed. The forestry plans and programmes shall be drawn up based on 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.

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 –16246.37 Gg CO_2 eq. for 1988 and –8220.83 Gg CO_2 eq for 2023. Despite the observed increase in forest area (*Figure 109*), 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.

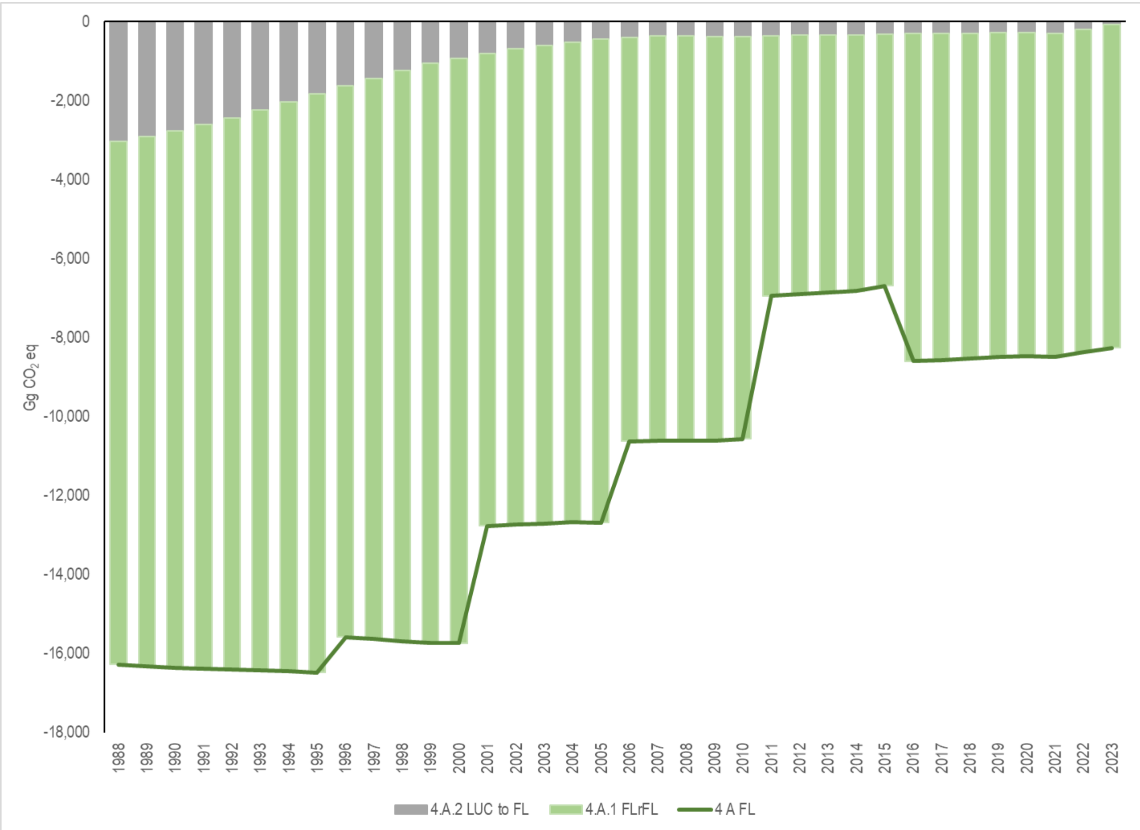


Figure 133 Net GHG emissions/removals (+/-) from 4.A Forest Land, Gg CO_2.

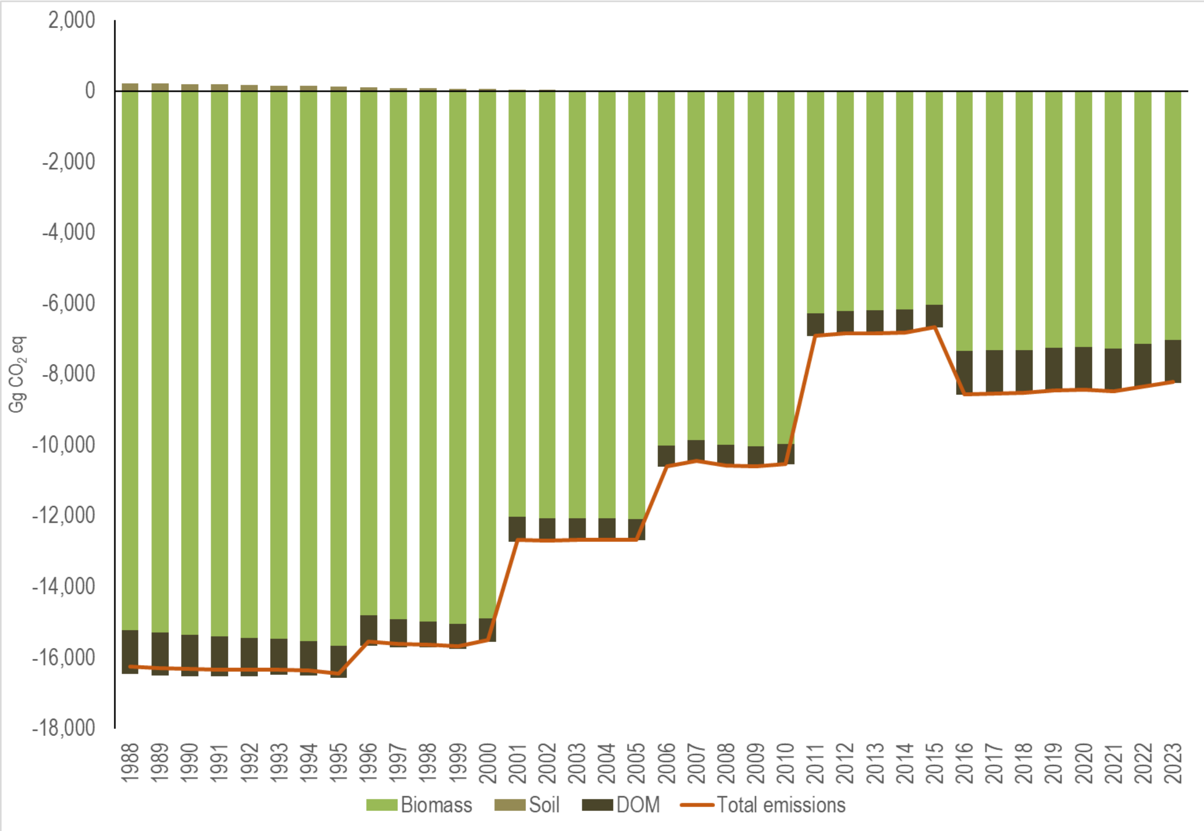


Figure 112 Net GHG emissions/removals (+/-) from 4.A Forest Land by carbon pools, Gg CO_2 eq.

Table 218 Net emissions/removals (+/-) from 4.A Forest Land category, Gg CO_2 eq

Year	4.A Forest Land	4.A.1 FL-FL		4.A.2 LUC to FL		
	Total emissions	CO_2 emissions and removals	Non-CO_2 emissions associated with biomass burning	CO_2 emissions and removals	Non-CO_2 emissions associated with biomass burning	Direct and Indirect N_2O associated with N mineralization in soils
1988	-16246.37	-13236.86	1.61	-3041.02	0.22	29.68
1989	-16289.06	-13402.35	0.78	-2915.94	0.10	28.34
1990	-16327.94	-13584.08	3.67	-2774.84	0.46	26.84
1991	-16348.98	-13763.02	1.81	-2613.18	0.21	25.19
1992	-16352.55	-13964.41	18.76	-2432.31	2.05	23.35
1993	-16334.47	-14190.99	65.55	-2236.89	6.56	21.31
1994	-16361.05	-14416.96	65.87	-2035.22	5.99	19.27
1995	-16459.48	-14642.74	2.01	-1836.15	0.16	17.24
1996	-15554.96	-13944.19	7.95	-1634.52	0.58	15.21
1997	-15615.45	-14198.60	2.90	-1433.12	0.19	13.19
1998	-15644.39	-14452.90	26.19	-1230.31	1.46	11.16
1999	-15682.50	-14667.76	31.38	-1057.09	1.53	9.43
2000	-15500.79	-14817.72	220.37	-921.01	9.55	8.02

Year	4.A Forest Land	4.A.1 FL-FL		4.A.2 LUC to FL		
	Total emissions	CO_2 emissions and removals	Non-CO_2 emissions associated with biomass burning	CO_2 emissions and removals	Non-CO_2 emissions associated with biomass burning	Direct and Indirect N_2O associated with N mineralization in soils
2001	-12679.53	-11965.07	77.12	-801.31	2.97	6.76
2002	-12699.30	-12039.27	25.00	-691.54	0.86	5.65
2003	-12685.56	-12113.17	19.67	-597.31	0.60	4.65
2004	-12671.85	-12166.82	4.40	-513.31	0.12	3.76
2005	-12672.35	-12233.26	5.60	-447.89	0.14	3.06
2006	-10607.19	-10221.43	14.38	-403.00	0.34	2.53
2007	-10440.82	-10247.87	168.65	-367.52	3.78	2.14
2008	-10576.54	-10243.49	21.12	-356.86	0.48	2.22
2009	-10606.11	-10241.26	8.82	-376.16	0.20	2.29
2010	-10538.72	-10195.48	25.35	-371.53	0.57	2.36
2011	-6916.44	-6582.77	27.82	-364.50	0.62	2.39
2012	-6848.94	-6553.58	50.69	-349.57	1.10	2.41
2013	-6841.84	-6523.55	12.89	-333.90	0.28	2.44
2014	-6819.21	-6494.19	3.59	-331.15	0.08	2.46
2015	-6668.06	-6381.83	21.35	-310.51	0.44	2.48
2016	-8571.31	-8294.48	24.66	-304.50	0.51	2.50
2017	-8542.06	-8268.10	17.78	-294.61	0.36	2.51
2018	-8527.70	-8242.76	5.66	-293.21	0.11	2.50
2019	-8461.22	-8216.25	22.35	-270.28	0.44	2.52
2020	-8438.28	-8190.71	20.48	-270.96	0.39	2.52
2021	-8467.55	-8186.29	12.25	-296.20	0.23	2.46
2022	-8341.83	-8186.32	31.67	-190.29	0.59	2.52
2023	-8220.83	-8181.20	36.85	-79.96	0.73	2.74

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 (*Figure 113*). 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 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 114). The drop in total harvesting since 2020 is related to the COVID crisis, the peculiarities of the regional timber market and the increasing difficulty of finding labour in the timber industry.

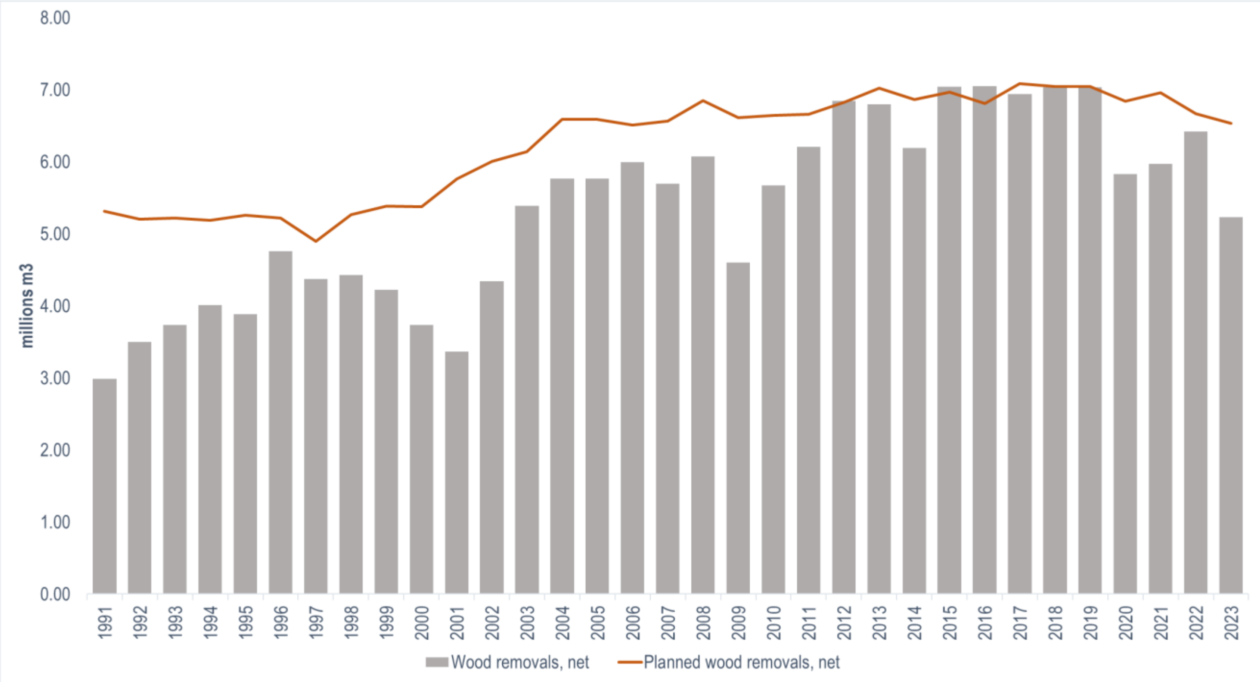


Figure 113 Trend in wood harvested vs planned harvest (mill m^3 o.b)

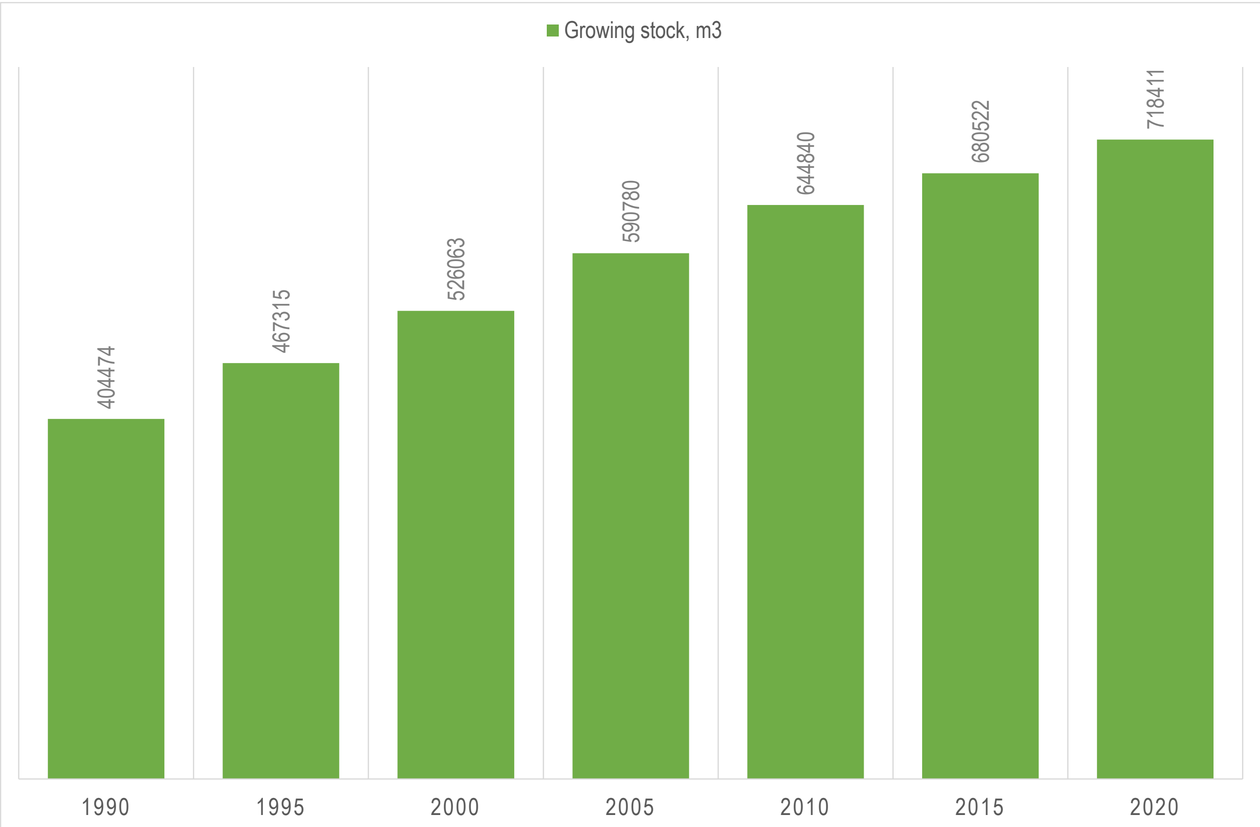


Figure 114 Standing growing stock in Bulgaria, official data

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 (aged >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 felled now.

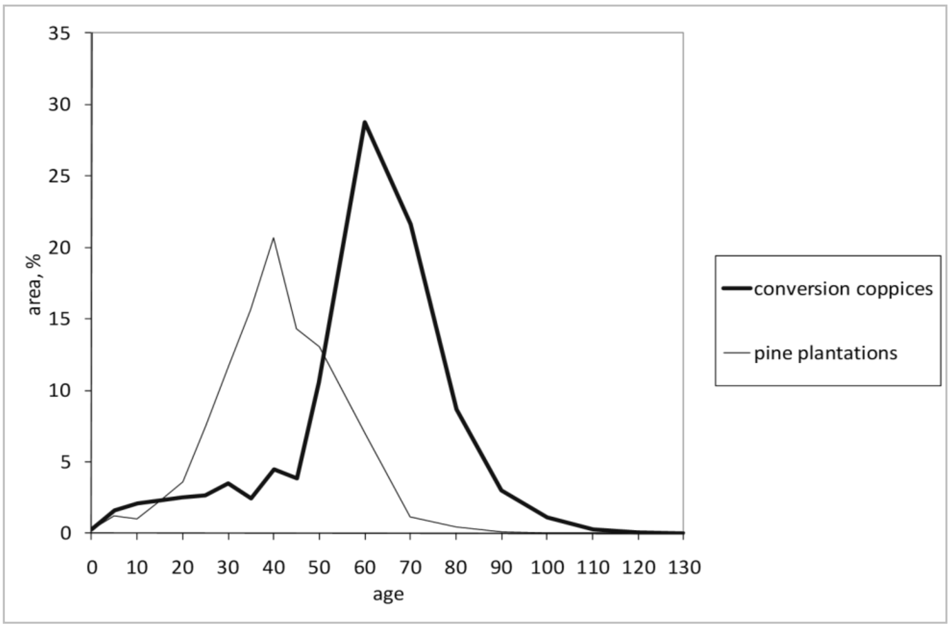


Figure 115 Forest area of pine plantations and conversion coppices by age

The non-CO_2 emissions in Forest Land category are associated with biomass burning due to wildfires as well as direct and indirect emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter due to land use conversion on mineral soils.

The trend of 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 in living biomass pool.

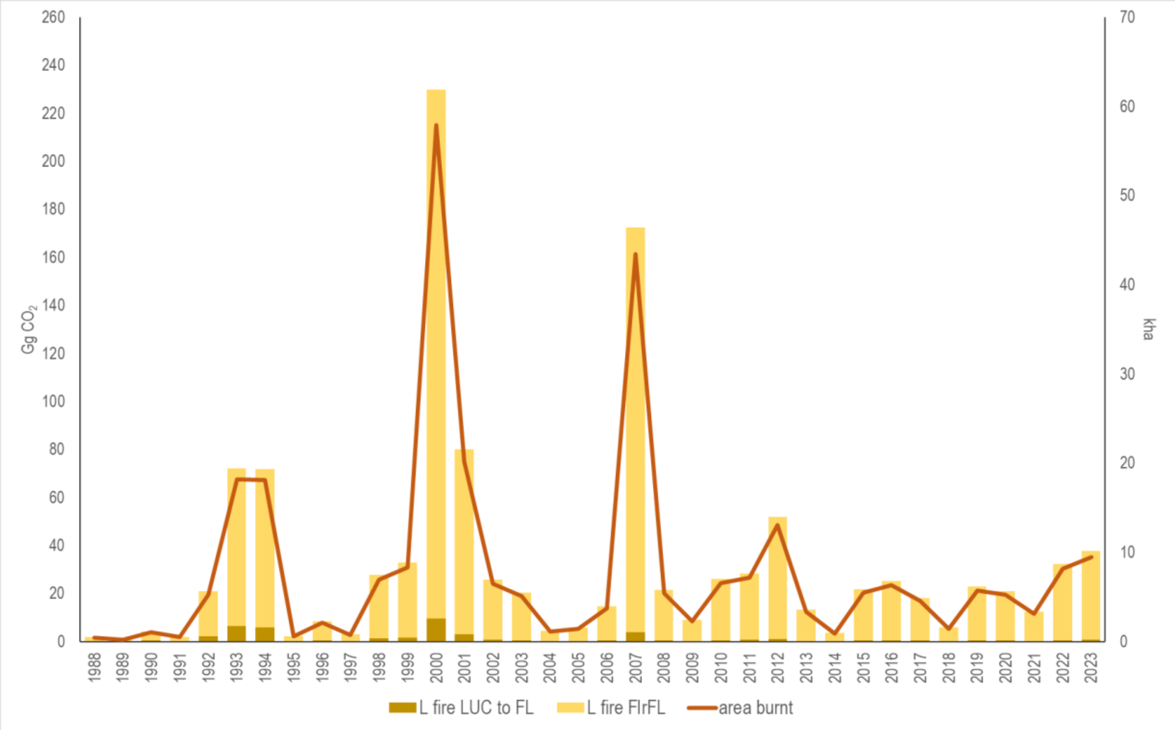


Figure 116 Non-CO_2 emissions associated with biomass burning from wildfires in 4A Forest Land category, Gg CO_2 eq.

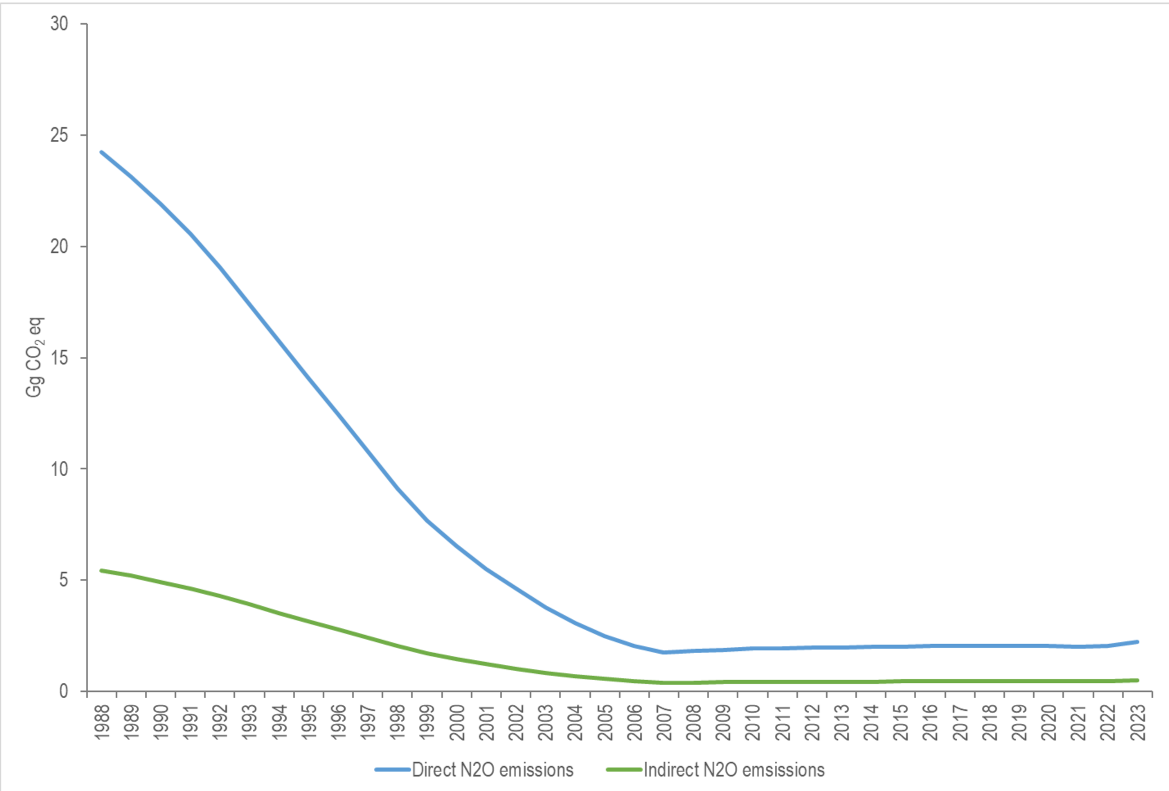


Figure 117 Direct and Indirect N_2O emissions associated with N mineralization

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. According to the official statistics on forest areas in Bulgaria, there is an increase in the forest territories by 20% since 1990. But not all of the increase is due to afforestation and reforestation activities. Many of these areas were forests before 1990. Thus, special consideration is needed when develop the land transition matrix. This was addressed with two studies. The first one was implemented in the period 2012-2014. The project has been launched following the plan for improvement of the estimation of LUC to FL (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 Submission 2014. The study extracted the potential AR areas based on the FMP, but it was not spatially explicit.
Due to financial and technical constraints and considering that Bulgaria accounts at the end of the CP, It was decided that it is not necessary to carry out such an assessment for each year, thus Bulgaria reported the AR units based on extrapolation.

In 2021 Bulgaria carried out an assessment on the AR areas since 1990 in response to its commitment to assess these units once again at the end of the commitment period. The approach used in that study is spatially explicit and is based on the intersection between forest map and cadastral map. More details are provided below.

The Law on Territorial Structure defines the main designation of lands in terms of spatial planning and development. According to their main purpose, defined by the concepts and schemes of spatial development and general development plans, the territories in the country are: urbanized areas (settlements, settlements and industrial parks outside the settlements and settlements), agricultural areas, forest areas, protected areas, disturbed areas for restoration, areas occupied by waters and water bodies, and areas of transport. The territories with designation of agricultural, forest or urbanized territories may be simultaneously and with designation protected territories determined by law.
The Executive Forest Agency owns and maintains digitalized information on forest territories, which include forested and non-forested areas such as pastures and meadows in between the forested lands, rocks, forest roads etc. The geospatial information on forest territories is part of the forest management plans of the State Forest Enterprises (SFE). This information is fragmented at national level and has different temporal coverage, because the data is collected in different years (when FMP is developed). Thus, a unified forest map could be elaborated by combining the forest maps of all state forest enterprises in the country (approx. 160). Currently, such unified maps are available for the years 2010 and 2020[28] by combining the information for all SFE for two consecutive forest inventories. As the forest inventory is conducted once per 10 years, it was considered that the information in the unified maps represents the state of the forest territories at two points in time – 2010, which is representative for the old, digitized forest management plans, and 2020 which is representative for the currently acting plans.

[28] https://maps.iag.bg/mapstore/#/viewer/openlayers/6

The geospatial information for the territories with agricultural and urbanized designation of lands is stored and maintained by the Cadaster agency into cadastral maps. Up until recently there was no full coverage of the cadaster in the country. For the areas, where no cadaster was available, the source for geospatial information for the agricultural territories was the map of restored property[29].

Thus, to assess the AR units of lands since 1990, the approach consists of spatial intersection of the forest territory map with the cadaster and/or the map of restored properties. Like this, all forests land which meet the forest definition but are outside the forest territories are identified. The intersection is carried out twice. First, the forest map for 2010 is intersected with the geospatial information for agricultural lands. The difference between the two maps is further analyze to identified only the newly developed forest. This is done by differentiating the forested areas by age, origin and tree species based on the attributes in the forest map. Like this, only the forest areas with an age up to 20 years and seed origin are considered and reported as AR. All the remaining forests – with an age bigger than 20 years, or forests with age less than 20 years but with of shoot origin are not considered as AR units. The same approach is made between the forest map for 2020 and the cadaster and the map of restored property, but the differentiating by age is done considering the forest stands with age of 30 years. Like this, all the AR outside the forest territories from 1990 until 2020 are identified. In addition, to define the AR units within the forest territories (for example on non-forested areas) the forest maps for 2010 and 2020 have been intersected. This is not applicable for the years before 2010, because there is not unified forest map available before 2010. However, we can suggest that the increase within forest territories before 2010 was lower than now (there were more cattle, sheep and goats animals in villages and countryside), thus the land use changes from non-forested to forested lands within the forest territories before 2010 have been ignored in the assessment of AR.

The following step is to reconstruct the annual forest area data from the base year. The results of the intersection and the further analysis provide the information for the net increase in forest for two points in time – 2010 and 2020. Therefore, the net increase in forest areas in 2020 plus the annual deforestation areas since 1991 must represent the total ARD areas since 1990. Then the reconstruction of the forested area in 1990 iss made as follow:

$$\boldsymbol{FL_{1990} = FL_{2020} - NiFL_{30} + D_{SM1991-2020}}$$

Where,

FL_{1990} – forested area in 1990

FL_{2020} – forested area in 2020

$NiFL$ – net increase in FL for the period 1990-2020

D_{SM} – D area for settlements since 1990

The annual change was estimated by interpolation in two periods according to the results of the study – 1991-2010 and 2011-2020.

The assessment of the former land use of the identified AR units of land was made by using the attributes of the cadaster map combined with an expert judgment. Land use (cropland, grassland, other land) typically follows ecological site conditions. The dominating land uses in a single district or SFE region is known, which facilitates the 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 and GL cannot grow.

[29] *Map of the restored property ownership (since 1995) – combines the data from the land division plan, the map of the existing old real borders, the map of the restored old real borders of agricultural lands created under the Law on the Property and Use of Agricultural Land (LAPP), and the map of the restored property on Forests and lands from the forest fund, established by the order of the Law for restoration of ownership of forests and lands from the forest fund*

The LUC to FL before the base year has been recalculated as well. Data on afforestation/reforestation were extracted from the National Statistical Institute and adjusted to meet the requirements for reporting land use changes as the period before 1988. This improvement led to significant change in the trend of subcategory LUC to FL as the period before 1988 is characterized with a massive afforestation programme (Popov e al., 2018).

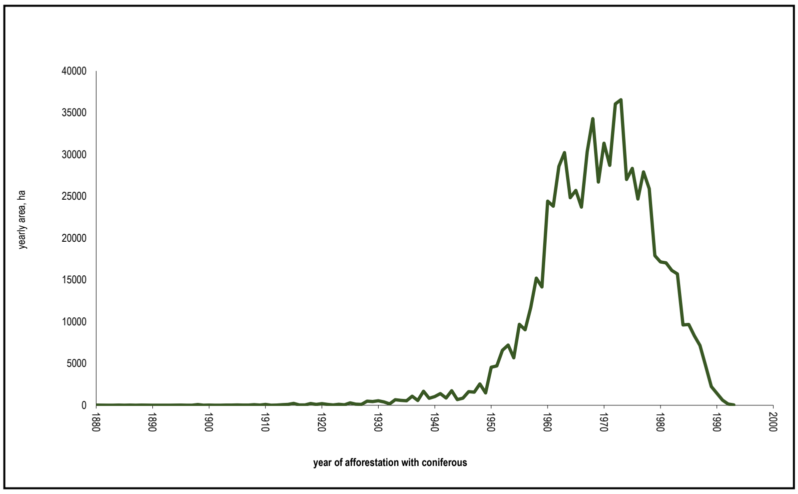


Figure 118 Trend of afforestation with coniferous species outside their natural habitat[30]

6.3.3 METHODOLOGY

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 Forest Land remaining Forest Land 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 are 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 CRT 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.
Concerning the **subcategory LUC to Forests**, Bulgaria estimates and reports carbon stock changes in all pools – living biomass, DOM and soil.

Non-CO_2 emissions from wildfires (Figure 116) 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.

[30] Popov et al, 2018 Coniferous plantations in Bulgaria created outside of their natural habitat

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.

Sources of information

Data on growing stock and forest characteristics

Forest Stand Descriptions (Description sheets)
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, 2015 and 2020.
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 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 219 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 90-95-00-05-10-15-20
3	Growing stock by age classes	Every 5 years since 1960; data used for the years 90-95-00-05-10-15-20
4	Forested area distributed by forest functions	Every 5 years since 1960; data used for the years 90-95-00-05-10-15-20
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 90-95-00-05-10-15-20
7	Forested area distributed by age classes and yield classes	Every 5 years since 1960; data used for the years 90-95-00-05-10-15-20

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.

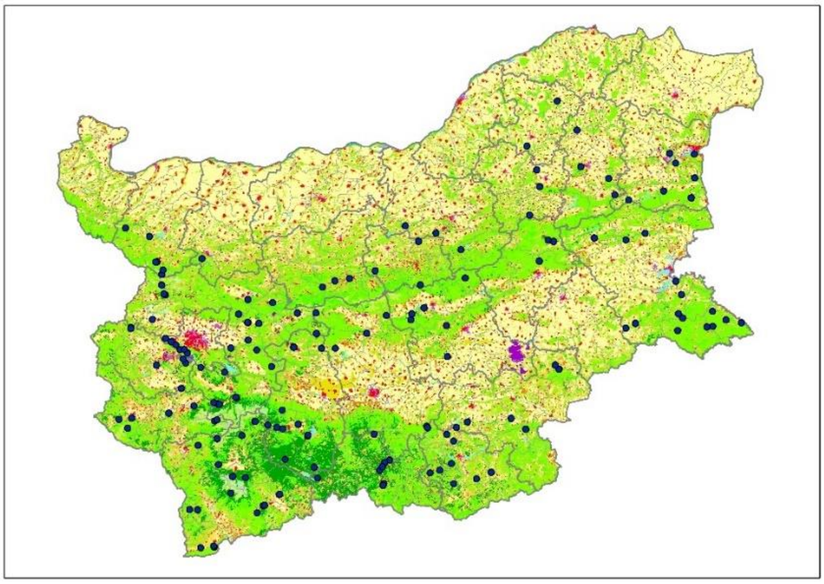


Figure 119 Distribution of the ICP-Forest sample plots at Level I

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, snow breaks 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.

$$C_B = (C_{t2} - C_{t1})/(t_2 - t_1)$$

The carbon stock in the biomass is calculated using the equation:

$$C = A \cdot V \cdot BCEF_s \cdot (1 + R) \cdot CF$$

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)

$$BECF_s = BEF_2 \cdot D$$

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 2020, 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, 2015 and 2020.

Table 220 Growing stock (o.b) - stemwood and branches by tree species

Stratum	unit	1990	1995	2000	2005	2010	2015	2020
Scots pine	m^3/ha	151.54	184.56	216.15	230.29	248.84	259.93	274.44
Norway spruce	m^3/ha	225.92	242.40	285.88	306.54	344.86	371.06	407.34
Black pine	m^3/ha	71.60	125.07	184.16	214.19	244.18	268.52	278.73
Silver fir	m^3/ha	328.85	342.51	372.32	383.41	405.65	453.31	494.98

Stratum	unit	1990	1995	2000	2005	2010	2015	2020
Other conifers	m^3/ha	148.25	187.59	213.31	194.71	285.47	322.08	350.06
Oak	m^3/ha	83.04	88.42	95.73	102.63	103.98	102.84	104.81
Beech	m^3/ha	194.37	213.63	223.76	240.69	251.07	265.19	277.76
Poplar	m^3/ha	86.36	89.08	82.46	96.99	115.73	117.52	114.68
Others	m^3/ha	69.22	77.81	79.61	83.45	89.03	90.63	92.01

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 221 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 222 Wood density (D)

Tree species	kg/m^3
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 GIs have been used according to the quantity of the aboveground biomass of each stratum during the time series.

Table 223 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
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, 2020). 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 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 and applied for Submission 2022 onwards. 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 analyze 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 (Table 225, Table 226) have been distributed proportionally to the ratio of the mortality in the forest stands per tree species and age. In doing so, we assume that forests that produce more dead trees also have more remaining dead wood and that the reported dead wood stock in literature is accumulated throughout the years of stand development according to the distribution of the mortality.
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 224 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

Tree species	a	k
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

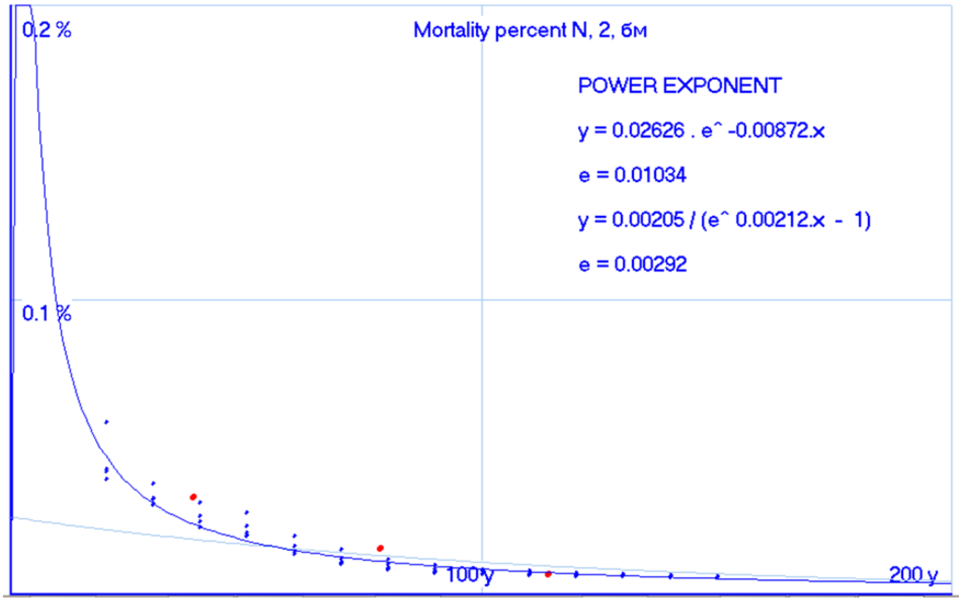


Figure 120 Annual mortality rate according to yield table for Pinus peuce

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.

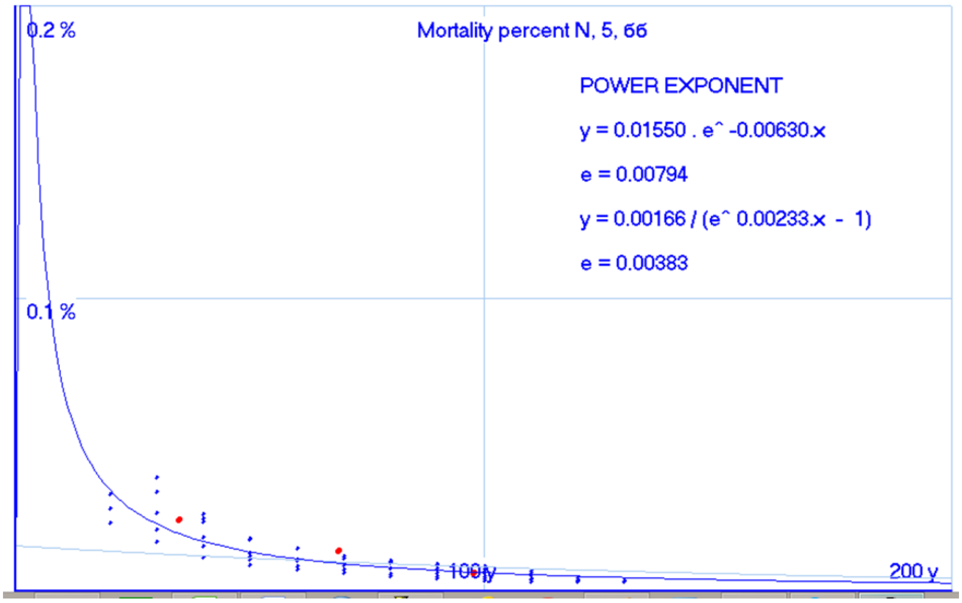


Figure 121 Annual mortality rate coefficient approximated to yield class III, (example for Pinus sylvestris)

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 conducted by Panayotov, Alexandrov, Zlatanov (not published).

Table 225 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 226 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 227 Factors used for convertion of the biomass volume stock to carbon content

Conversion factors	coniferous	broadleaves	Source:
Density, t/m^3	0.362	0.427	L. Di Cosmo et al., 2013
CF	0.510	0.480	IPCC 2006

Table 228 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

Tree species	Year of stands	Carbon stock in DW, tC/ha	Year of stands	Carbon stock in DW, tC/ha
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 and 2020 and multiplied by the area per age class to obtain the total dead wood stock in the respective years. Changes in the carbon stock of DW for FL-FL 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 2020 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 (Table 229, Table 230) 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 122*). 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.

Table 229 Time series of dead wood stock per tree species, tC

Tree species	1995	2000	2005	2010	2015	2020
Scots pine	1,195,751	1,365,480	1,497,750	1,579,924	1,572,019	2,061,480
Norway spruce	309,796	338,257	363,925	390,582	397,155	225,090
Black pine	643,275	714,505	787,931	863,042	909,364	1,405,132
Silver fir	61,104	62,358	61,326	66,977	67,463	66,393
Other conifers	87,820	113,614	128,110	135,426	135,213	119,821
Oak	871,543	1,049,186	1,309,740	1,493,678	1,910,941	2,514,425
Beech	1,013,340	1,042,295	1,158,931	1,254,828	1,383,394	1,375,627
Poplar	107,844	107,734	107,659	107,222	101,690	95,177
Others broadleaves	589,412	607,317	688,571	752,493	914,752	1,065,453
Total	**4,879,885**	**5,400,747**	**6,103,942**	**6,644,172**	**7,391,991**	**8,928,599**

Table 230 Time series of dead wood stock per hectare and tree species, tC/ha

Tree species	1995	2000	2005	2010	2015	2020
Scots pine	2.27	2.59	2.84	3.00	2.99	3.91
Norway spruce	2.04	2.22	2.39	2.57	2.61	1.48
Black pine	2.36	2.62	2.89	3.16	3.33	5.15

Silver fir	1.99	2.03	2.00	2.18	2.19	2.16
Other conifers	2.58	3.34	3.76	3.98	3.97	3.52
Oak	0.60	0.72	0.90	1.03	1.32	1.73
Beech	1.70	1.75	1.94	2.10	2.32	2.31
Poplar	5.17	5.17	5.16	5.14	4.88	4.56
Other broadleaves	0.82	0.85	0.96	1.05	1.28	1.49
Total	**19.53**	**21.29**	**22.85**	**24.21**	**24.88**	**26.32**

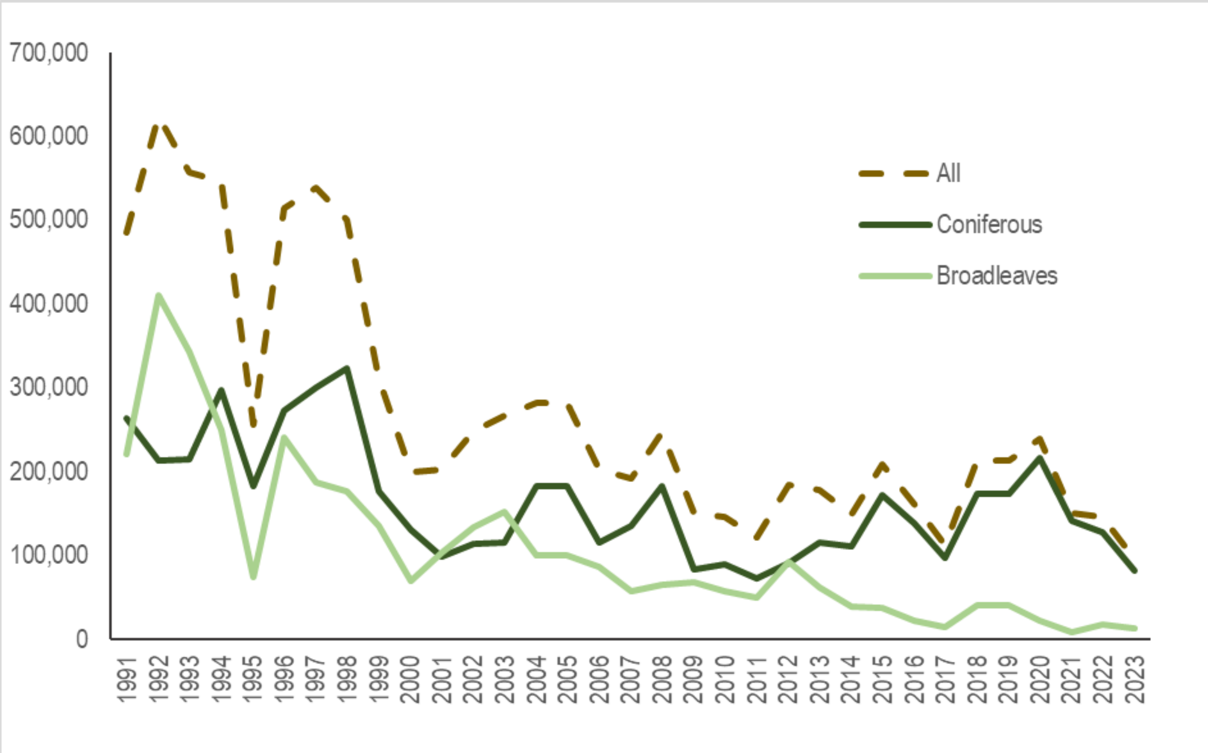


Figure 122 Harvest of dry and fallen mass, m^3

6.3.3.1.2.2 Changes in carbon stock in litter

Since the 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[31] of litter is:

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. 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

[31] http://www.icp-forests.org/pdf/FINAL_soil.pdf (see Annex 7 Soil horizon designation p.195)

(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. Organic fine substance amounts to more than 70 % by volume.

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 these 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 123 and Figure 124), 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 (Stoeva and Kirova, 2021). 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.

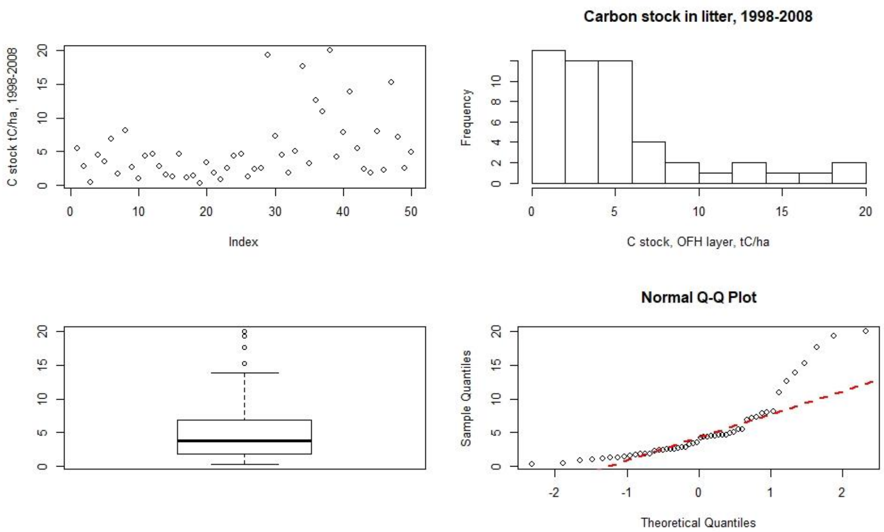


Figure 123 Distribution of the carbon stock in litter layer for the period 1998-2008, n=50

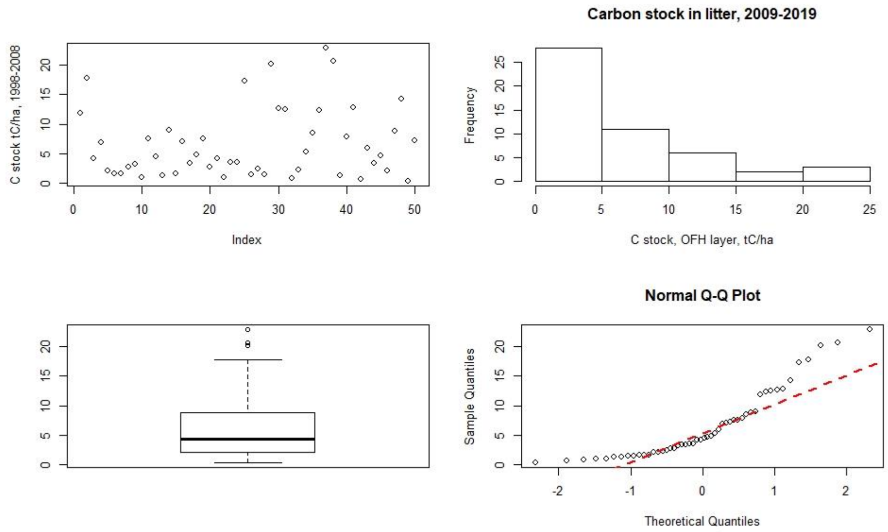


Figure 124 Distribution of the carbon stock in litter layer for the period 2009-2019, n=50

Table 231 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

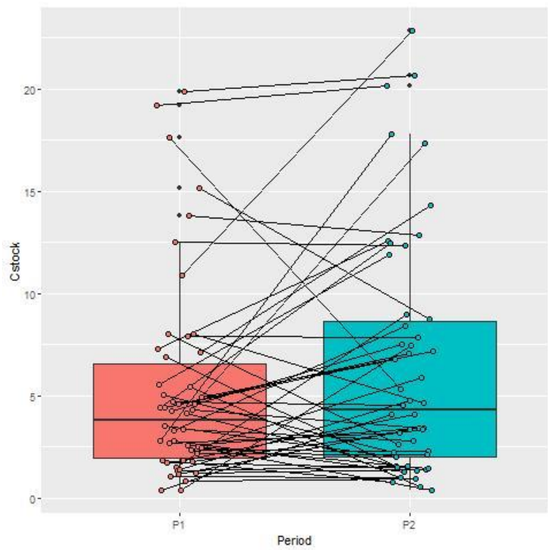


Figure 125 Distribution in the C stock in litter layer for the two periods and the change in the stock, n=50.

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 2020 assuming that the pools are not a source. Since the 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 data for 171 sample plots have been collected and stored electronically. The data covers from 1998 to 2020. 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 bulk density data for those plots were gap-filled using later observations. The bulk density for the deeper layers has been estimated using the Alexander B (1980) PTF function 4:

$$\boldsymbol{\rho}\text{b}=\mathbf{1.72-0.294}*(\boldsymbol{org.C},\%\mathbf{0.5}))$$

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 are 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.

$$SOC = \sum_{horizon=1}^{horizon=n} SOC_{horizon} = \sum_{horizon=1}^{horizon=n} \left([SOC] \bullet BulkDensity \bullet Depth \bullet (1 - frag) \bullet 10\right)_{horizon}$$

A total of 418 soil carbon stock calculations were performed for the 0-30 cm depth, derived 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 ± 2 σ) and removed (7 outliers in total). Like this the sample size of the paired plots have been reduced to 84. 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 84 plots does not follow the normal distribution (Figure 125 and Figure 126), thus a paired t-test has been used to compare whether their population means differ. The outcome of the test confirms the null hypothesis (p-value = 0.064), that difference in means is not significant (Stoeva and Kirova, 2021)[32]. 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.

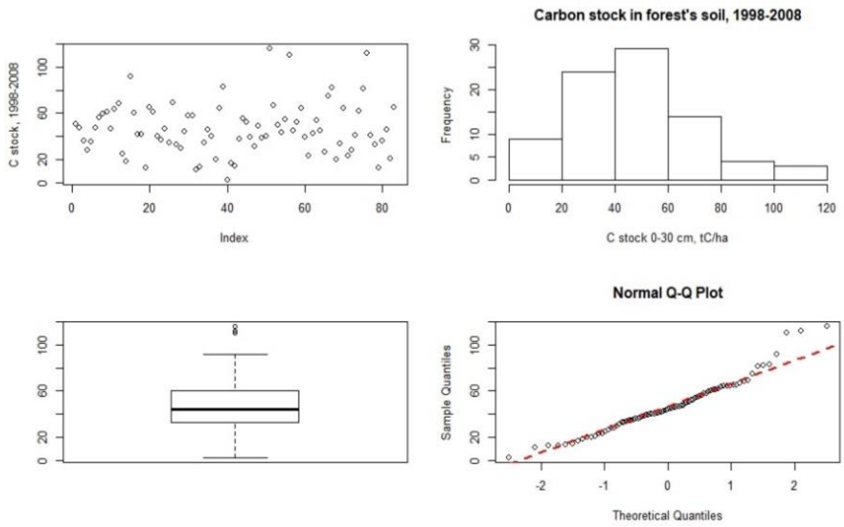


Figure 126 Distribution of the soil organic carbon stock for 0-30 cm for the period 1998-2008, n=84

[32] Stoeva, L., L. Kirova. 2021. Assessing the carbon stock changes in forest soils in Bulgaria. Silva Balcanica22(3): 69-78. https://doi.org/10.3897/silvabalcanica.22.e76252

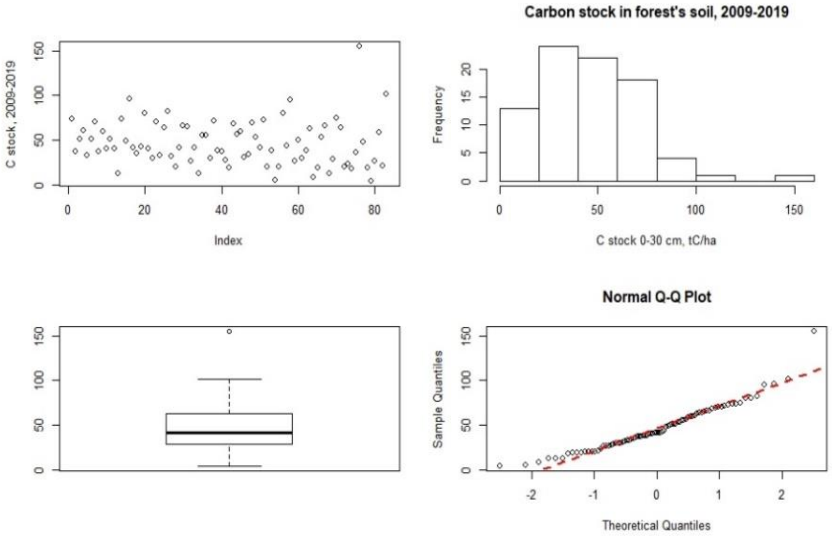


Figure 127 Distribution of the soil organic carbon stock for 0-30 cm for the period 2008-2019, n=84

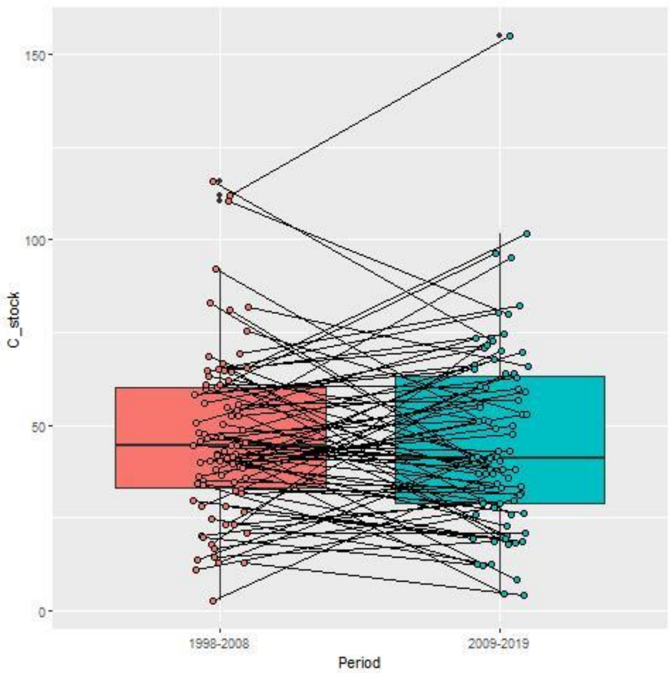


Figure 128 Distribution in the C stock in soil for the two periods and the change in the stock, n=84

Table 232 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	3.244	38.757	49.765	50.753	62.855	115.683
SOC, P2	4.185	29.057	41.233	46.176	63.104	154.856
CSC	-2.245	-0.716	-0.269	-0.199	0.389	1.871

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:

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

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 CO_2 - 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 116

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 has the LUC from GL to FL, followed by annual CL, perennial CL and OL.
The total emissions from wildfires (e.g. 4.A.1 and 4.A.2) are presented in *Figure 116*

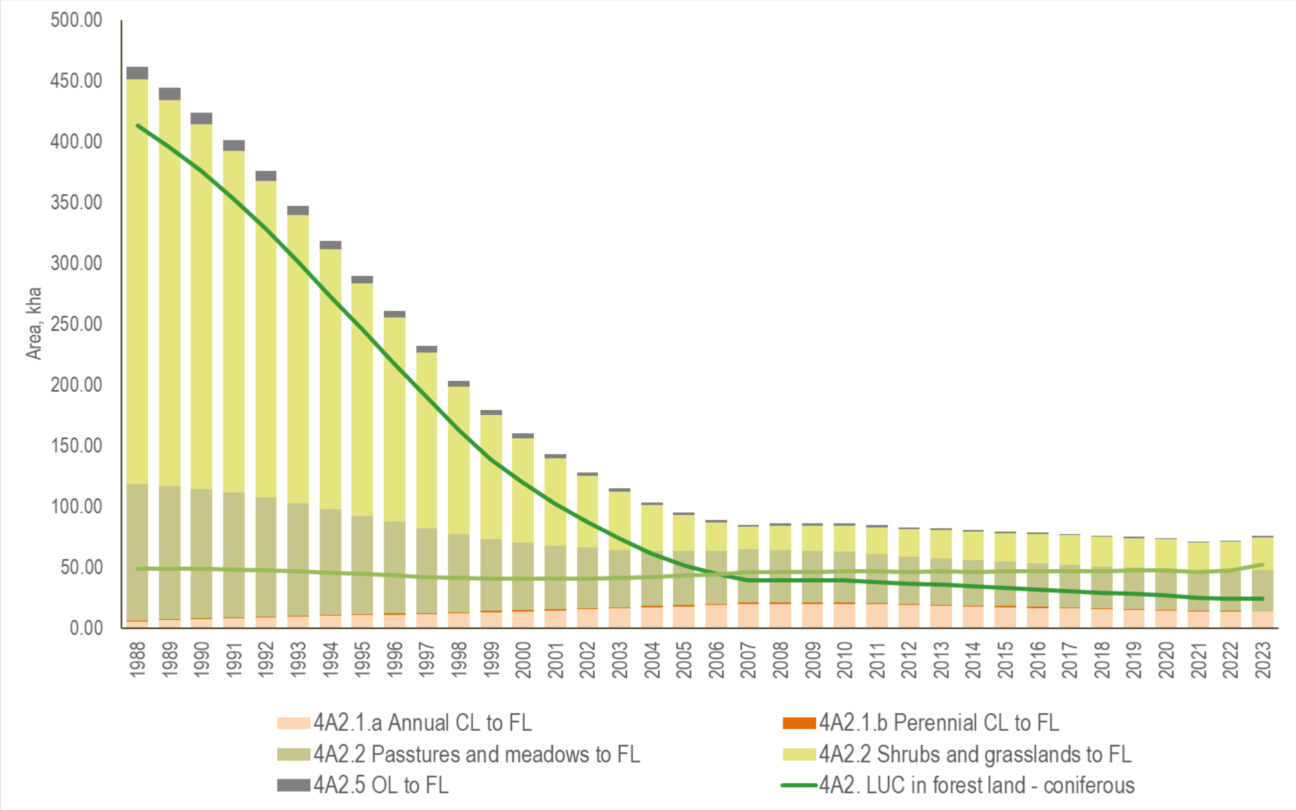


Figure 129 Area of LUCs to FL (20 years)

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, 2020. Once we obtained the weighed mean volume by forest type (3.76 m^3/ha for coniferous and 1.94 m^3/ha deciduous), which are assumed to represent the average current annual increment, biomass conversion and expansion factors are used to convert the increment to an average annual biomass growth. The coefficients used are shown in the table below.

Table 233 Expansion and conversion factors used to convert the average annual increment into average annual biomass growth

	BEF_2	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 default values for the ratio of the below-ground biomass to above-ground biomass were used (table 4.4 2006 IPCC Gls).

The carbon fraction is again estimated as a weighted mean.

Like this, the calculated ΔC_G for LUC to coniferous forest equals to 1.49 tC/ha and 0.77 tC/ha for deciduous stands.

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 – Table 239 Total (above- and below-ground) biomass (tC/ha) and accumulation rate (tC/ha/y) in perennials, for 1988-2023 y.
- 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

In response to ERT's recommendation to develop country specific value for deadwood and litter in its 2024 Submission Bulgaria defined an average value for annual deadwood accumulation in lands converted to forests. The values are differentiated by forest type and represent the average annual accumulation of dead wood due to mortality in the first 20 years of the stand development. To convert the dead wood volume to biomass, the coefficients used for estimating CSC in dead wood in FL remaining category were used.
The emissions estimates follow the Tier 1 methodology where it is assumed that the dead wood increases linearly from zero (in the non-forest land-use category) to the adopted values over a period of 20 years, which is the default period of conversion. The country specific average C accumulation in dead wood is estimated to 0.078 tC/ha/y for LUC to coniferous forest and to 0.080 tC/ha/y for LUC to deciduous stands. These values are like the minimum values from the default ranges of the dead wood stock for temperate continental forests and temperate mountain system presented in Table 2.2 of the IPCC 2019.

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 166 sample plots, analysed in the period 2001-2019. According to the data available it was estimated that the carbon stock in litter amounts to 11.75 tC/ha in coniferous forests and to 4.12 tC/ha in deciduous. The emissions estimates follow the Tier 1 approch where it is assumed that the litter increases linearly from zero (in the non-forest land-use category) to the average values over a period of 20 years, which is the default period of conversion.

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:

$$\Delta \boldsymbol{C}_{\boldsymbol{mineral\ soil}} = \left[\left(\boldsymbol{SOC}_{\boldsymbol{FL}} - \boldsymbol{SOC}_{\boldsymbol{non\ forest\ land}}\right) \cdot \boldsymbol{A}_{\boldsymbol{Aff}}\right] / \boldsymbol{T}_{\boldsymbol{Aff}}$$

where:

$\Delta C_{mineral\ soil}$ - annual change in the carbon stock in mineral soils in the year of assessment, tonnes C/yr

SOC_{FL} – average 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.

The source of information for the contents of organic carbon in soils is the National System for Environment Monitoring (EAEW-MOEW). The soil observations are carried out in uniform grid at 16x16 km at 397 sample plots. The monitoring periodicity is 5 years.

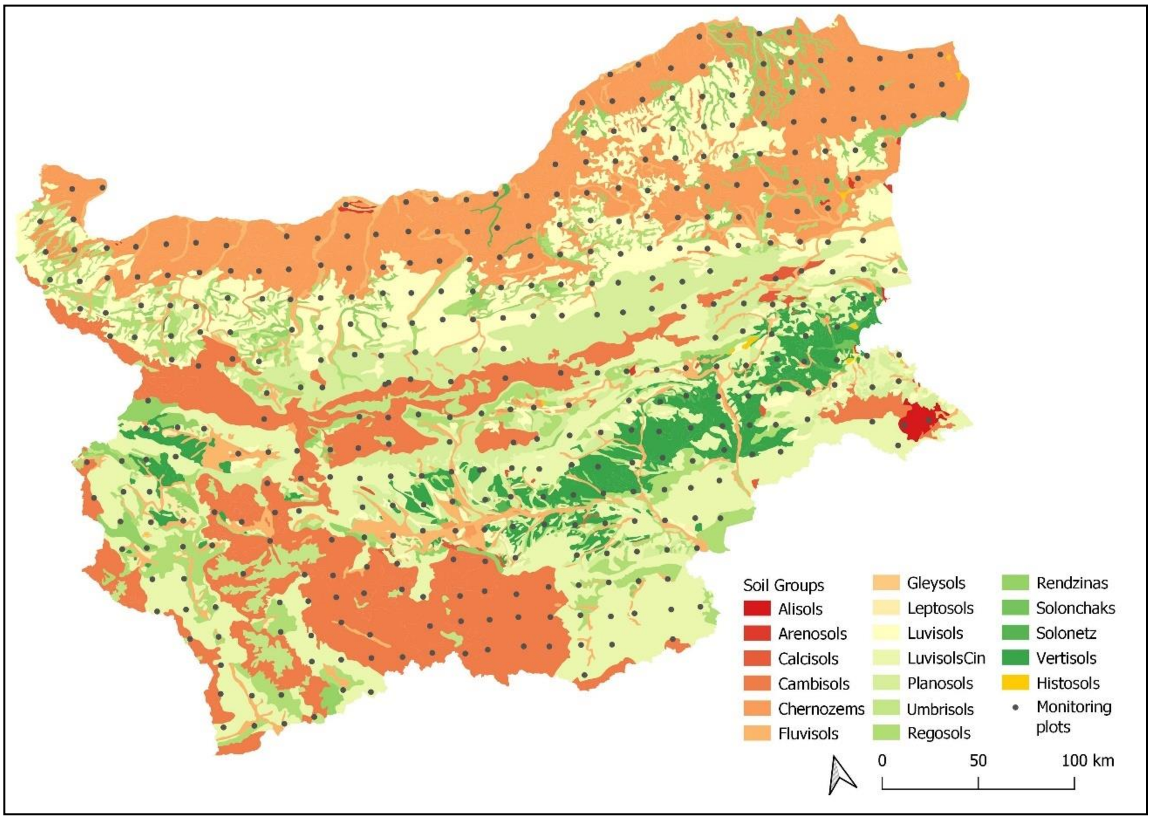


Figure 130 Soil type distribution and soil monitoring grid.

The approach used to derive the soil organic carbon stock in soils under different land uses has been revised for Submission 2024. The revision consists of using only one data source to maintain better consistency. The data was processed and analysed considering the similarity guidance and stratification considering the soil type and climate region as much as possible.

The distribution of soil types in the country is characterized by a specific horizontal and vertical zonation (figure above), which can be assumed to reflect the differences in the climatic regions and sub-regions of the country. For example, in the alpine parts of the mountains, which are characterised by the presence of mountainous and subarctic climates, conditions for the formation of mountain-meadow soils (Umbrisols), which do not occur elsewhere in the country. This is also relevant for other soil groups – for example, the Chernozems are only present in Danube valley and fall into a single climate region. Only Luvisols are distributed among different climate regions and subregions in the country.

To take into account, the climatic differences in this case, for stratification purposes we decided we use the national soil classification. It distinguishes between the Luvisols in the northern part of the country

(where the continental climate predominates) and those present in the southern part of the country (where the influence of the Mediterranean climate is stronger). Therefore, we keep two separate layers for the soils under the Luvisols group (Luvisols for the soils in the northern part of the country and LuvisolsCin for those in southern Bulgaria).
After the stratification was done, an intersection of the land use (based on LPIS data) with soil types/groups distribution has been done in order to get the distribution of the soil type under each land use category.
The soil monitoring data consist of information on chemical and physical properties of the analysed soils and of the land use of the sample plots. The data on soil properties is gathered and analysed per layers 0-20 cm (i.e 0-10, 10-20 cm), 20-40 cm. The information was processed to derive the carbon stock in 0-30 cm depth. The data on bulk density is available only for the upper layer. Therefore, the bulk density of the soil from the layer 20-30 cm has been approximated using the Alexander B (1980) PTF function[33]:

$$\boldsymbol{\rho}_{\mathrm{b}} = \mathbf{1.72} - (\mathbf{0.294} * (\boldsymbol{org.C}, \%)^{\mathbf{0.5}}))$$

Thus, the organic carbon stock has been calculated for all samples from the dataset. Then, the samples have been grouped by land use and soil type.
The SOCref has been derived based on sample plots under native vegetations and weighted to the soil type distribution in the country. **The SOCref has a value of 65.05 tC/ha.** For all the others land uses an average soil organic carbon stock has been estimated weighted by the soil type distribution under the respective land use category.

An important aspect in the new calculation approach is that the CSC in LUC categories is derived as a difference in the mean area-specific soil organic carbon stock (tC/ha) of the relevant pre- and post-conversion land use by addressing the weight of each soil type distribution of the land use category after conversion. By applying this approach, we assume that the similarity requirement under the IPCC guidelines (2006, 2019), which suggests deriving the CSC on paired plots is approximately addressed. This approach minimizes the possibility to introduce a bias of the effect of the carbon-rich soil types such as Chernozems, that dominate under Cropland, which was the case of the previously used approach in estimating the CSC after LUC. By implementing the new approach, it is assumed that it would better represent the probability of conversions by soil type from the different land uses.

Like this the CSC factors for Lands converted to FL have been defined as follows:

Table 234 Carbon stock change factors in soils for Lands converted to FL

LU cateroes before LUC	SOC mineral before LUC to FL, tC/ha	SOC mineral after LUC to FL, tC/ha	CSC, tC/ha/y
aCL	56.69	59.15	0.12
pCL	54.10	61.87	0.39
PM	62.65	62.14	-0.03
ShrGL	66.90	63.39	-0.18
WL	NO	NO	NO
SM	NO	NO	NO
OL	51.80	65.05	0.66

**PM – Pastures and meadows, ShrGL – Shrubs and grasslands*

The average soil organic carbon stock in OL is estimated as a weighted mean value for the SOC reference levels for HAC soils (table 2.3 from the2006 IPCC Guidelines) for the respective climate regions. According to "Classification scheme for default climate regions" (IPCC, 2006) Bulgaria is in the

[33]G.TAULYA et al., 2005 Validation of pedotrasfer functions for soil bulk density estimation on a Lake Victoria Basin soilscape

"warm temperate dry" (appr. 60%), "cool temperate dry" (appr. 20%) and "cool temperate moist" (appr. 20%) regions. Concerning the soil type, more than 80% of the territory is under high activity clay soils. The result for the 0-30 cm depth is 51.80 tC/ha.

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 have 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.

Bulgaria applies CS values for C/N ratio in mineral soils derived by following the approach used to assess the CSC in mineral soils, described in the previous chapter. Emissions associated with N mineralization in LUC to FL occur when there are conversions from both GL subcategories: Pastures and meadows and Shrubs and grasslands. The C/N ratio used have the value of 10.22 in the case of conversion of Pastures and meadows to Forest Land and 10.54 for Shrubs and grassland converted to Forest Land. The N_2O emissions from N mineralization associated with a loss of soil organic matter are presented in Figure 117.

6.3.4 UNCERTAINTY ASSESSMENT

The overall uncertainty in estimation of gas emissions and removals over a year for the category "Forests" is **244**%. The trend uncertainty due to activity data and emission factors amounts to **19**%.

The combined uncertainty for the sub-category "Forest land remaining forest land" is **245**% and the uncertainty in the trend of the gas emissions is **46**%.

The combined uncertainty for the sub-category „Land use changed to forest land" is **205**%. The trend uncertainty in gas emissions is **5**%.

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 shrubs and grasslands) 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.

More information for the used emission factor/estimation parameter uncertainty can be found in subchapter 6.1.5.

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.

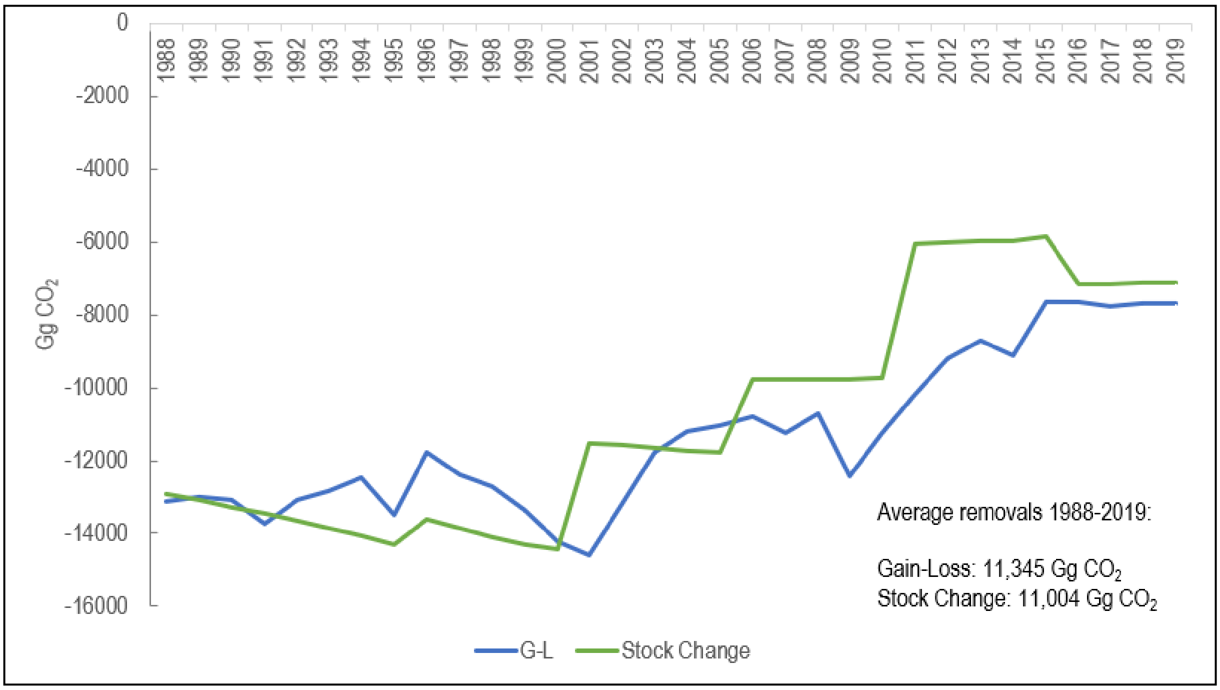


Figure 131 Comparison between the emissions and removals estimates – gain-loss method vs. stock difference method

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 (>200%). 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

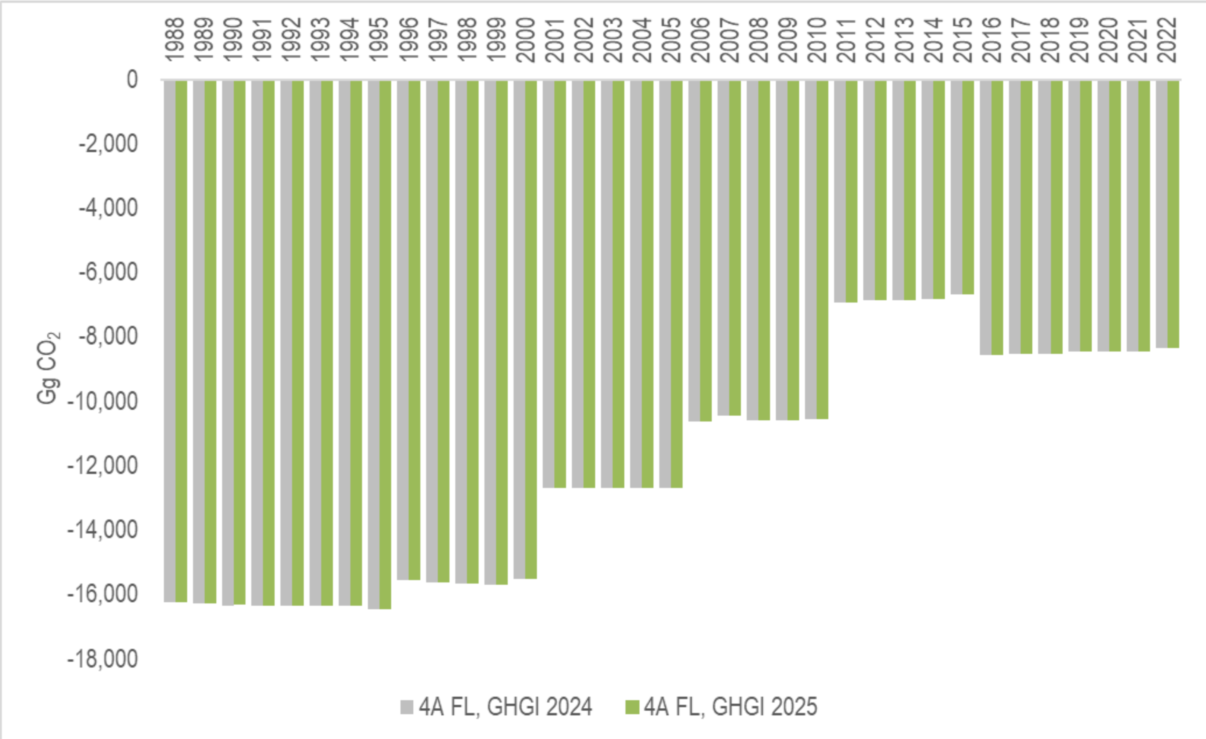


Figure132 Recalculations in Forest Land category

The recalculations in FL are small and are due to recalculation of losses in biomass of perennials converted to forests and refinement of the estimates of direct and indirect N_2O emissions associated with N mineralization due to land use change. For this submission new, country specific C/N ratio were derived. More information can be found in Chapters 6.3.3 and 6.3.3.2.4.

6.3.7 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

1. Change in method of estimating the CSC in living biomass from Stock Change to Gain-Loss
2. Improve the estimates in DOM pool

6.4 CROPLAND (4.B)

6.4.1 DESCRIPTION OF THE CATEGORY

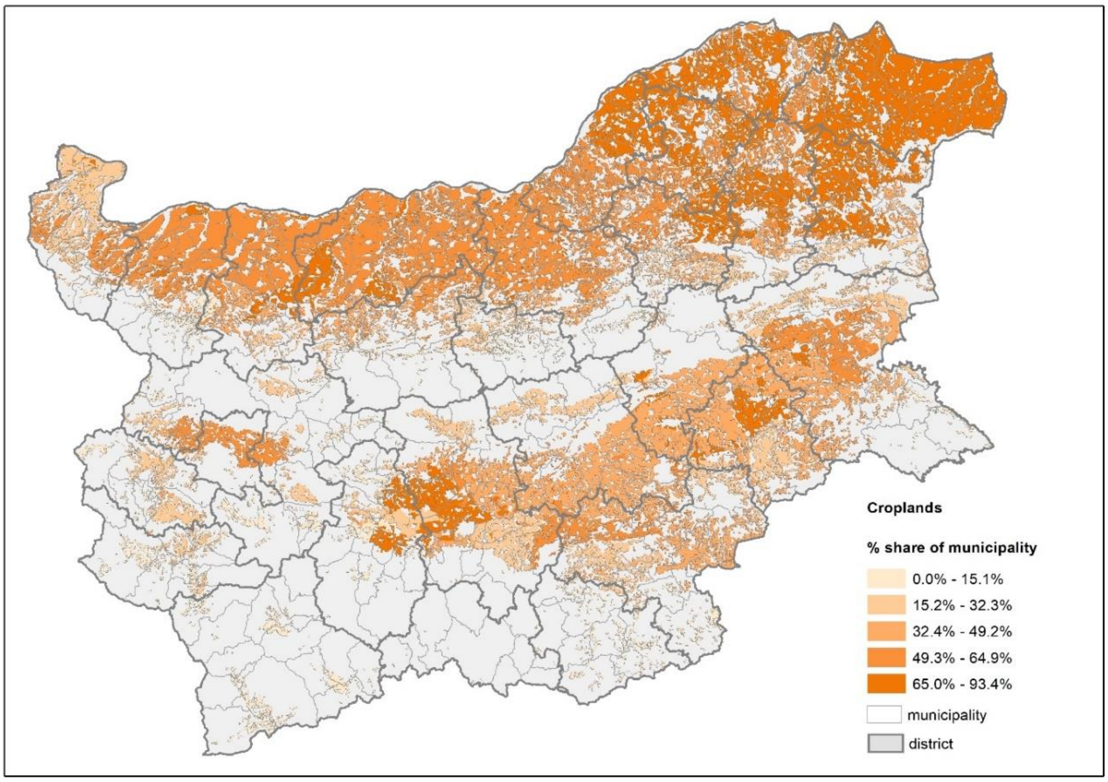


Figure 133 Share of municipality area occupied by Cropland.
The map is elaborated based on CLC, 2018

In 2023, croplands in Bulgaria cover an area of 3670 kha which represents 33.06 % of the country's territory. The figure below presents data on the area of Cropland for the reporting period.

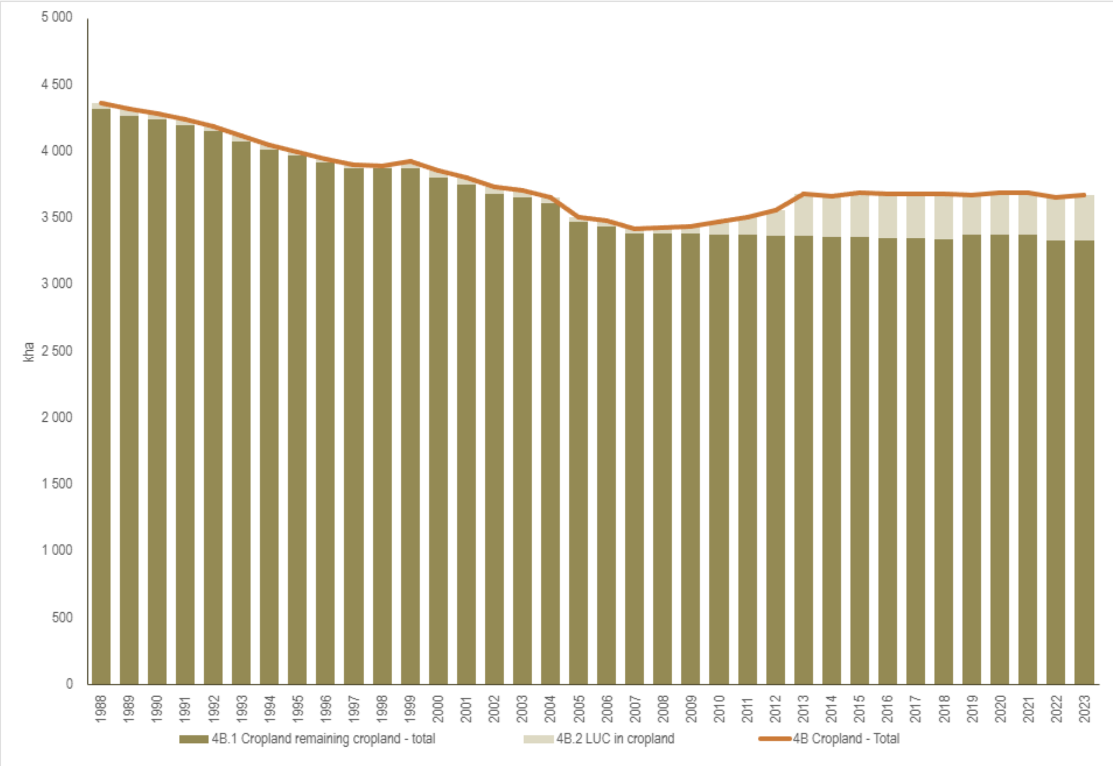


Figure 134 Trends in arable lands in Cropland category 1988-2023

There is a constant decrease in cropland since the base year, nevertheless the trend of LUC to CL has increase in the past 10 years. The total cropland area is 15.89% lower, comparing to the base year, and varies from 4363 kha in 1988 to 3670 kha in 2023.

Annual crops have a share of 96.27% from the total cropland's territory and the rest 3.74% are referred to perennial crops. Since the recalculations in the land representation for 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 as a subcategory. The trend in the areas of cropland category is presented in the figure below.

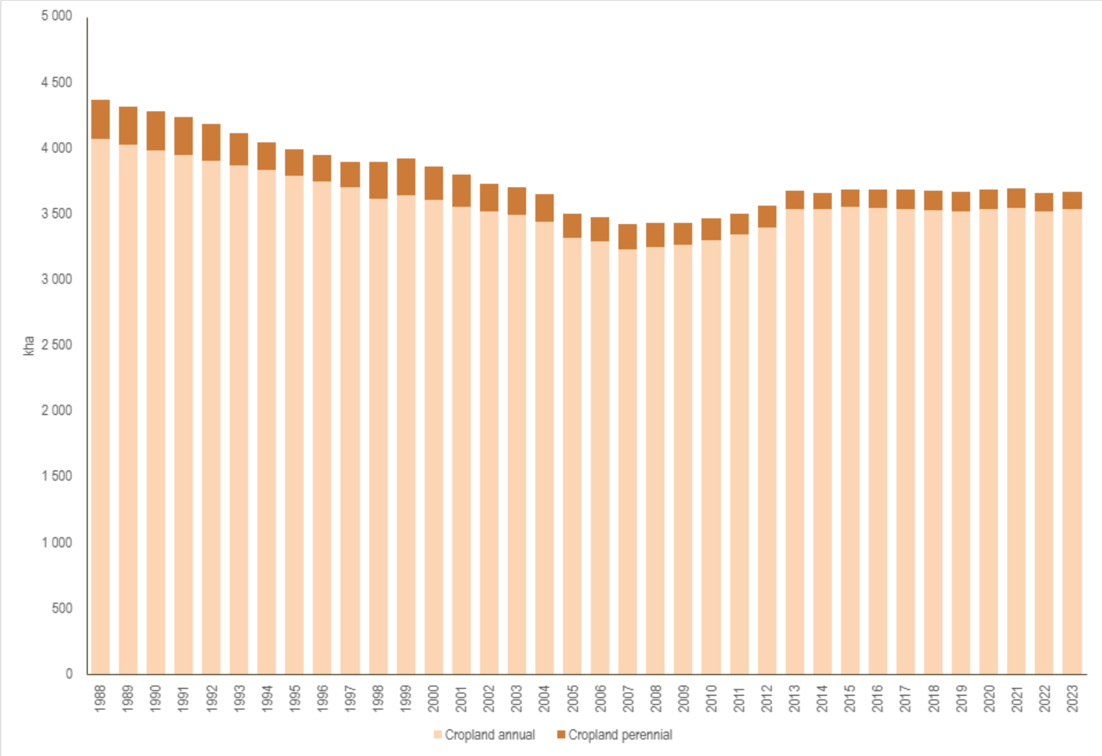


Figure 135 Annual and perennial cropland's distribution under CL category

The steady decrease in croplands is 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 is due to implementation of the Common Agricultural Policy (CAP).

The cropland's emissions over the reporting period range from 296.29 Gg CO_2 eq in 1988 to 875.25 Gg CO_2 eq in the last reporting year. The category is a net source of emissions throughout the whole time series. Major source of the emissions within subcategory LUC to CL is the carbon stock change in the soil pool when converting Grassland to Cropland.

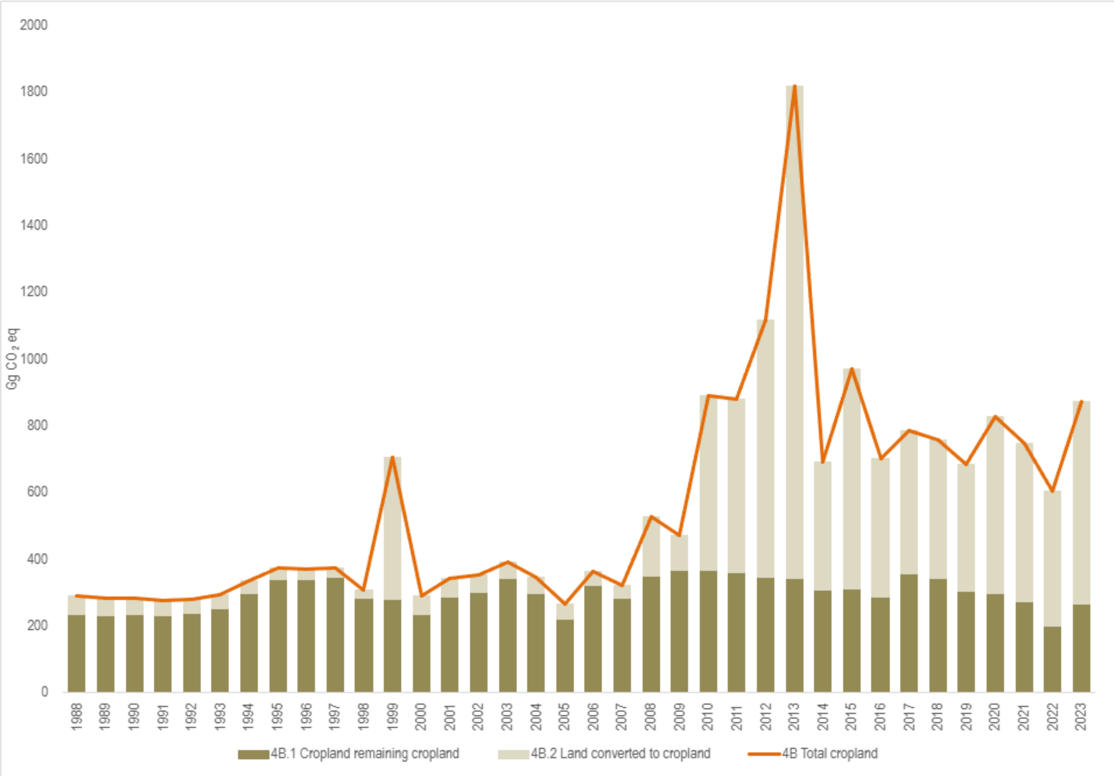


Figure 133 Net GHG emissions/removals (+/-) from 4.B Cropland category, Gg CO_2.

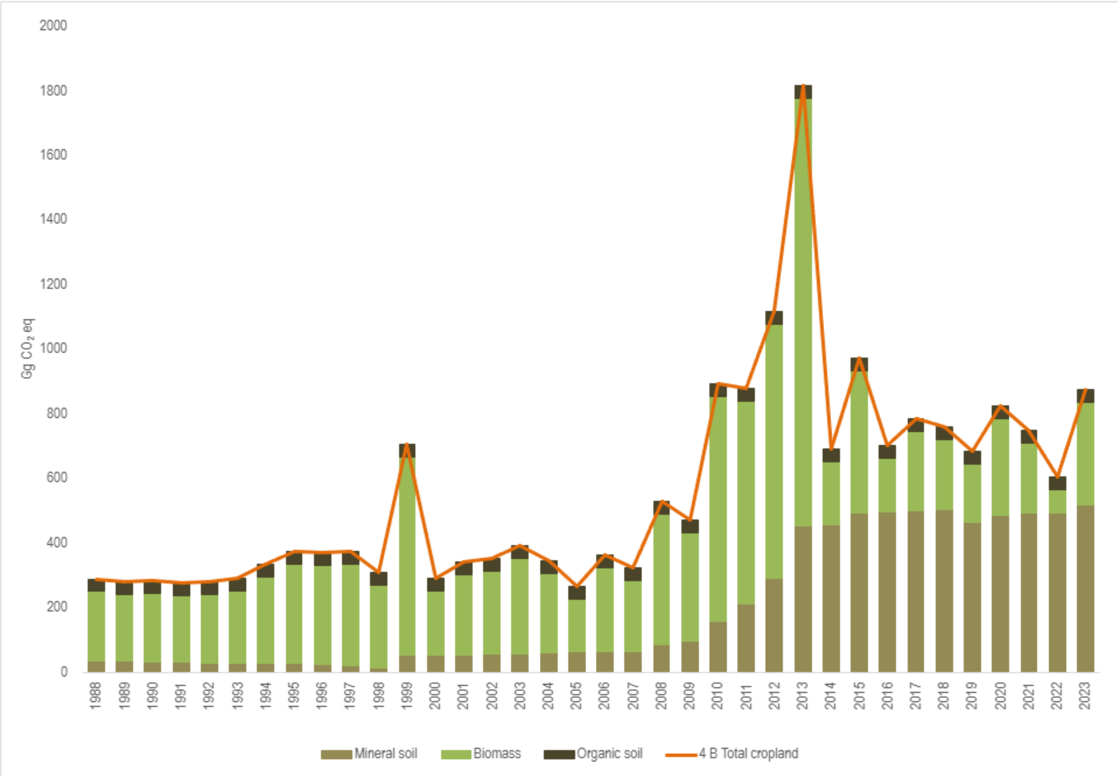


Figure 136 Net GHG emissions/removals (+/-) from 4.B Cropland by carbon pools, Gg CO_2.

Table 235 Emissions and removals from Cropland category, Gg CO_2 eq

Year	4.B Total Cropland	4.B.1 Cropland remaining Cropland	4.B.2 Land converted to Cropland	4.B.2.2.a Pastures and meadows converted to Cropland	4.B.2.2.b Shrubs and grasslands converted to Cropland	4.B.2.5 Other land converted to Cropland	4.B.2.2 Grassland converted to Cropland (Direct and indirect N_2O emissions)
1988	297.76	235.20	54.56	24.32	30.25	NO	8.00
1989	289.91	230.80	51.52	23.04	28.49	NO	7.58
1990	291.03	235.29	48.58	21.67	26.91	NO	7.16
1991	285.32	232.86	45.72	20.40	25.32	NO	6.74
1992	287.63	238.38	42.94	19.20	23.74	NO	6.32
1993	298.98	253.08	40.01	17.85	22.16	NO	5.89
1994	340.87	298.18	37.21	16.64	20.57	NO	5.47
1995	380.72	341.32	34.35	15.36	18.99	NO	5.05
1996	376.76	340.64	31.49	14.08	17.41	NO	4.63
1997	378.22	345.39	28.62	12.80	15.83	NO	4.21
1998	312.90	283.39	25.72	11.47	14.24	NO	3.79
1999	714.79	281.71	424.24	313.46	110.78	NO	8.84
2000	299.92	234.25	57.25	25.60	31.65	NO	8.42
2001	350.01	287.53	54.48	24.41	30.07	NO	8.00
2002	359.68	300.41	51.70	23.21	28.49	NO	7.58
2003	400.72	344.57	48.99	22.08	26.91	NO	7.16
2004	352.44	299.52	46.18	20.86	25.32	NO	6.74
2005	271.64	221.96	43.37	19.63	23.74	NO	6.32
2006	368.55	322.11	40.55	18.39	22.16	NO	5.89
2007	327.94	284.82	37.65	17.08	20.57	NO	5.47
2008	537.09	351.59	177.81	110.39	67.42	NO	7.69
2009	480.80	368.76	103.51	54.09	49.41	NO	8.53
2010	908.47	368.61	523.61	318.94	204.66	NO	16.25
2011	902.98	359.49	520.46	298.95	221.51	NO	23.03
2012	1152.04	348.21	770.64	442.19	328.45	NO	33.18
2013	1872.89	344.10	1474.39	850.16	624.23	NO	54.41
2014	745.57	307.63	383.53	120.62	262.91	NO	54.41
2015	1032.41	313.53	659.73	292.19	367.54	NO	59.15
2016	762.14	286.97	416.03	129.18	286.85	NO	59.15
2017	844.44	355.54	429.52	137.44	292.08	NO	59.38
2018	819.02	342.55	417.09	129.05	288.04	NO	59.38
2019	739.85	305.88	380.06	112.60	267.46	NO	53.91
2020	883.37	297.12	529.82	207.37	322.46	NO	56.43
2021	805.96	273.38	474.85	166.54	308.32	NO	57.73
2022	664.17	199.73	406.71	120.38	286.33	NO	57.73
2023	936.40	266.74	608.51	246.81	361.70	NO	61.16

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 because 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. In addition, there is very good consistency between the LPIS data on agricultural land and BANCIK statistics.

Regarding the reporting of LUCs, there are no land use changes from forests to cropland or grassland. Converting other lands, wetlands, and settlements to CL is improbable because settlements cover artificial surfaces, while other lands include bare lands and rocks. Thus, it has been considered that the only possible gains in 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 area of CL and GL follow the opposite directions throughout the time series.

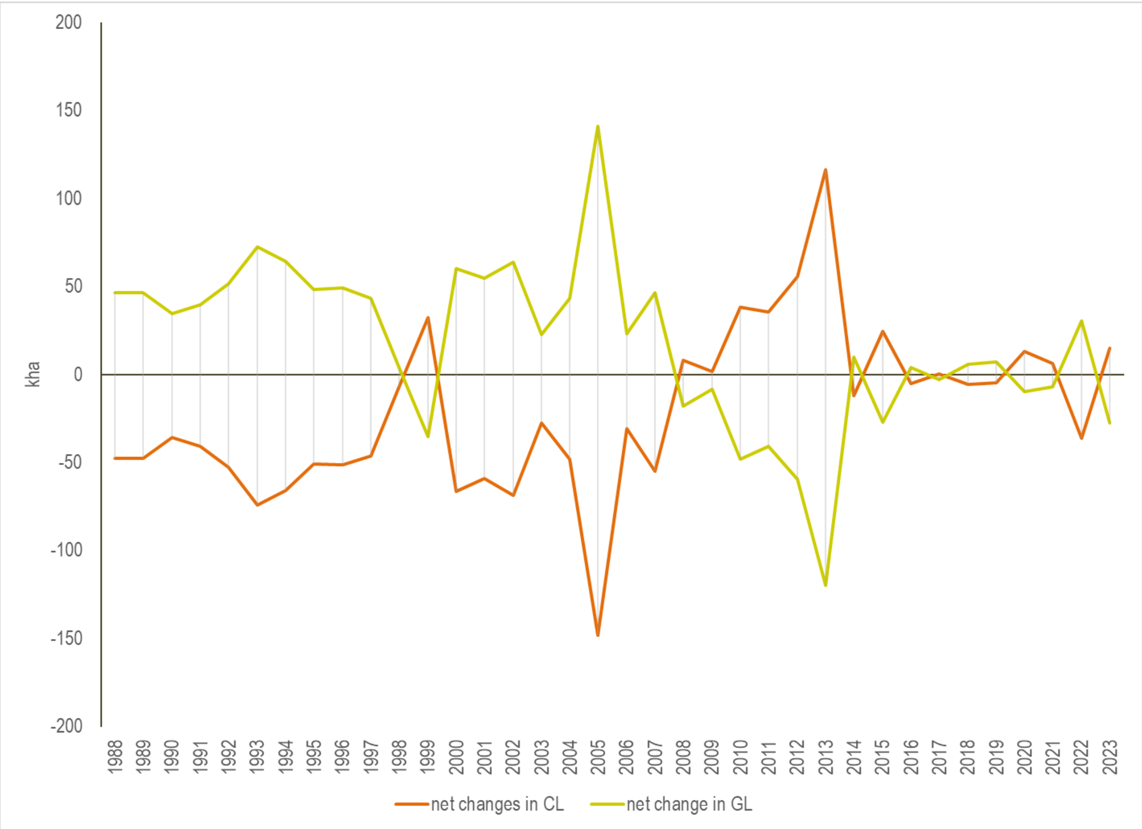


Figure 137 Net change in area of Cl and GL

The LUCs within CL category – between annual and perennial is reported according to data from BANCIK statistics since 2000. Interpolated data from three-time intervals are used to assess the LUC between annual and perennial crops as well as the LUCs from GL to CL. The first period covers data on LUC in the first years since 2000 and the data is used to present the LUCs from the base year to the year 2000. The second period covers the years 2000-2013 and the third is from 2013-2023. These results are cross-checked with information from Corine Land Cover (CLC) and similar trends in conversion areas are observed. For example, CLC reports almost two times bigger area in conversion from perennial to annual crops in the period 1990-2000. The interpolated data from BANCIK for the first period (yearly 2000’s) shows that the area converted from perennial crops to annuals is by 60% higher than the area of conversion from annual to perennial crops. For the second period 2000-2013, the CLC from 2006 and 2012 shows that the area of conversion is almost equal between annual and perennial crops in conversion between them. The same are the results from BANCIK statistics for the period 2000-2013.

6.4.3 METHODOLOGY

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 in remaining category are estimated only for perennial crops following Tier 2 approach, considering the gains and losses in above-and belowground biomass. The biomass stock and accumulation rates for perennials have been estimated for three perennial subcategories – orchards, walnuts and viticulture, considering their different maturity age and age class distribution over the years. For annual crops, the increase in biomass stocks within a single year is assumed to be equivalent to the losses from harvest and mortality during the same period—resulting in no net accumulation of biomass carbon stocks (IPCC 2006, Vol. 4, Ch. 5.2.1.1). Changes in carbon stock in biomass for the areas in conversion: 1) between annual and perennial crops and 2) from GL to CL have also been estimated using country-specific data.

The report of carbon stock changes in DOM in CL-CL follows the assumptions under Tier 1 for all cropland remaining cropland. Changes in DOM in LUC to cropland are reported under T1 assumption where there is not DOM accumulation in CL. In the cases of conversion from subcategory Shrubs and grasslands to CL losses in DOM are not estimated, assuming that they are insignificant.

The carbon stock changes in soil pool in CL are reported following Tier 2 applying country-specific carbon stock change factors.

Non-CO2 emissions associated with the management of permanent agricultural lands are estimated as part of Agriculture Chapter from this report. Direct and indirect N_2O emissions associated with N mineralization due to land use conversion are reported in this chapter following Tier 2 approach with country specific data.

6.4.3.1 Cropland remaining Cropland (4.B.1.)

6.4.3.1.1 Changes in carbon stocks in living biomass of perennials remaining perennials

The estimation of changes in carbon stock for perennial biomass adheres to the approach for calculating annual growth and loss rates, as prescribed by the Tier 2 method in the 2006 IPCC Guidelines, assessing gains and losses in both above-and belowground biomass.
The average carbon accumulation rate in above and belowground biomass and the mean biomass stock for perennial crops have been estimated considering the main three groups of perennial crops separately – orchards, viticulture and walnuts. These three subcategories of perennial crops have been formed to distinguish the difference in biomass accumulation rate, maturity cycle and management of these groups and to better cover the fluctuation in area developments throughout the years. Based on

literature data we defined the maturity cycle of each of these subcategories – 20 years for orchards and 30 years for viticulture and walnuts. Thus, data on area distribution of orchards, walnuts and viticulture back to 1959 have been extracted from National Statistical Institute (NSI).

Table 236 Total area of perennial crops from 1959–2023 in kha.

Year	Orchards	Walnuts	Viticulture	Total Area
1959	149.02	2.96	174.02	326.00
1960	160.88	3.73	180.39	345.00
1965	199.91	4.26	191.53	395.70
1970	183.55	6.89	195.16	385.60
1975	172.78	13.24	196.39	382.40
1980	155.30	19.25	174.95	349.50
1985	137.68	16.94	165.18	319.80
1990	132.11	15.18	148.70	296.00
1995	83.14	6.44	114.42	204.00
2000	99.52	9.72	143.05	252.29
2005	72.82	8.53	106.63	187.98
2010	73.72	7.22	82.68	163.61
2011	74.38	7.02	78.47	159.87
2012	74.22	7.52	77.34	159.08
2013	66.17	8.55	60.47	135.19
2014	62.75	10.10	53.52	126.37
2015	66.15	13.12	54.21	133.48
2016	73.30	15.15	52.52	140.97
2017	78.78	16.06	53.25	148.09
2018	81.11	18.13	53.79	153.03
2019	81.13	18.60	53.01	152.74
2020	83.66	16.50	51.36	151.52
2021	82.53	16.26	50.25	149.04
2022	76.94	14.85	47.55	139.34
2023	75.23	14.85	46.95	137.03
2023-1959	-50%	502%	-27%	-42%

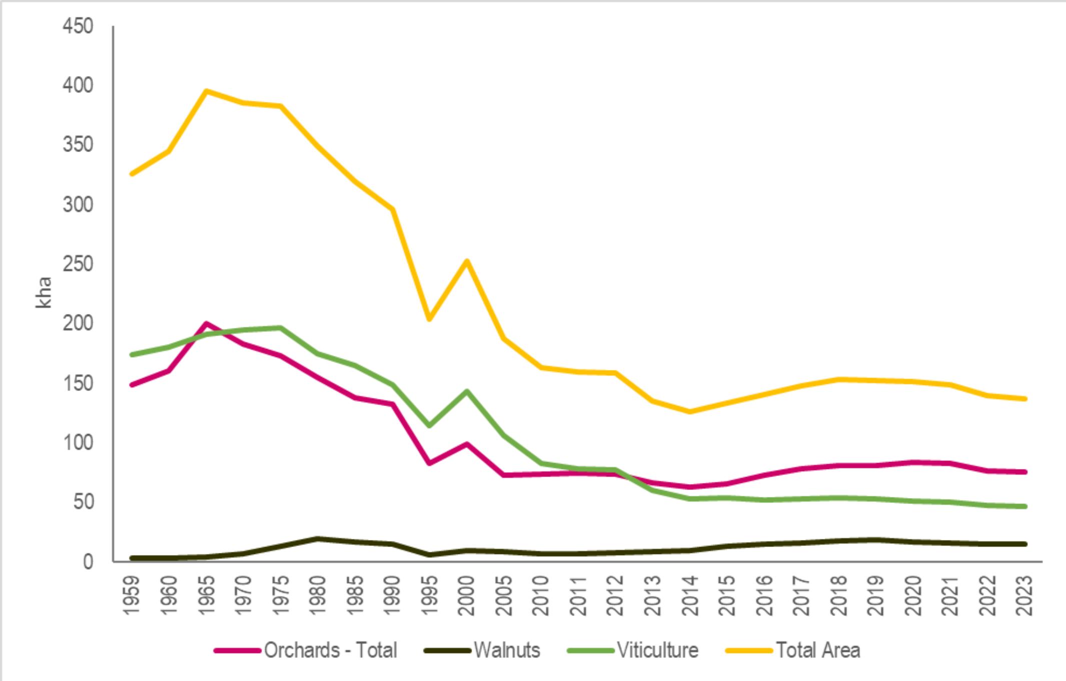
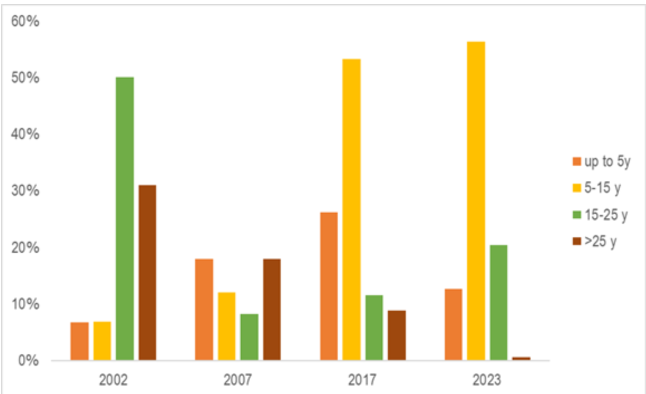


Figure 138 Trend of total perennial cropland area (kha) from 1959–2023.

In addition, data for the age structure of all three subcategories – orchards, walnuts and viticulture, was extracted from agronomic reports on perennial crops in Bulgaria. The reports are periodically published by Agrostatical department of the Ministry of agriculture. Detailed information on the area, age structure and density distribution have been extracted for the years:

The reports clearly show that the change in the age-class structure towards aging has occurred in all perennial crops since the socio-economic changes in the country in the 1990s. However, in the past 10 years there has been a clear trend in the revival of the cultivation of perennials since BG is part of the EU and has access to CAP finance.



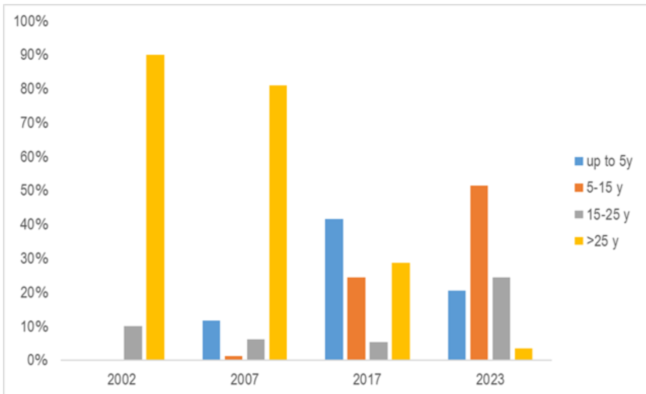


Figure 139 Orchard's (left) and walnut's (right) age structure

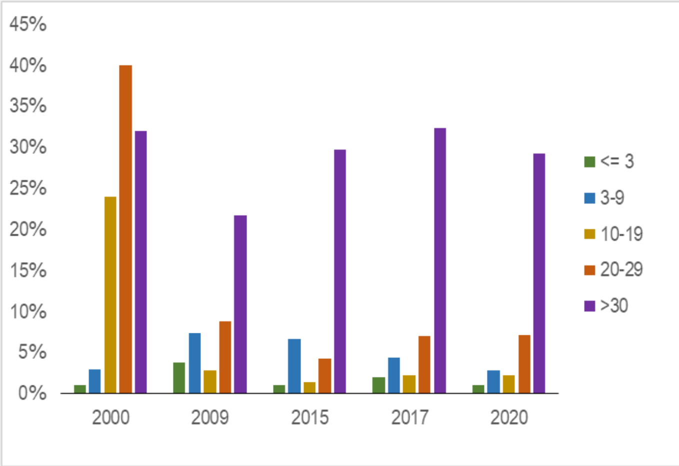


Figure 140 Viticulture's age structure in Bulgaria

As we lack country-specific information regarding the biomass stock (AGB and BGB) of perennial crops, we adopted the proposed default carbon stock at specific age from the MediNet project (table 29 from Canaveirra et al., 2018) and derived a weighted mean biomass stock (AGB+BGB) and accumulation rate for the years with activity data on age class distribution in the country. Interpolation and extrapolation were applied to build a consistent time series over the years. The first available data was extrapolated back to the base year

Table 237 Total (above- and belowground) biomass stock (tC/ha) and accumulation rate (tC/ha/y) for perennials

Year	Orchards		Walnuts		Viticulture	
	Biomass	Accumulation rate	Biomass	Accumulation rate	Biomass	Accumulation rate
2000	11.51	0.46	13.85	0.46	8.82	0.19
2001	11.51	0.46	13.85	0.46	8.67	0.18
2002	11.03	0.46	13.65	0.46	8.52	0.17
2003	10.56	0.46	13.44	0.45	8.37	0.16
2004	10.08	0.46	13.23	0.44	8.22	0.14
2005	9.60	0.46	13.02	0.43	8.07	0.13
2006	9.13	0.46	12.82	0.43	7.91	0.12
2007	9.20	0.46	12.47	0.42	7.76	0.11
2008	9.28	0.46	12.13	0.40	7.61	0.10
2009	9.35	0.47	11.78	0.39	7.46	0.09
2010	9.43	0.47	11.44	0.38	7.59	0.08
2011	9.50	0.48	11.09	0.37	7.72	0.08
2012	9.58	0.48	10.75	0.36	7.86	0.08
2013	9.65	0.48	10.40	0.35	8.00	0.07
2014	9.73	0.49	10.06	0.34	8.13	0.07
2015	9.80	0.49	9.71	0.32	8.22	0.05
2016	9.88	0.49	9.37	0.31	8.39	0.06
2017	10.00	0.50	9.66	0.32	8.57	0.06
2018	10.12	0.51	9.96	0.33	8.69	0.07
2019	10.25	0.51	10.26	0.34	8.77	0.07
2020	10.37	0.52	10.55	0.35	8.93	0.07
2021	10.49	0.52	10.85	0.36	8.93	0.07
2022	10.61	0.53	11.15	0.37	8.93	0.07

Year	Orchards		Walnuts		Viticulture	
	Biomass	Accumulation rate	Biomass	Accumulation rate	Biomass	Accumulation rate
2023	10.73	0.54	11.44	0.38	8.93	0.07

To determine the annual change in the biomass carbon stock of the perennials the following equations have been used:

$$\begin{aligned}\textbf{\textit{Annual change in the biomass carbon stock of orchards}}\\ &= (\textbf{\textit{area of the orchards remaining}}\\ &\cdot \textbf{\textit{coefficient of accumulation of carbon at specific year}})\\ &- \big(\textbf{\textit{area of the orchards 20 years earlier}}^{\mathbf{1}}\\ &\cdot \mathbf{0.05}\ (\textbf{\textit{i.e. proportion of area at end of rotation period}})\\ &\cdot \textbf{\textit{coefficient of mean biomass stock of orchards at specific year}}\big);\end{aligned}$$

$$^{\mathbf{1}}\ \textbf{\textit{excluding area lost through land}} - \textbf{\textit{use change}}$$

$$\begin{aligned}\textbf{\textit{Annual change in the biomass carbon stock of walnuts/viticulture}}\\ &= (\textbf{\textit{area of the walnuts/viticulture remaining}}\\ &\cdot \textbf{\textit{coefficient of accumulation of carbon at specific year}})\\ &- \big(\textbf{\textit{area of the walnuts/viticulture 30 years earlier}}^{\mathbf{1}}\\ &\cdot \mathbf{0.33}\ (\textbf{\textit{i.e. proportion of area at end of rotation period}})\\ &\cdot \textbf{\textit{coefficient of mean biomass stock of walnuts/viticulture at specific year}}\big);\end{aligned}$$

$$^{\mathbf{1}}\ \textbf{\textit{excluding area lost through land}} - \textbf{\textit{use change}}$$

6.4.3.1.2 Changes in carbon stock in 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}).

$$\textbf{\textit{The annual change of carbon stock in biomass}} = \boldsymbol{A_{conversion}}(\boldsymbol{L_{conversion}} + \Delta \boldsymbol{C_{growth}})$$

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[34] have been used (Table 238). The expansion factors for the rest of the aboveground biomass stem from Austria and the root–to-shoot ratios - from US. Since both countries

[34] The expansion factors according to Bodenfruchtbarkeitsbeirat 2001 (pers. comm.)
Root-to-shoot ratios are published by West, T.O., 2008

belong like Bulgaria to the temperate region, they are considered as appropriate for Bulgarian conditions.

Table 238 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

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

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

$$B_{\frac{t}{ha},1995,2000,2005,2010,2015} = \sum B\ total\ x \,/ \sum area\ x$$

Where,

B – biomass in t/ha

B total – total biomass (above and belowground)

Area – ha

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 to **ΔC_{Growth} = 3.56 tonnes C ha^{-1}.**
The losses in biomass of perennial crops converted to annual are estimated based on the carbon stock before and immediately after the conversion.

$L_{conversion} = C_{after} - C_{before}$

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 carbon stock before conversion is estimated as a weighted mean biomass stock taking into consideration the respective share of the perennial crop types over the years.

Table 239 Total (above- and below-ground) biomass (tC/ha) and accumulation rate (tC/ha/y) in perennials, for 1988-2023 y.

	Total in perennials	
Year	Biomass	Accumulation rate
1988	10.04	0.31
1989	10.05	0.31
1990	10.06	0.32
1991	10.07	0.32
1992	10.04	0.31
1993	10.10	0.32
1994	10.04	0.31
1995	9.97	0.31
1996	9.99	0.31
1997	9.98	0.31
1998	10.07	0.32
1999	10.06	0.32
2000	9.99	0.31
2001	9.87	0.30
2002	9.62	0.29
2003	9.36	0.27
2004	9.15	0.26
2005	8.87	0.25
2006	8.64	0.24
2007	8.56	0.24
2008	8.46	0.24
2009	8.48	0.26
2010	8.57	0.27
2011	8.65	0.27

	Total in perennials	
Year	Biomass	Accumulation rate
2012	8.72	0.28
2013	8.88	0.30
2014	8.99	0.32
2015	9.06	0.33
2016	9.20	0.36
2017	9.39	0.38
2018	9.55	0.38
2019	9.69	0.39
2020	9.87	0.40
2021	9.98	0.40
2022	10.08	0.40
2023	10.19	0.40

6.4.3.1.3 Changes in carbon stock in 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.

$$\boldsymbol{Annual\ change\ in\ carbon\ stock\ in\ biomass} = \left(\boldsymbol{area\ of\ the\ converted\ lands\ for\ 20\ yeats} \cdot \Delta \boldsymbol{C_{growth}}\right) + \left(\boldsymbol{actual\ annual\ area\ of\ conversion} \cdot \boldsymbol{L_{conversion}}\right)$$

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: 3.56 tonnes C $ha^{-1}y$.

6.4.3.1.4 Changes in carbon stock in soils of croplands remaining croplands

Mineral soils

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 approach used in deriving the CSC factors is described in 6.3.3.2.3 on p.351.

6.4.3.1.4.1 Changes in carbon stock in 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 (IPCC, 2019 Refinement). For the Perennials the default factors are adopted, taking into consideration that 90% of the input is due to mineral fertilizers, and 10% - manure Table-240~~ Applied management factors for calculating the changes in carbon stock in soils for the subcategory cropland remaining cropland (annual and perennial)~~. Data on management practices on soil disturbance (till and non-till) and input (mineral and organic fertilizers) have been derived from agronomic reports on perennial crops in Bulgaria for different years. This information was used to develop a consistent time series on soil related management practices and to recalculate the CSC from the soil pool in perennials remaining perennials.
Land use factors have been incorporated when the average SOC content in soils of perennial and annual crops have been estimated.

Table 240 Applied management factors for calculating the changes in carbon stock in soils for the subcategory cropland remaining cropland (annual and perennial)

MG f	Non-till	Reduced till	Full till	Mt Input
Annual	1.06	1.01	1	
Perennial	1.04		1	1.073

The CSC factor in perennials remaining category has the value of 0.0063 tC/ha/y. The CSC factor in annual remaining category has the value of 0.019 tC/ha/y.

6.4.3.1.4.2 Changes in carbon stock in 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:

$$\Delta \boldsymbol{SOC_{20}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}} = \mathbf{0.05}\ \boldsymbol{tC/ha}$$

where,
SOC_0 – carbon stocks in the soils after 20 years of transition = 53.24 t C/ha,
SOC_{0-T} – carbon stock in the soils before the conversion = 52.20 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 carbon stock in 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:

$$\Delta \boldsymbol{SOC_{20}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\boldsymbol{20}} = -\boldsymbol{0.67\ tC/ha}$$

where,
SOC_0 – carbon stocks in the soils after 20 years of transition = 45.55 t C/ha,
SOC_{0-T} – carbon stock in the soils before the conversion = 58.87 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.

Organic soils

Histosols covers less than 0.05 % of the country's territory. Most of the area with Histosols are in protected areas. However, some of the territories with organic soils are under agricultural use. To get information on the extent of that, an intersection of the Histosoils soil map (provided by Soil Research Institute) with IACS data on physical blocks have been done. The area of Histosols within the CL category is 1.367 kha and stays constant over the reporting period. The CO_2 emissions from managed organic soils are estimated to 39.60 Gg CO_2 and are calculated according to Tier 1 of the Wetlands Supplement (2013). The emission factors used follow those provided in table 2.1 in Wetlands Supplement. Considering the negligible size of the area no LUC have been assessed and reported. CO_2 emissions from organic soils are reported in LULUCF in remaining category, while the associated direct and indirect N_2O emissions are reported in Agricultural sector, CRT table 3.D.

6.4.3.2 Lands converted to croplands (4.B.2.)

6.4.3.2.1 Changes in carbon stock in 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 carbon stock in the living biomass after the conversion (C_{After}) is equal to 0. The carbon stock in biomass before conversion from Pastures and meadows is 6.58 tC/ha. It is calculated on basis of statistical data (National Statistical Yearbook) for the average yield of hay from grasslands for a period of 20 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 carbon stock in biomass of Shrubs and grassland before conversion is 5.24 tC/ha as suggested by MediNet project results (Canaveira, P. et al. 2018).
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 6.4.3.1.3.
The quantity of carbon in the biomass is adopted by default - 0.5 (2006 IPCC).

6.4.3.2.1.1 Changes of carbon stock in 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 carbon stock in soils of grassland converted to annual crops

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:

$$\Delta \boldsymbol{C_{GLsoil}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\boldsymbol{20}}$$

Where,

ΔC_{GLsoil} - annual change in carbon stock in soils in land converted to CL

SOC_0 – carbon stocks in the soils after 20 years of transition,

SOC_{0-T} – carbon stock in the soils before the conversion

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.

The following parameters were used:

Table 241 CSC factors in soil after LUC from GL to aCL

LU cateroes before LUC	SOC mineral before LUC to aCL, tC/ha	SOC mineral after LUC to aCL, tC/ha	CSC, tC/ha/y
PM	59.95	56.11	-0.19
ShrGL	65.21	53.99	-0.56

6.4.3.2.1.3 Changes in 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:

$$\Delta C_{GLsoil} = \frac{[(SOC_0 - SOC_{0-T})]}{20}$$

Where,

ΔC_{GLsoil} - annual change in carbon stock in soils in land converted to CL

SOC_0 – carbon stocks in the soils after 20 years of transition

SOC_{0-T} – carbon stock in the soils before the conversion

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.

The following parameters were used:

Table 242 CSC factors in soil after LUC from GL to pCL

LU cateroes before LUC	SOC mineral before LUC to pCL, tC/ha	SOC mineral after LUC to pCL, tC/ha	CSC, tC/ha/y
PM	59.71	50.15	-0.48
ShrGL	69.98	64.94	-0.25

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 **55%**. The trend uncertainty due to activity data and emission factors amounts to **199**%.
The combined uncertainty for the sub-category "Cropland remaining cropland" is **173%** and the uncertainty in the trend of the gas emissions is **79%.**
The uncertainties for the sources "Living biomass" and "Soil" within the sub-category "Cropland remaining cropland" were determined.
The combined uncertainty for the sub-category „Land use changed to cropland" is **36%**. The trend uncertainty for the sub-category exceeded more than 100 times the estimated tendency in emissions, which was primarily due to high uncertainty introduced by the emission factors.
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 shrubs and grasslands, MGL) changed to cropland (annuals and perennials)" and "Other land changed to cropland (annuals and perennials)" were estimated.

More information for the used emission factor/estimation parameter uncertainty can be found in subchapter 6.1.5.

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

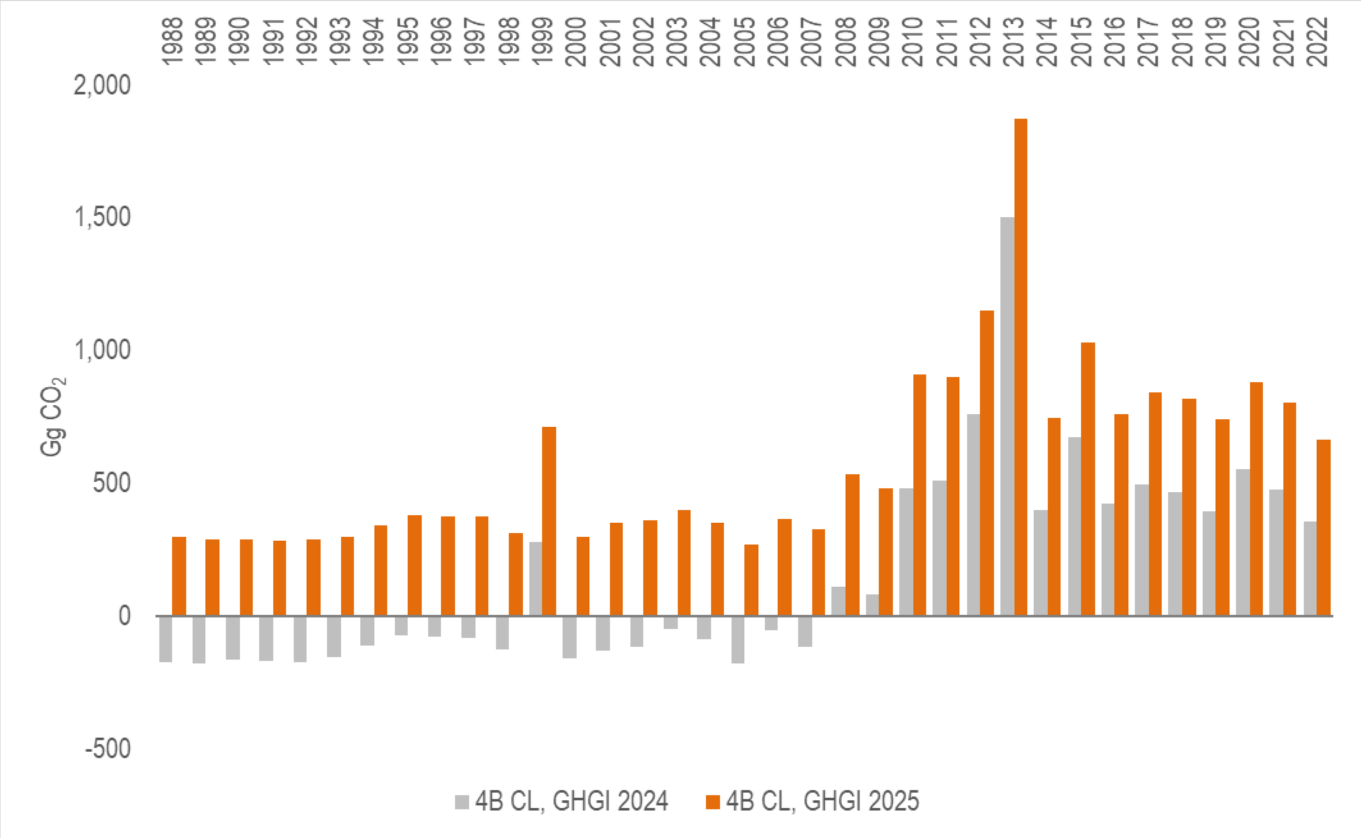


Figure 141 Recalculations in Cropland category

The recalculations in CL category are related mainly to the following:

1. The recalculations are related to changes in area representations, and more specifically – improved estimates of LUC conversions between annual and perennial crops and vice versa over the time series.
2. Recalculations in carbon stock changes in living biomass and soils of perennials remaining perennials by including reporting of gains and losses in both above and belowground biomass.
3. Improving the estimates in the soil pool of perennials remaining perennials. Data on management practices on soil disturbance (till and non-till) and input (mineral and organic fertilizers) have been derived from agronomic reports on perennial crops in Bulgaria for different years. This information was used to develop a consistent time series on soil related management practices and to recalculate the CSC from the soil pool in perennials remaining perennials.
4. In addition, there are small recalculations in direct and indirect N2O emissions associated with N mineralization due to land use changes, because of refinement of the C/N ratio data.

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. In addition, we plan to derive more information for the soil improvements/management methods in CL and GL categories.

6.5 GRASSLAND (4.C)

6.5.1 DESCRIPTION OF THE CATEGORY

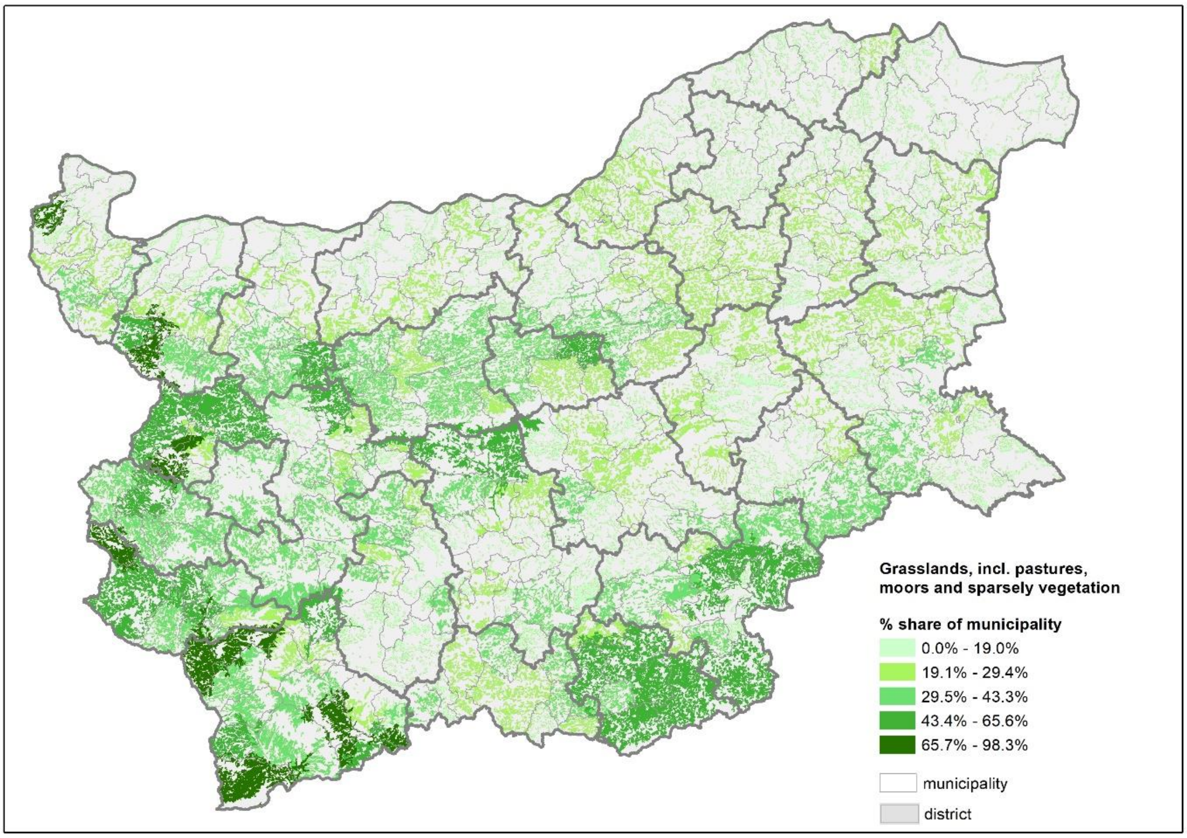


Figure 142 Share of municipality area occupied by Grasslands.
The map is elaborated based on CLC, 2018.

Grassland in Bulgaria cover an area of 2555 kha in 2023, which represents 23.02 % of the country's territory. The total grassland area is 28.06 % higher, comparing to the base year 1988 - 1995 kha. The figure below presents data on the area of Grasslands for the reporting period.

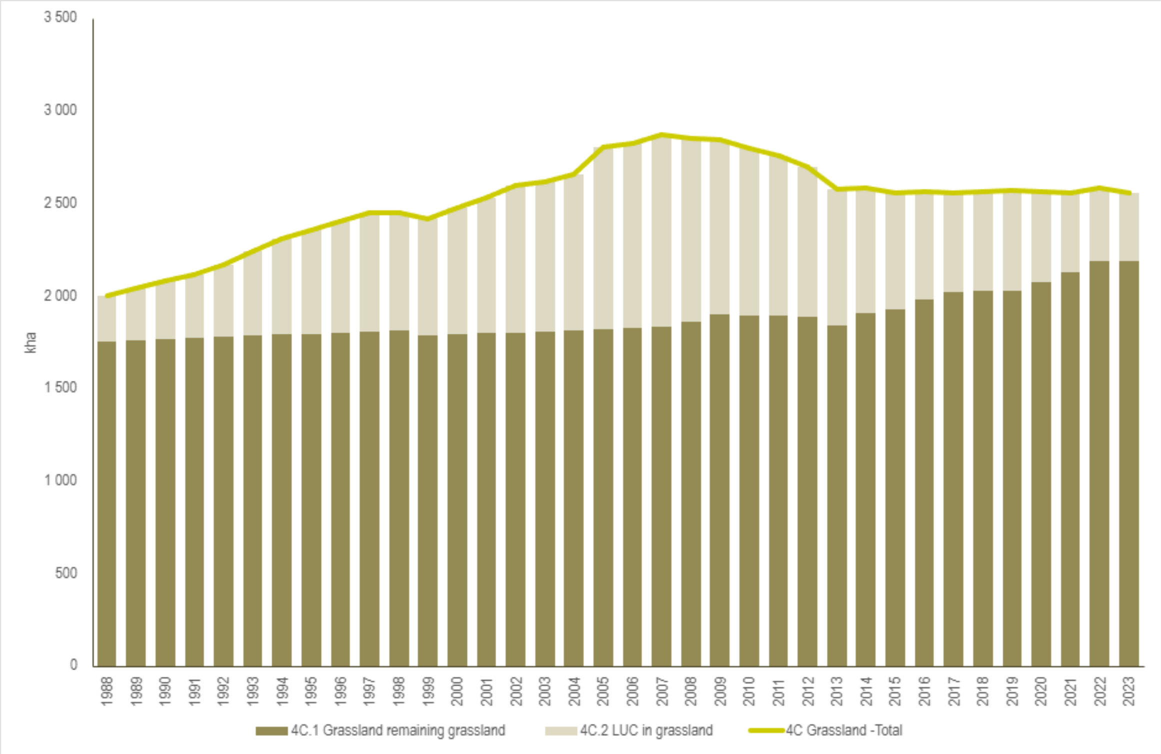


Figure 143 Trends in area of Grassland category 1988-2023

Grassland category includes 1382 kha pastures and meadow, which represent 54.10% of these lands, and the other 45.90% of the category or 1173 kha represent shrubs and grasslands. Over the reporting period there are fluctuations in the area of GL, presented in the figure below, which are in the opposite direction of the changes observed in the CL area.

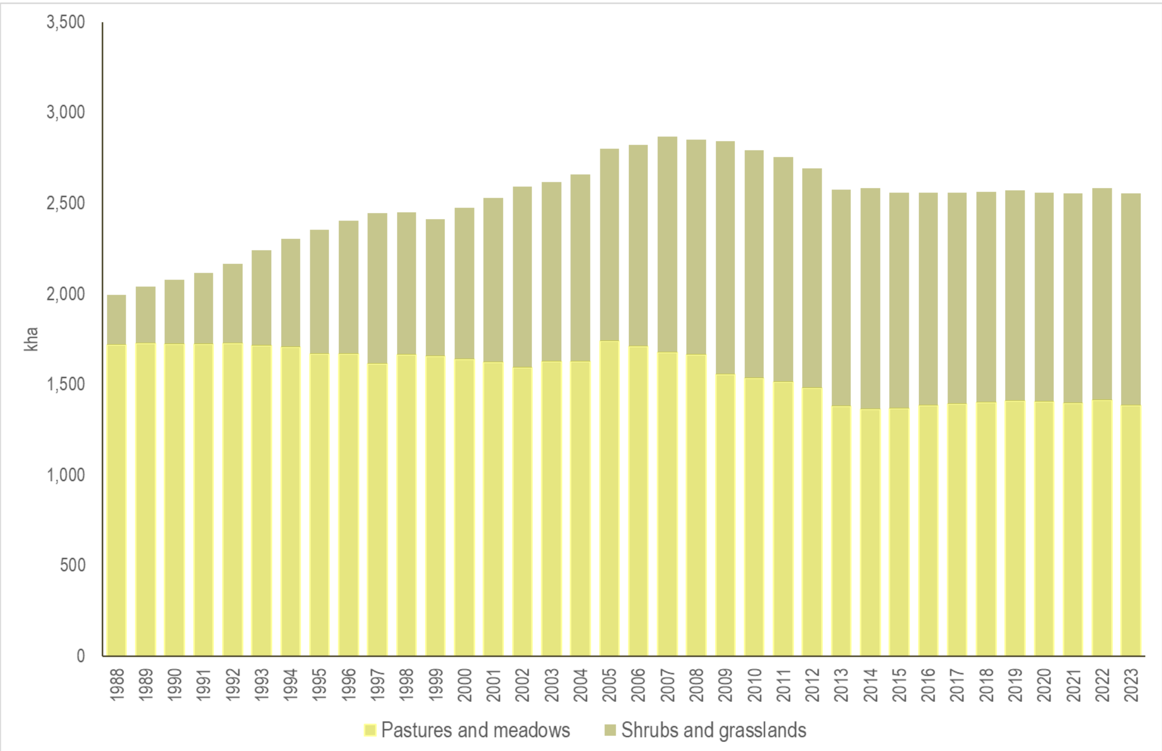


Figure 144 Subcategories' distribution under GL category

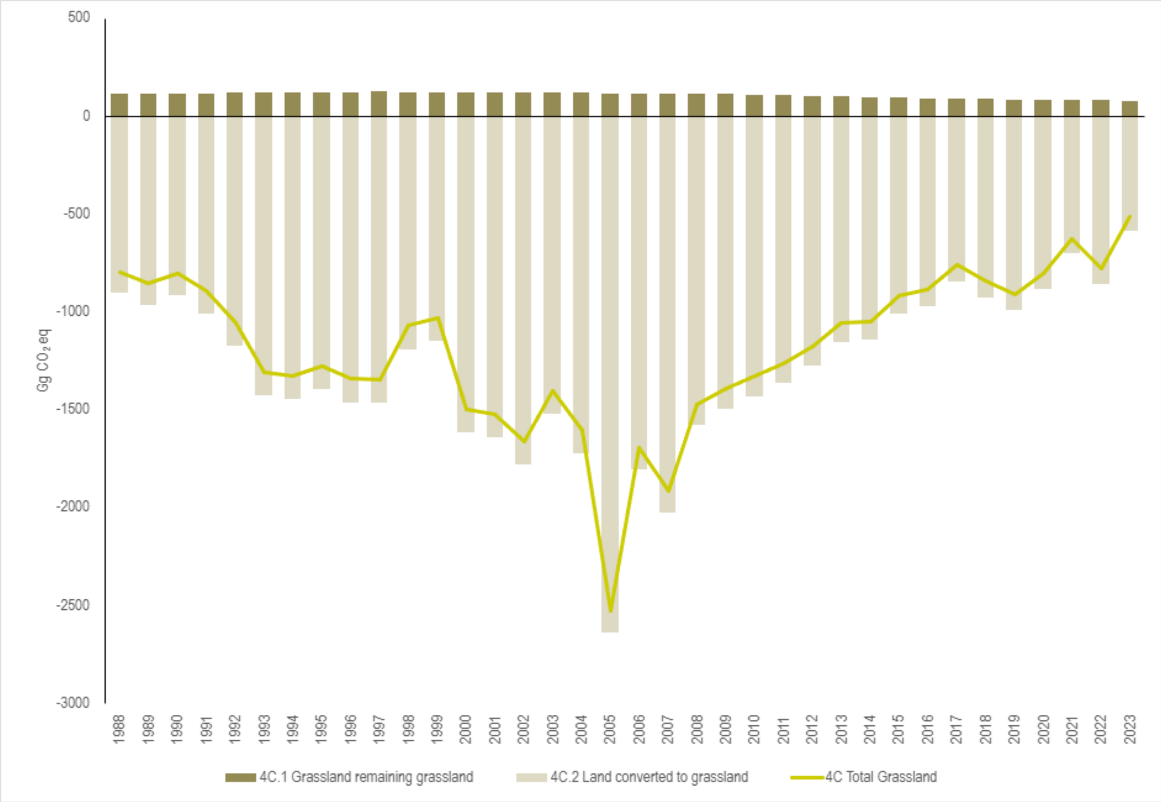


Figure 145 Net GHG emissions/removals (+/-) from 4.C Grassland, Gg CO_2.

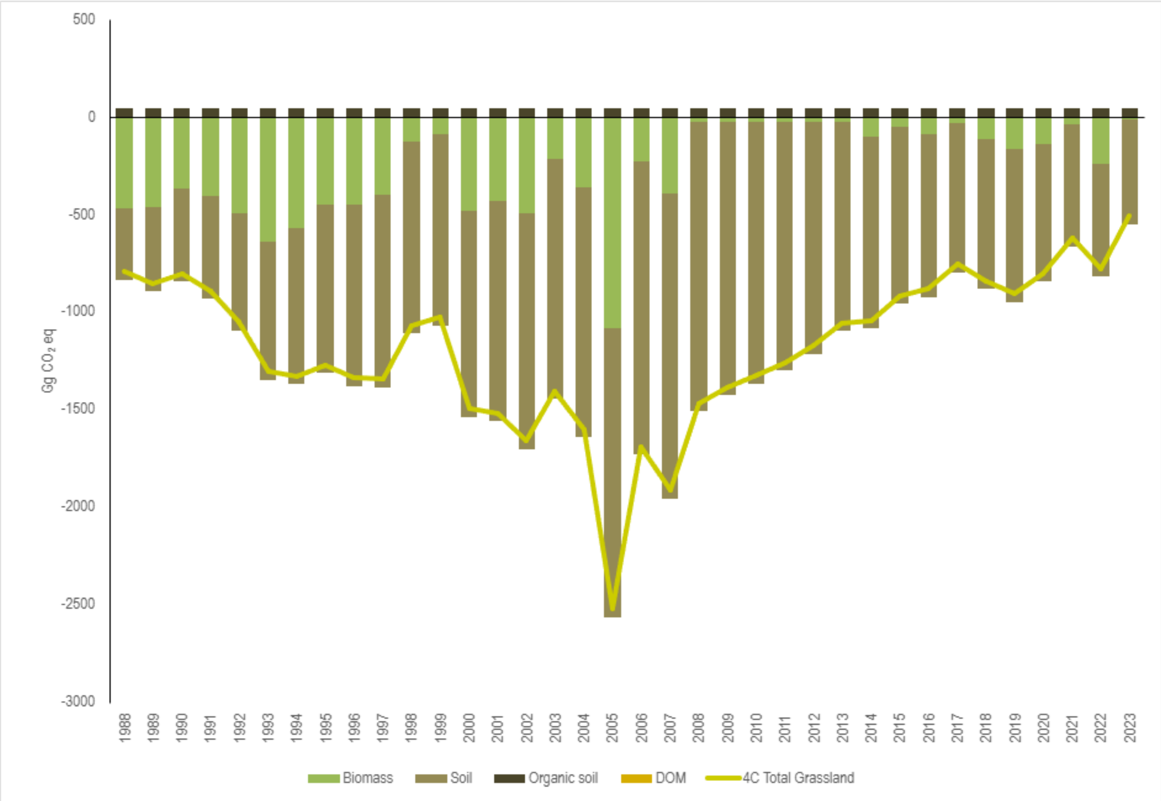


Figure 146 Net GHG emissions/removals (+/-) from 4C Grassland by carbon pools, Gg CO_2 eq.

Table 243 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 Other Land converted to Grassland	4 (III) Direct and Indirect N_2O emissions
1988	-776.43	111.86	-905.04	-687.93	-217.11	16.75
1989	-838.03	113.24	-968.04	-746.52	-221.52	16.76
1990	-785.61	114.72	-917.11	-691.17	-225.93	16.78
1991	-876.64	115.95	-1009.39	-778.99	-230.40	16.80
1992	-1037.94	117.22	-1171.98	-937.12	-234.86	16.82
1993	-1291.03	118.92	-1426.78	-1187.55	-239.22	16.83
1994	-1312.32	120.10	-1449.26	-1205.60	-243.66	16.84
1995	-1256.33	121.52	-1394.68	-1149.35	-245.33	16.83
1996	-1323.62	121.67	-1462.11	-1212.48	-249.63	16.82
1997	-1327.76	122.85	-1467.39	-1216.23	-251.16	16.78
1998	-1053.27	120.77	-1190.81	-935.92	-254.89	16.77
1999	-1011.40	119.82	-1147.98	-889.32	-258.66	16.76
2000	-1482.02	120.24	-1618.99	-1421.90	-197.09	16.73
2001	-1502.97	120.30	-1639.96	-1446.30	-193.66	16.70
2002	-1645.47	120.43	-1782.55	-1592.31	-190.24	16.65
2003	-1388.48	118.27	-1523.37	-1336.80	-186.57	16.62
2004	-1586.86	117.28	-1720.73	-1537.68	-183.05	16.59
2005	-2506.53	114.75	-2637.90	-2458.45	-179.45	16.61
2006	-1673.64	114.35	-1804.62	-1628.65	-175.97	16.62
2007	-1897.83	114.12	-2028.57	-1856.08	-172.49	16.62
2008	-1451.66	111.24	-1579.50	-1415.27	-164.23	16.59
2009	-1369.75	110.72	-1496.97	-1340.22	-156.75	16.51
2010	-1310.43	107.03	-1433.87	-1285.24	-148.64	16.41
2011	-1244.53	103.72	-1364.56	-1222.25	-142.31	16.31
2012	-1157.91	100.48	-1274.58	-1140.56	-134.01	16.19
2013	-1041.56	98.36	-1155.95	-1026.89	-129.05	16.02
2014	-1029.81	95.82	-1141.48	-1019.92	-121.57	15.85
2015	-901.81	92.61	-1010.13	-868.58	-141.55	15.71
2016	-868.69	89.77	-974.03	-825.39	-148.64	15.56
2017	-741.07	87.61	-844.14	-733.83	-110.31	15.45
2018	-827.47	85.34	-928.14	-762.81	-165.33	15.32
2019	-892.61	83.01	-990.82	-759.01	-231.81	15.20
2020	-789.12	81.13	-885.33	-642.26	-243.07	15.09
2021	-609.23	79.62	-703.83	-557.34	-146.49	14.97
2022	-763.26	78.38	-856.53	-730.78	-125.75	14.89
2023	-494.16	77.43	-586.36	-470.44	-115.93	14.77

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 137)
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

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.

6.5.3.1 Grassland Remaining Grassland (4.C.1.)

6.5.3.1.1 Changes of carbon stock in 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 carbon stock in soils

Mineral soils

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 6.3.3.2.3 on p. 358.
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:

$$\Delta \boldsymbol{SOC_{20}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\boldsymbol{20}} = \mathbf{0.28\ tC/ha/y}$$

where,

SOC_0 – carbon stocks in the soils after 20 years of transition = 64.32 t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 58.72 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.

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:

$$\Delta \boldsymbol{SOC_{20}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}} = -\mathbf{0.34}\ \boldsymbol{tC/ha}$$

where,

SOC_0 – carbon stocks in the soils after 20 years of transition = 57.98 tC/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 64.81 tC/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.

Organic soils

Histosols covers less than 0.05 % of the country's territory. Most of the area with Histosols are in protected areas. However, some of the territories with organic soils follow under agricultural use. To get information on the extent of that, an intersection of the Histosoils soil map with IACS data on physicial blocks have been done. The area of Histosols within the GL category is 1.745 kha and stays constant throughout the reporting period. The CO_2 emissions from managed organic soils in GL are estimated to 41.02 Gg CO_2 and are calculated according to Tier 1 of the Wetlands Supplementt (2013). The emission factors used follow those provided in table 2.1 in Wetlands Supplement. Considering the negligible size of the area no LUC have been assessed and reported. CO_2 emissions from organic soils are reported in LULUCF in remaining category, while the associated direct and indirect N_2O emissions are reported in Agricultural sector, CRT table 3.D.

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 carbon stock in living biomass of lands converted to grassland

The estimates of the changes in biomass carbon stock are based on country-specific data.

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}

The carbon stock in the living biomass of Pastures and meadows subcategory has been estimated based on 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 0.87 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 by following the equation below:

$$\boldsymbol{B_{total}} = \left[(\boldsymbol{B_{cut}} \cdot \mathbf{0.47}) + (\boldsymbol{B_{peak\ aboveground}} \cdot \mathbf{0.47})\right] \cdot (\mathbf{1} + \boldsymbol{R})$$

where:

B_{total} – total biomass (aboveground and belowground), tonnes d.m.

B_{cut}- yield biomass = 2.09 tonnes d.m

$B_{peak\ aboveground}$ – 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)

Like this B_{total} is the annual average growth rate in biomass of subcategory Pastures and meadows. The value of B_{total} is 6.58 tC/ha.

In order to calculate the CSC in living biomass of LUC to GL the following parameters are used:

ΔC_{growth} = 6.58 tC/ha forPastures and meadows

ΔC_{growth} = 5.24 tC/ha for Shrubs and Grasslands (based on data from MediNet Project)

C_{after}= 0

C_{before} = 3.56 tC/ha, for annual crops converted to GL (calculated for Bulgaria, Section 6.4.3.2)

C_{before} = Table 239 Total (above- and below-ground) biomass (tC/ha) and accumulation rate (tC/ha/y) in perennials, for 1988-2023 y.

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 carbon stock in soils of lands converted to grassland

The average SOC in soils of grassland and cropland has been calculated as described in 6.3.3.2.3 on p. 358. 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:

$$\Delta \boldsymbol{C_{GLsoil}} = \frac{[(\boldsymbol{SOC_0} - \boldsymbol{SOC_{0-T}})]}{\mathbf{20}}$$

where,

ΔC_{GLsoil} - annual change in carbon stock in soils in land converted to GL

SOC_0 – carbon stocks in the soils after 20 years of transition

SOC_{0-T} – carbon stock in the soils before the conversion

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. The following parameters were used:

Table 244 CSC factors in soil of lands converted to Pastures and meadows

LU cateroes before LUC	SOC mineral before LUC to PM, tC/ha	SOC mineral after LUC to PM, tC/ha	CSC, tC/ha/y
aCL	59.04	68.02	0.45
pCL	46.39	62.60	0.81

Table 245 CSC factors in soil of lands converted to Shrubs and grasslands

LU cateroes before LUC	SOC mineral before LUC to ShrGL, tC/ha	SOC mineral after LUC to ShrGL, tC/ha	CSC, tC/ha/y
aCL	59.50	63.46	0.20
pCL	54.35	69.89	0.78

6.5.4 UNCERTAINTY ASSESSMENT

The overall uncertainty in estimation of gas emissions and removals of over a year for the category "Grassland" is 106%. The trend uncertainty due to activity data and emission factors amounts to 22%. Larger portion of this uncertainty is accounted for by the sub-category "Grassland remaining grassland". Its combined uncertainty is estimated to be 152% and the uncertainty in the trend of the gas emissions is 73%.
The uncertainties for the two principal pools "Living biomass" and "Soil" within the sub-category "Grassland remaining grassland" were determined.
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 shrubs and grasslands, MGL)", "Cropland (annuals and perennials) changed to grassland", "Other land changed to grassland" were estimated.
More information for the used emission factor/estimation parameter uncertainty can be found in subchapter 6.1.5.

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

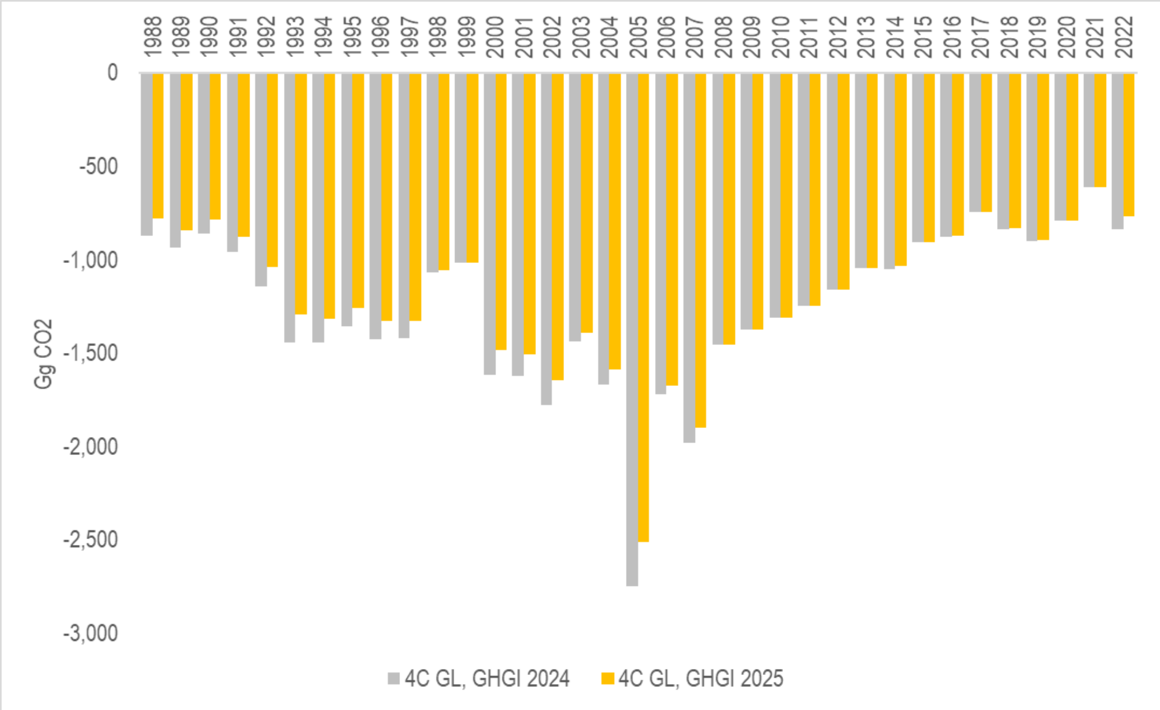


Figure 147 Recalculations in Grassland category

The recalculations in GL category are related to the following:

1. Changes in reporting biomass sotck in perennial crops. The change affects the conversion of perennials to grasslands. This involves the reporting of losses in both aboveground and belowground biomass, which results in increased emissions in grassland areas.
2. Soils related N_2O emissions by updating the C/N ratio consistently with the methodology applied in CSC estimates in soil pool.

6.5.7 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

For Grassland category it is planned to continue working on the land-use classification and representation across the time series. In addition, we plan to derive more information for the soil improvements/management methods in CL and GL categories.

6.6 WETLANDS (4.D)

6.6.1 DESCRIPTION OF THE CATEGORY

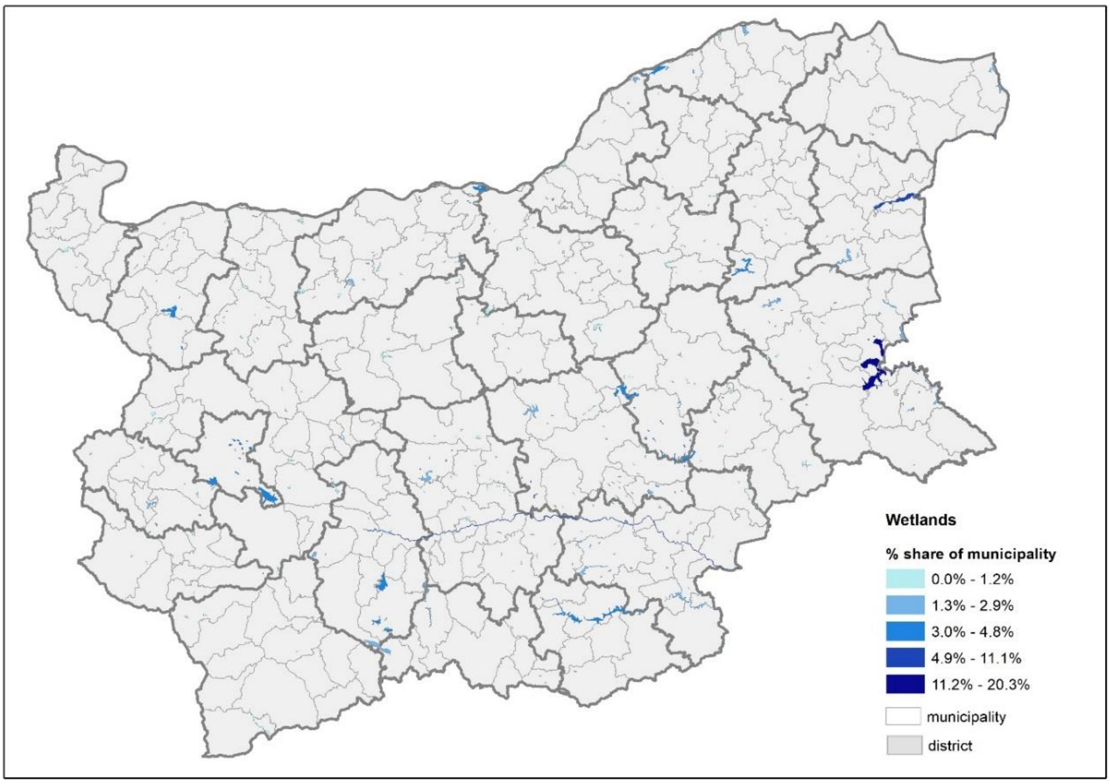


Figure 148 Share of municipality area occupied by Wetlands.

The map is elaborated based on CLC, 2020.

In 2022, Wetlands in Bulgaria cover an area of 233 kha which represents 2.09 % of the country's territory. The total wetland area is 8.86 % higher, comparing to the base year 1988 - 214 kha. The figure below presents data on the area of Wetlands for the reporting period.

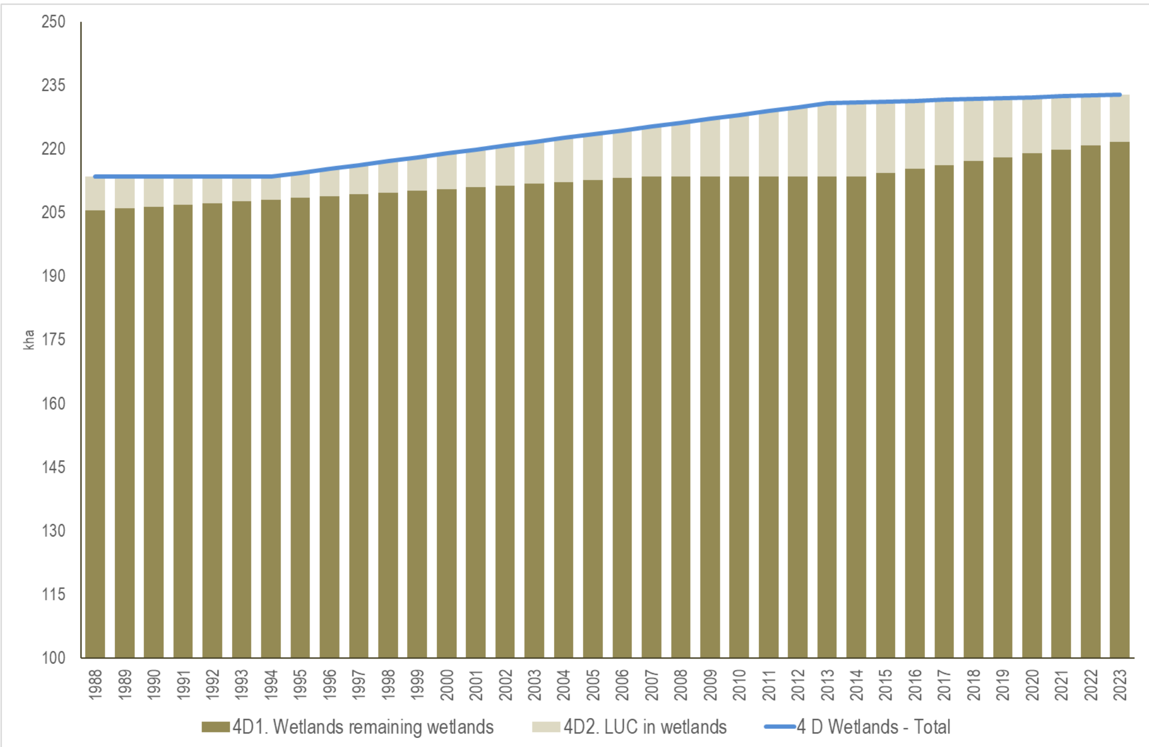


Figure 149 Trends in Wetland category 1988-2023

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.

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.

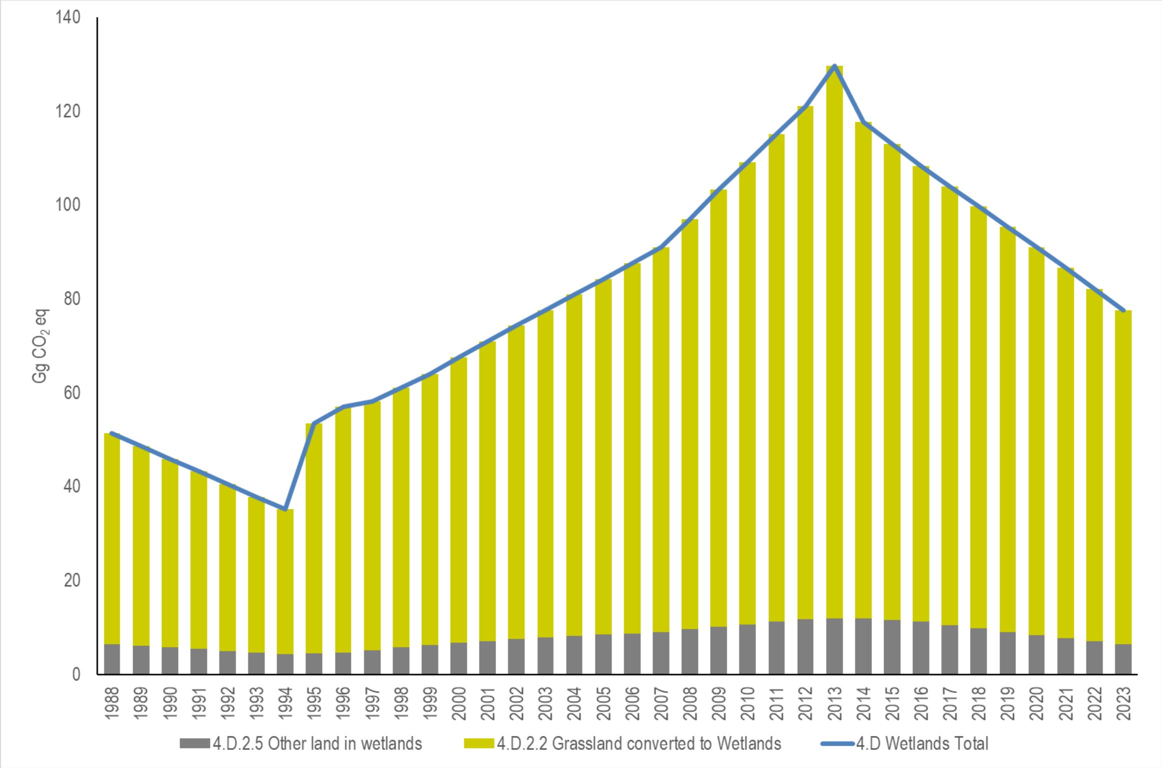


Figure 150 Net GHG emissions/removal (+/-) from 4.D Wetlands, Gg CO2 eq

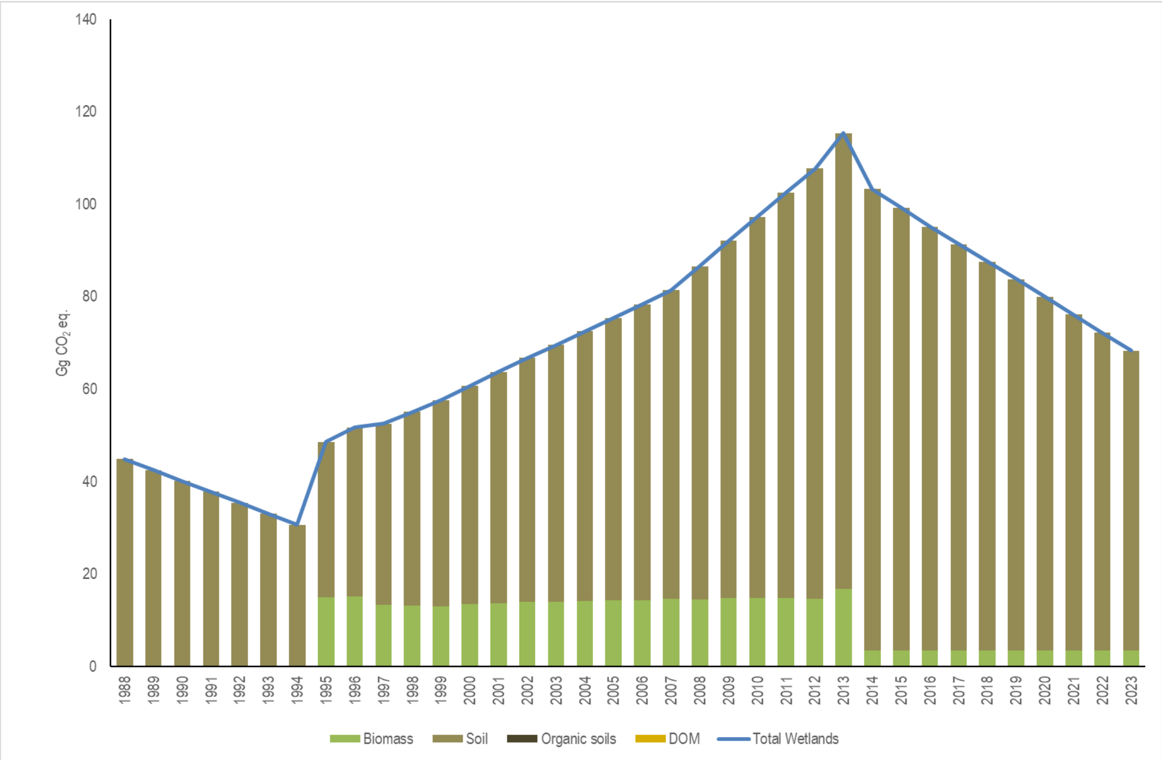


Figure 151 Net GHG emissions/removals (+/-) from 4.D Wetlands by carbon pools, Gg CO eq.

Table 246 Emissions (+)/removals (-) of GHGs in Wetlands Remaining Wetlands and Lands Converted to Wetlands (Gg CO_2 equivalent)

Year	4.D Wetlands Total	4.D.2.2 Grassland converted to Wetlands	4.D.2.5 Other land in wetlands	4.D (III) GL in WL (N_2O converted into CO_2 eq)	4.D.(III) OL in WL (N_2O converted into CO_2 eq)
1988	51.32	39.32	5.56	5.65	0.80
1989	48.62	37.25	5.27	5.35	0.76
1990	45.92	35.18	4.98	5.05	0.71
1991	43.22	33.11	4.68	4.75	0.67
1992	40.52	31.04	4.39	4.46	0.63
1993	37.82	28.97	4.10	4.16	0.59
1994	35.12	26.90	3.81	3.86	0.55
1995	53.45	44.68	3.95	4.26	0.57
1996	56.97	47.66	4.06	4.67	0.58
1997	58.19	48.05	4.50	4.99	0.65
1998	61.12	50.14	4.96	5.30	0.71
1999	64.05	52.21	5.44	5.61	0.78
2000	67.51	54.88	5.86	5.94	0.84
2001	70.92	57.52	6.22	6.28	0.89
2002	74.40	60.29	6.53	6.64	0.94
2003	77.56	62.75	6.84	6.99	0.98
2004	80.90	65.40	7.13	7.35	1.02
2005	84.21	68.03	7.40	7.72	1.06
2006	87.59	70.76	7.64	8.09	1.10
2007	91.05	73.60	7.85	8.47	1.13
2008	97.00	78.28	8.36	9.15	1.20
2009	103.21	83.28	8.83	9.83	1.27
2010	109.17	88.01	9.31	10.52	1.34
2011	115.17	92.78	9.79	11.20	1.41
2012	121.13	97.50	10.27	11.88	1.47
2013	129.60	105.07	10.37	12.67	1.49
2014	117.64	92.84	10.47	12.83	1.50
2015	113.00	89.11	10.14	12.29	1.46
2016	108.34	85.35	9.83	11.75	1.41
2017	103.98	82.17	9.20	11.30	1.32
2018	99.66	79.05	8.54	10.85	1.23
2019	95.36	75.97	7.87	10.40	1.13
2020	91.00	72.76	7.25	9.94	1.04
2021	86.58	69.47	6.69	9.47	0.96
2022	82.11	66.07	6.18	8.98	0.89
2023	77.64	62.68	5.66	8.49	0.81

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 - 2020. 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 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.

$$\textbf{The annual change in the carbon stock} = \textbf{anual area of lands converted to wetlands} \cdot (\mathbf{B_{after}} - \mathbf{B_{before}}) \cdot \mathbf{CF}$$

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 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:

$$\Delta \boldsymbol{C_{wl}} = \boldsymbol{A} \cdot \frac{\boldsymbol{SOC}_{\boldsymbol{after}} - \boldsymbol{SOC}_{\boldsymbol{before}}}{\boldsymbol{20}}$$

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, 66.90 tC/ha for soils of shrubs and grasslands and 51.80 tC/ha for other lands

SOC_{after} – carbon stock in the soil 20 years after the conversion, 33.04 tC/ha.

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 **16** %. The trend uncertainty due to activity data and emission factors is **17**% (Table 239).
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.

More information for the used emission factor/estimation parameter uncertainty can be found in subchapter 6.1.5.

6.6.5 DATA VERIFICATION

See 6.1.6 QA/QC VERIFICATION

6.6.6 CATEGORY-SPECIFIC RECALCULATIONS

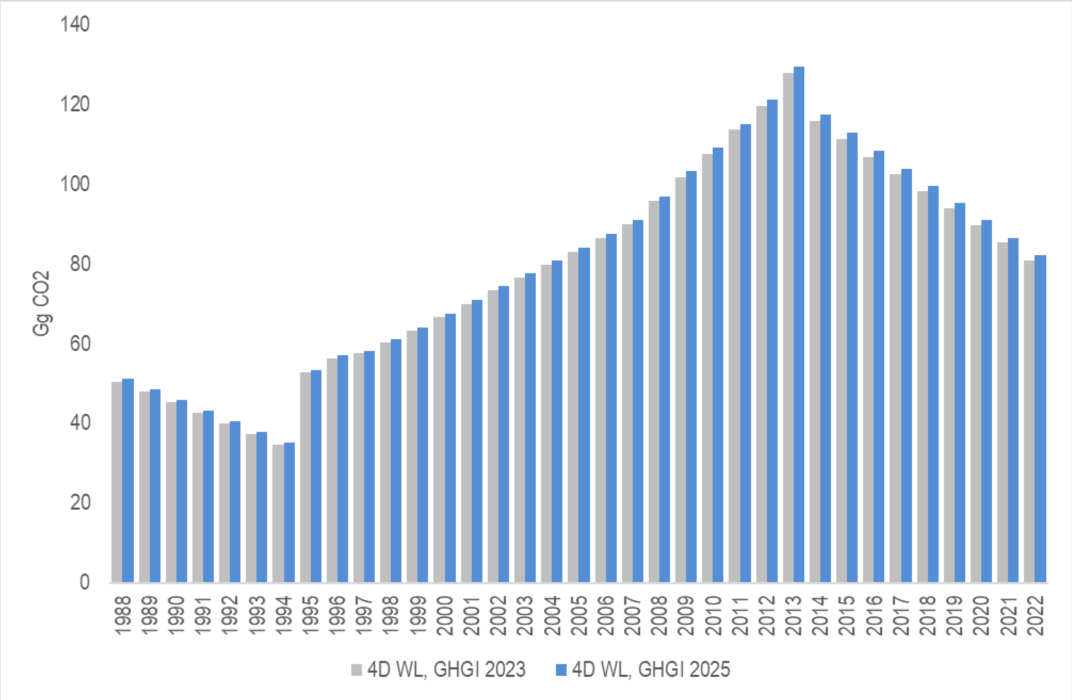


Figure 152 Recalculations in Wetlands category

The changes in WL category are related to refine estimates of N_2O emissions from soils by updating the C/N ratio consistently with the methodology applied in CSC estimates in soil pool.

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

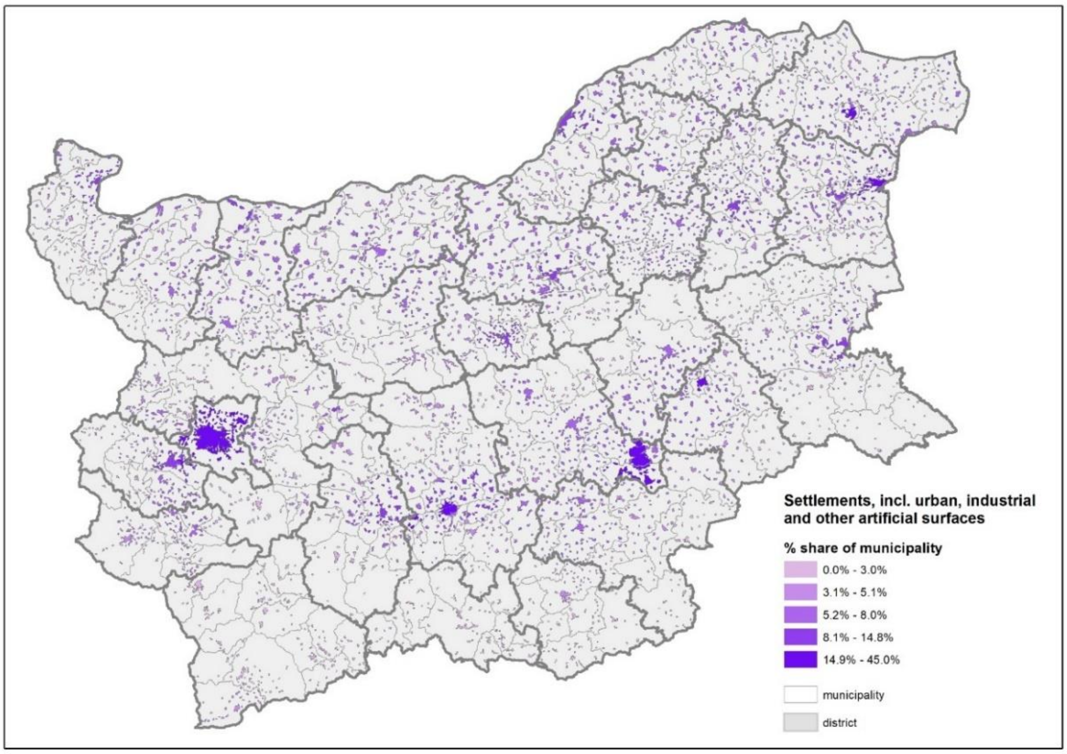


Figure 153 Share of municipality area occupied by Settlements.
The map is elaborated based on CLC, 2018.

Settlements cover an area of 545 kha in 2022, which represent 4.91 % of the total territory of the country. The total settlements area is 18.05 % higher, comparing to the base year 1988 - 460 kha. The area of settlements has increased gradually over the years. The figure below presents data on the area of Settlements for the reporting period.

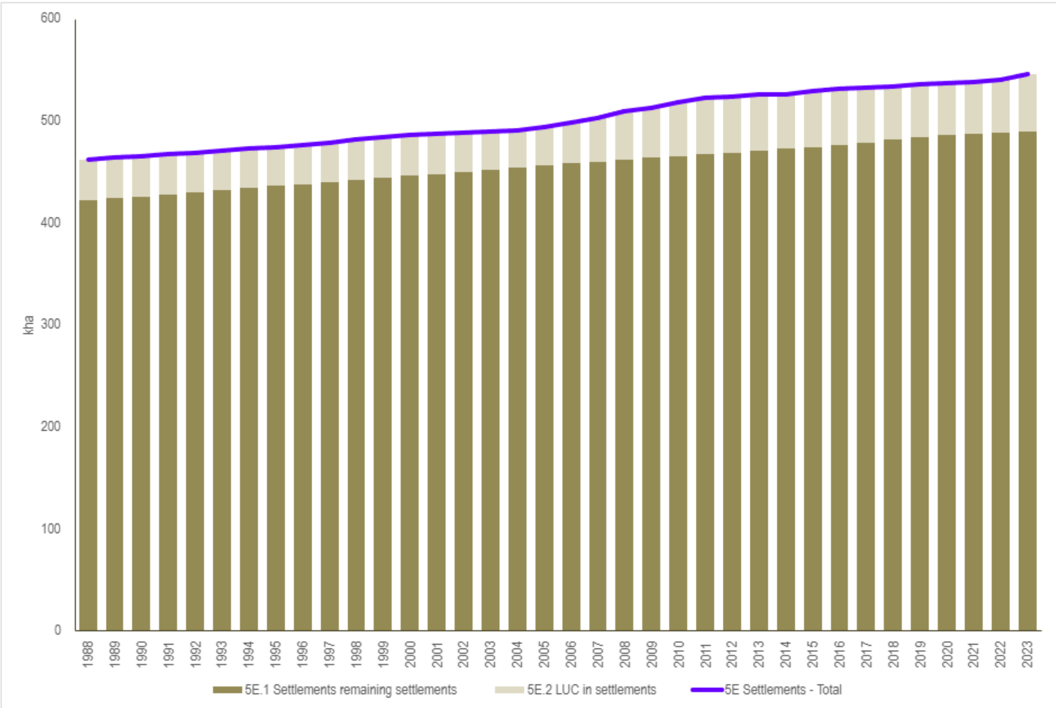


Figure 154 Trends in Settlements category 1988-2023

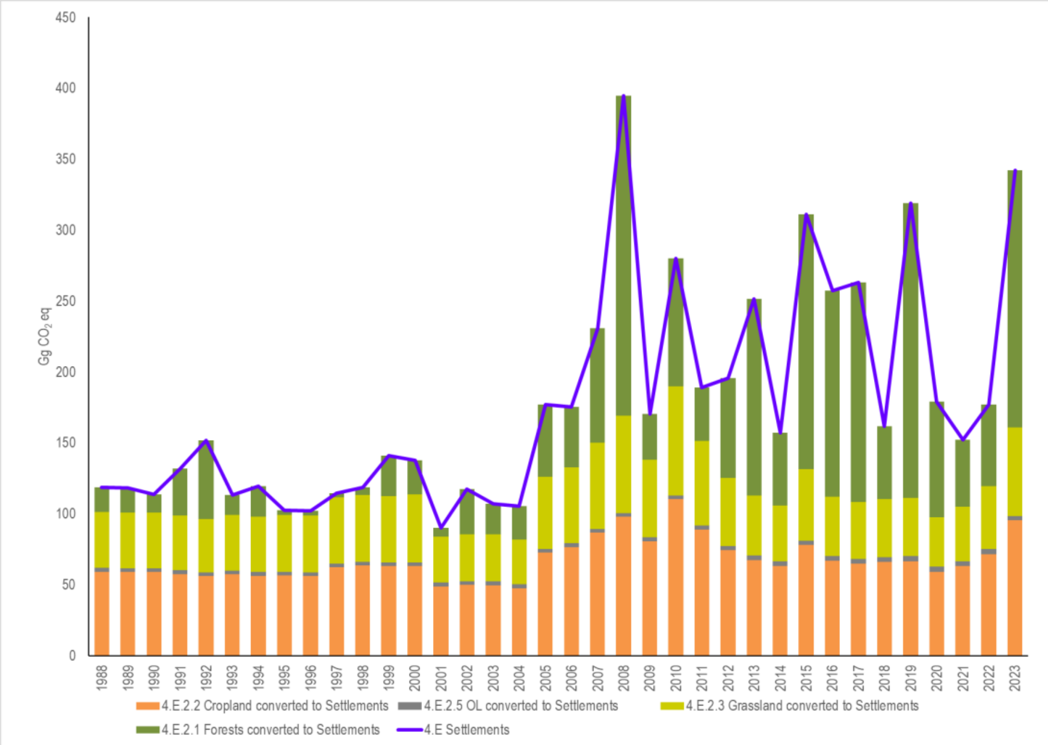


Figure 155 Net GHG emissions/removals (+/-) in 4.E Settlements, Gg CO_2 eq

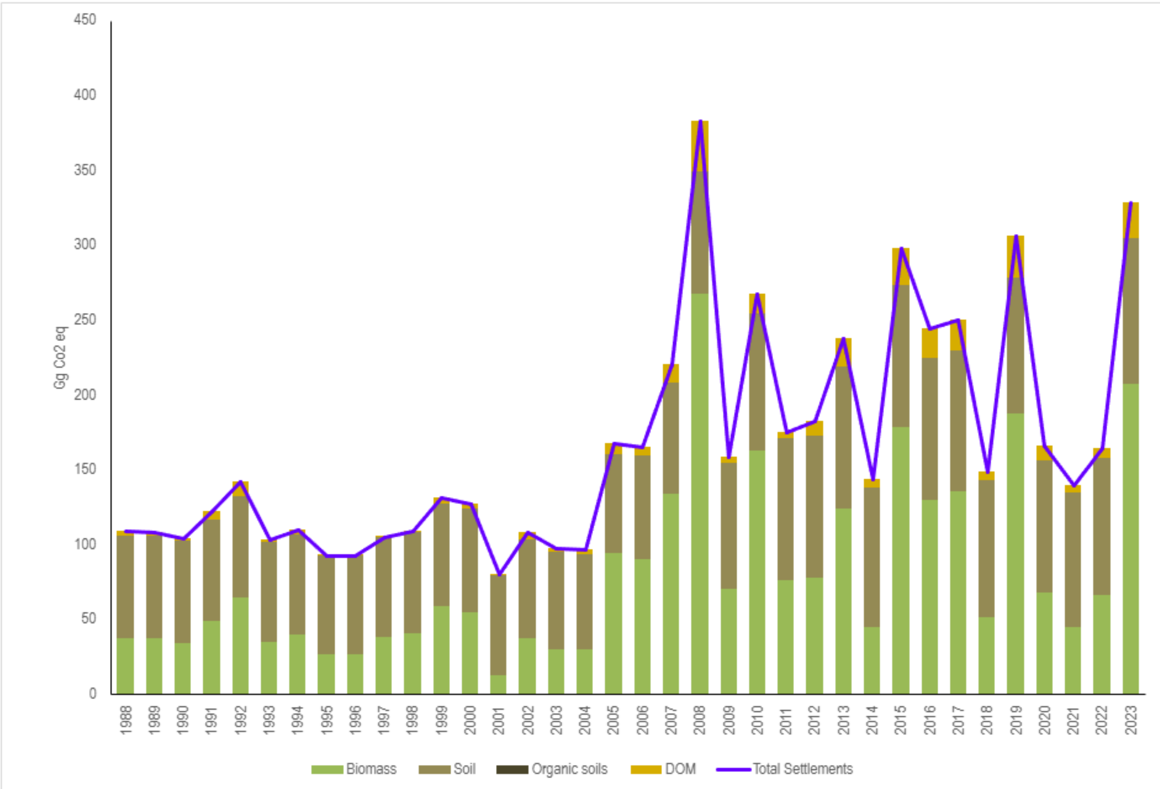


Figure 156 Emissions /removals (+/-) from 4.E Settlements by carbon pools, Gg CO_2 eq.

Table 247 Emissions (+)/removals (-) of CO_2 in Settlements remaining Settlements and Lands converted to Settlements, Gg CO_2 eq.

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	108.81	NE	108.81	17.04	53.61	35.64	2.52
1989	108.32	NE	108.32	17.04	53.34	35.63	2.30
1990	104.05	NE	104.05	12.66	53.35	35.74	2.30
1991	122.36	NE	122.36	33.00	52.09	34.97	2.30
1992	142.04	NE	142.04	54.98	50.60	34.17	2.29
1993	103.59	NE	103.59	13.66	51.79	35.87	2.26
1994	109.81	NE	109.81	20.86	50.89	35.81	2.25
1995	92.96	NE	92.96	2.93	51.18	36.61	2.23
1996	92.66	NE	92.66	2.77	50.81	36.85	2.22
1997	105.20	NE	105.20	2.83	56.93	43.27	2.17
1998	108.96	NE	108.96	4.94	58.03	43.78	2.20
1999	131.22	NE	131.22	28.17	57.73	43.09	2.23
2000	127.62	NE	127.62	23.58	57.70	44.10	2.25
2001	80.30	NE	80.30	5.84	43.33	28.68	2.45
2002	108.12	NE	108.12	31.47	44.52	29.70	2.44
2003	97.71	NE	97.71	20.91	44.57	29.79	2.44
2004	96.30	NE	96.30	23.03	42.53	28.26	2.48
2005	167.72	NE	167.72	50.43	67.52	47.62	2.15
2006	165.42	NE	165.42	42.30	71.04	49.93	2.14
2007	220.07	NE	220.07	79.91	80.98	57.13	2.05
2008	383.14	NE	383.14	225.06	91.37	64.74	1.97
2009	158.51	NE	158.51	31.80	73.92	50.51	2.28
2010	267.09	NE	267.09	89.41	103.01	72.75	1.93
2011	175.42	NE	175.42	36.84	81.28	55.00	2.31
2012	182.27	NE	182.27	69.61	66.73	43.32	2.61
2013	238.00	NE	238.00	137.76	59.68	37.78	2.78
2014	144.05	NE	144.05	50.70	55.73	34.73	2.89
2015	297.75	NE	297.75	178.58	70.38	46.04	2.74
2016	243.97	NE	243.97	144.12	59.53	37.36	2.97
2017	249.85	NE	249.85	153.47	57.60	35.77	3.00
2018	148.60	NE	148.60	49.91	58.97	36.73	3.00
2019	306.09	NE	306.09	206.18	59.72	37.18	3.02
2020	166.29	NE	166.29	79.66	52.25	31.25	3.14
2021	139.46	NE	139.46	45.76	56.27	34.31	3.13
2022	164.17	NE	164.17	55.97	64.57	40.58	3.05
2023	328.20	NE	328.20	179.29	88.06	58.25	2.61

Table 248 Total N_2O emissions from N mineralization associated with loss of soil organic matter, Gg CO_2 eq.

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	9.86	0.38	5.58	3.52	0.38
1989	9.81	0.38	5.56	3.48	0.38
1990	9.75	0.38	5.55	3.45	0.38
1991	9.70	0.40	5.52	3.41	0.38
1992	9.65	0.45	5.47	3.36	0.37
1993	9.59	0.44	5.44	3.34	0.37

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
1994	9.54	0.44	5.41	3.32	0.37
1995	9.49	0.42	5.38	3.31	0.37
1996	9.43	0.40	5.35	3.31	0.37
1997	9.55	0.39	5.42	3.38	0.37
1998	9.67	0.37	5.49	3.45	0.37
1999	9.80	0.38	5.54	3.50	0.38
2000	9.92	0.38	5.59	3.56	0.38
2001	9.63	0.37	5.43	3.45	0.38
2002	9.43	0.38	5.31	3.36	0.38
2003	9.24	0.38	5.19	3.28	0.39
2004	9.02	0.38	5.06	3.18	0.39
2005	9.45	0.42	5.32	3.31	0.39
2006	9.91	0.44	5.62	3.46	0.40
2007	10.60	0.50	6.03	3.67	0.40
2008	11.68	0.70	6.58	4.00	0.40
2009	12.05	0.71	6.80	4.13	0.41
2010	13.14	0.78	7.44	4.50	0.41
2011	13.54	0.77	7.71	4.65	0.41
2012	13.59	0.76	7.73	4.67	0.43
2013	13.53	0.87	7.63	4.59	0.43
2014	13.31	0.89	7.48	4.49	0.45
2015	13.58	1.05	7.56	4.51	0.46
2016	13.55	1.18	7.47	4.43	0.47
2017	13.33	1.31	7.28	4.27	0.47
2018	13.08	1.34	7.13	4.14	0.47
2019	13.00	1.49	7.01	4.03	0.48
2020	12.66	1.53	6.79	3.85	0.49
2021	12.78	1.55	6.85	3.88	0.49
2022	13.02	1.56	7.00	3.97	0.50
2023	13.86	1.69	7.47	4.23	0.47

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 - 2020. 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 2020. 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 2020. 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 2020, 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

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.

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 6.2.3. 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 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 249 Living biomass stocks which are used to calculate the emissions associated with forest loss to settlements

		1990	1995	2000	2005	2010	2015-2022
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 35 carried out in Bulgaria on mapping and assessment of ecosystem services in urban areas (Project TunesinUrb,

[35] 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

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))[36], shrubs (Nowak et al. (2002)[37]) and ground vegetation ((Zhiyanski et al. 2013)[38]) in this 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 250 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, because 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 tC/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 251 Dead wood stocks used for estimating the changes in DW pool after deforestation

		1990	1995	2000	2005	2010	2015 - 2022
DW stock	tC/ha	3.24	3.24	3.60	4.01	4.31	4.58

6.7.3.1.1.3 Changes in 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 applying the revised approach in estimation the CSC factors in soil after LUC. The approach is described in more details in Section 6.3.3.2.3 on p.358. For the SOC of land under Settlement, 80% of the SOC of the pre-conversion category was used, based on the Tier 1 approach by the 2006 IPCC GL. For FL before conversion SOC value of 52.04 tC/ha was used. The CSC factor is estimated to -0.52 tC/ha/y.

[36] 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

[37] Nowak, D.J., Crane, D.E., 2002. Carbon storage and sequestration by urban trees in the USA. Environmental Pollution 116 (3), 381-389.

[38] Zhiyanski, M., V. Doichinova, K. Petrov. 2013. The social aspects and role of green infrastructure in mitigating climatic changes at regional level. Proceedings of
3rd International Conference "Ecology of urban areas 2013", Zrenjanin, October 11, 2013, Serbia, 451-459

6.7.3.1.2 Cropland converted to settlements

6.7.3.1.2.1 Changes in 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 (Table 239 Total (above- and below-ground) biomass (tC/ha) and accumulation rate (tC/ha/y) in perennials, for 1988-2023 y.) and the growth rates of the carbon stock in the biomass of the settlements (Section 6.4.3.1)

The annual emissions of carbon dioxide are presented in Table 238

6.7.3.1.2.2 Changes in carbon stock in soils for croplands converted to settlements

The calculation of the emissions from soils as a result of the conversion of cropland to settlements has been made by applying the revised approach in estimation the CSC factors in soil after LUC. The approach is described in more details in Section 6.3.3.2.3 on p.358. For the SOC of land under Settlements, 80% of the SOC of the pre-conversion category was used, based on the Tier 1 approach by the 2006 IPCC GL. A SOC value of 44.69 tC/ha has been used for aCL before conversion and a SOC value of 45.26 tC/ha – for perennials converted to settlements. The CSC factors are estimated to -0.45 tC/ha/y in the both cases.

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

The calculation of the emissions from soils as a result of the conversion of grassland to settlements has been made by applying the revised approach in estimation the CSC factors in soil after LUC. The approach is described in more details in Section 6.3.3.2.3 on p.358. For the SOC of land under Settlements, 80% of the SOC of the pre-conversion category was used, based on the Tier 1 approach by the 2006 IPCC GL. A SOC value of 49.92 tC/ha has been used for Pastures and Meadows before conversion and a SOC value of 51.78 tC/ha – for Shrubs and Grasslands converted to settlements. The CSC factors are estimated to -0.50 tC/ha/y for PM to SM and -0.52 tC/ha/y for ShrGL to SM.

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 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). For the SOC of land under Settlements, 80% of the SOC of the pre-conversion category was used, based on the Tier 1 approach by the 2006 IPCC GL. The CSC factor is estimated to -0.52 tC/ha/y.

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 **12**%. The trend uncertainty due to activity data and emission factors is **32**% (Table 245).
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.
More information for the used emission factor/estimation parameter uncertainty can be found in subchapter 6.1.5.

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

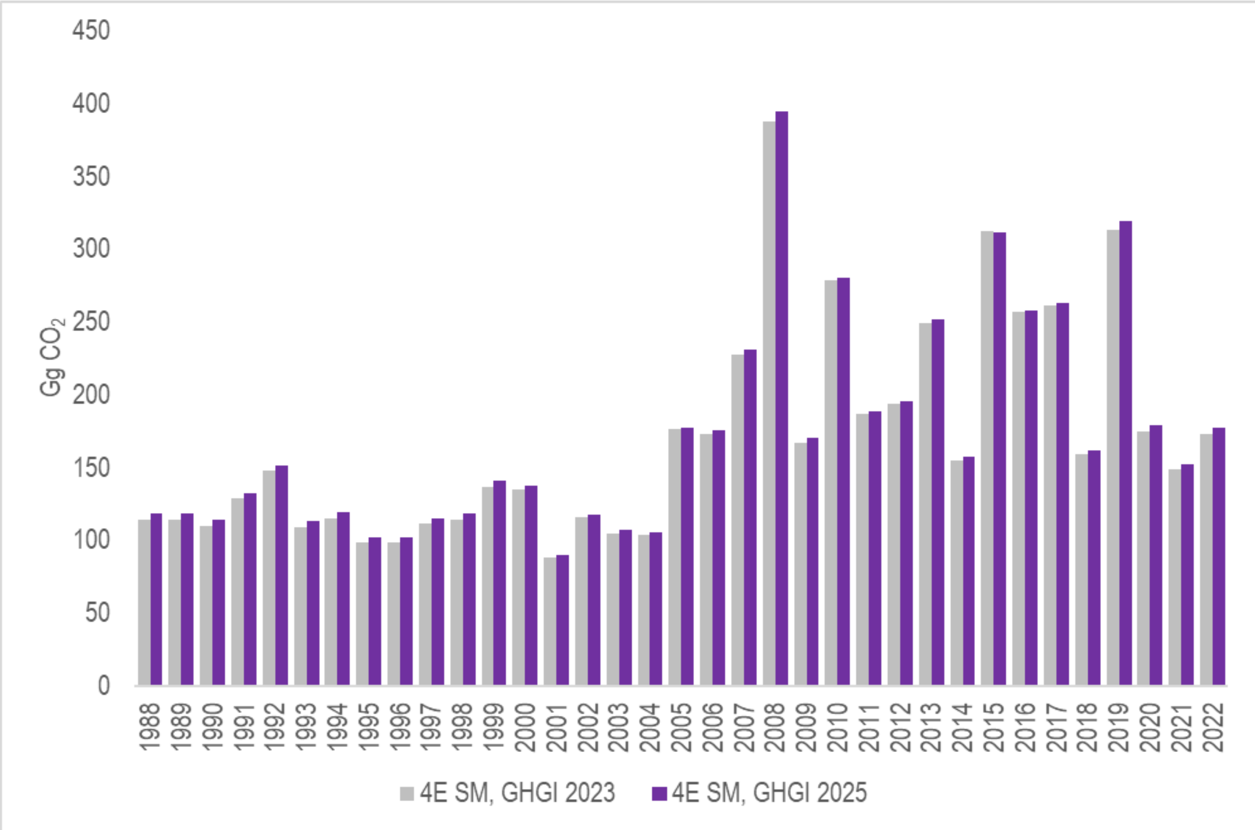


Figure 157 Recalculations in Settlements category

The changes in SM category are due to the following:

1. Changes in reporting of biomass sotck in perennial crops. The change affects the conversion of perennials to settlements. This involves reporting of losses in both aboveground and belowground biomass, which results in increased emissions in settlements area.
2. Soils related N_2O emissions by updating the C/N ratio consistently with the methodology applied in CSC estimates in soil pool.

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 MAF 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%.

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.

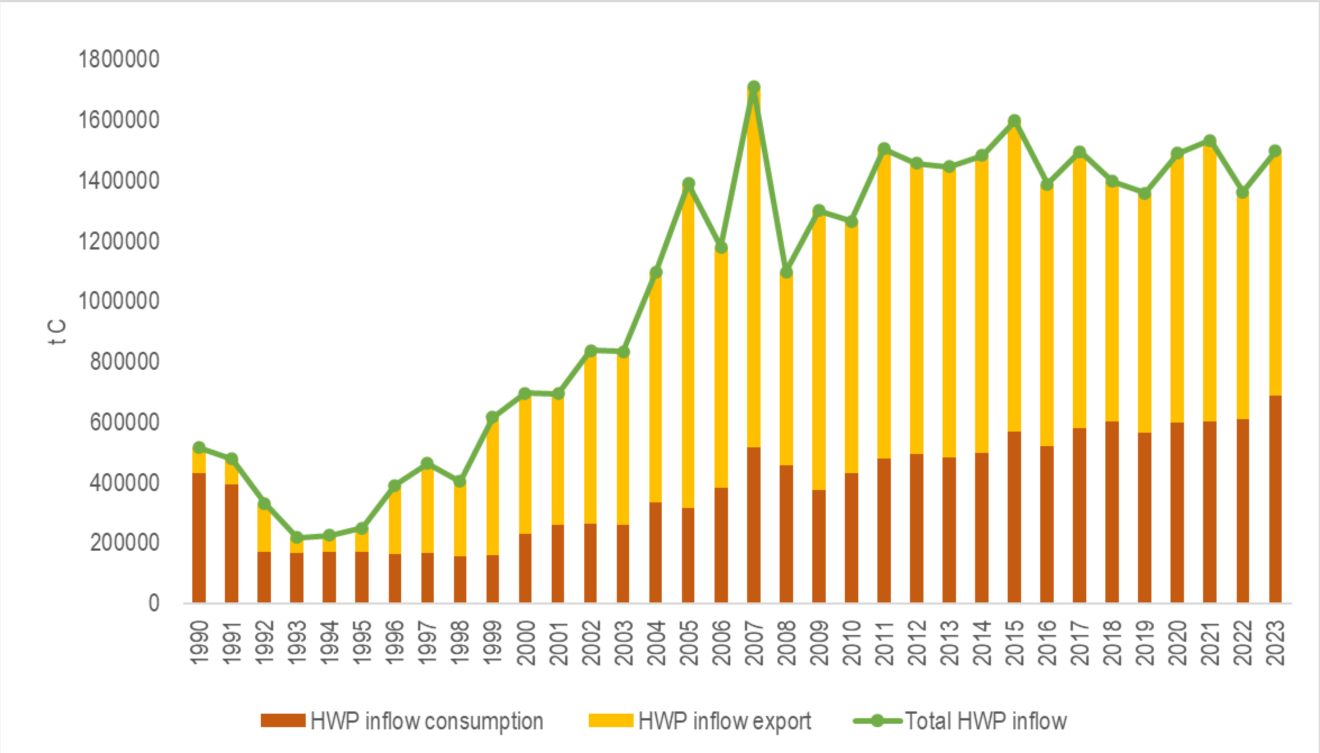


Figure 158 Annual HWP Inflow

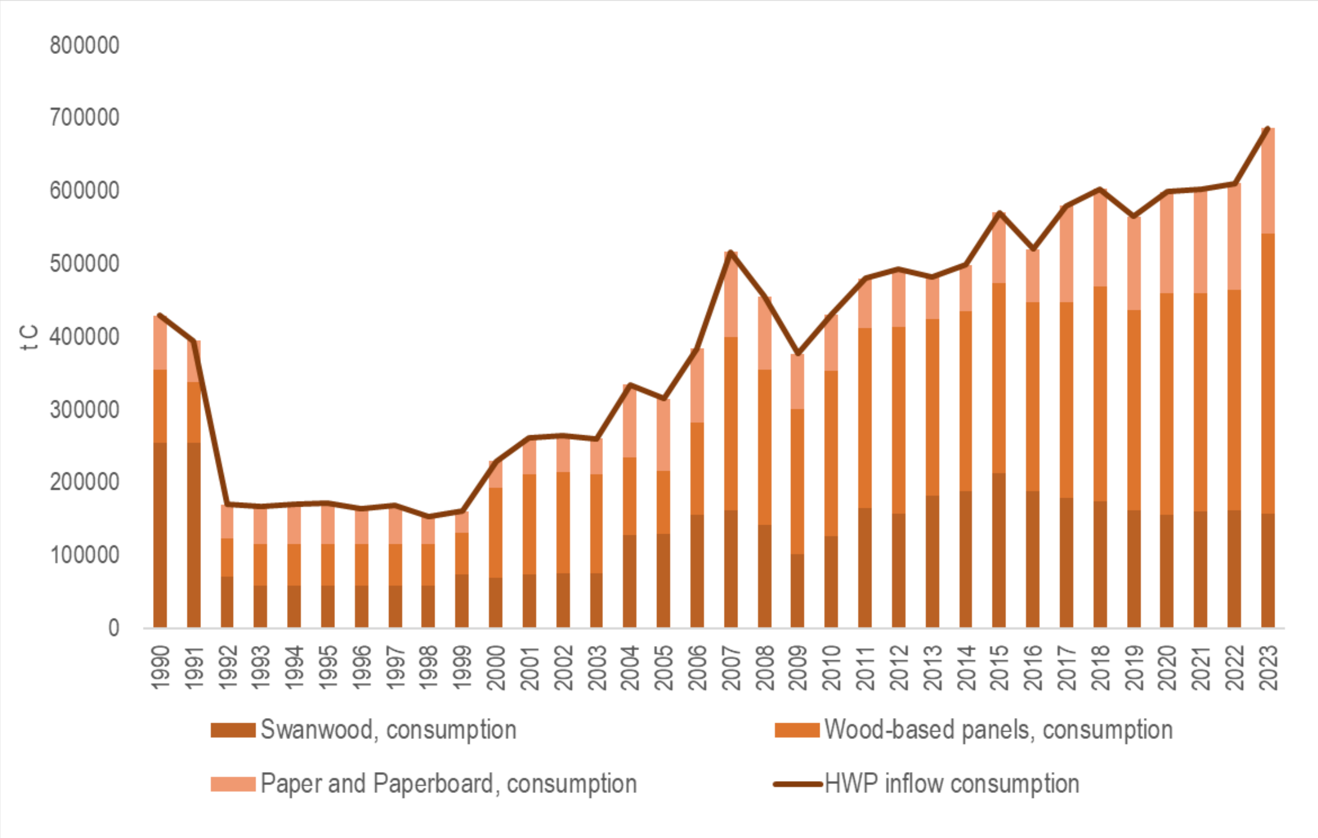


Figure 159 Annual Inflow of HWP in consumption by semi-finished products, Mt C

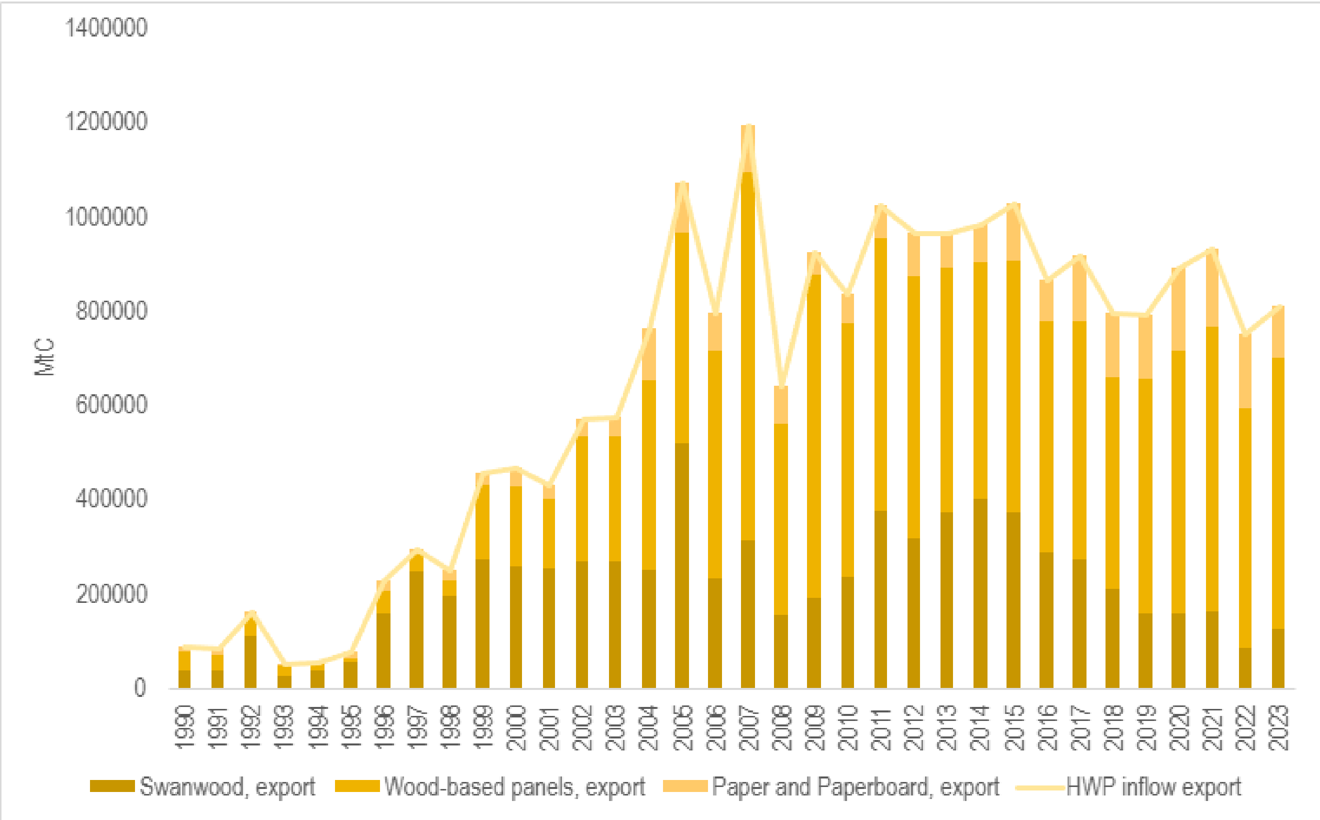


Figure 160 Annual Inflow of exported HWP by semi-finished products, Mt C

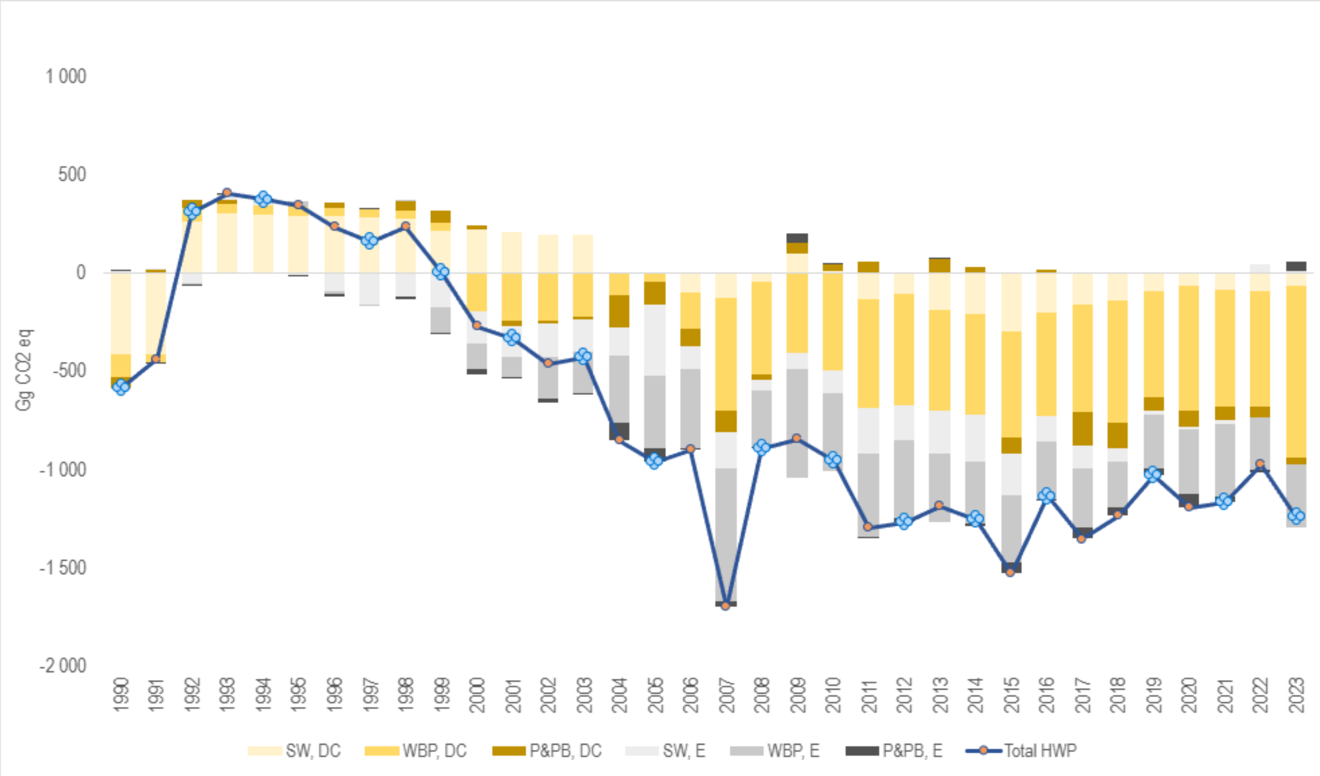


Figure 161 Emissions and removals from HWP, Gg CO_2 eq

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**%.

7 WASTE (CRT 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 CRT 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 211 and following figures.

Table 252 Trend in GHG emissions from Waste by sub-sectors for 1988-2023

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	71.46	NO	7.00539E-05	108.96	NO	0.0049	0.80	18.51
1990	74.98	NO	7.48604E-05	105.75	NO	0.0052	0.67	19.83
1995	88.36	NO	7.9019E-05	63.98	NO	0.0055	0.59	20.91
2000	98.23	NO	0.00023071	43.86	NO	0.0169	0.56	62.58
2005	102.59	NO	0.000205957	29.41	NO	0.0145	0.48	54.83
2010	105.78	NO	5.25229E-05	22.42	NO	0.0034	0.48	13.45
2011	106.50	0.33	3.87843E-05	21.50	0.02	0.0024	0.47	9.71
2012	104.61	0.37	7.68446E-05	20.48	0.02	0.0052	0.48	20.09
2013	102.46	0.43	0.000143959	24.49	0.03	0.0104	0.48	38.90
2014	98.66	0.24	4.30434E-05	25.30	0.01	0.0029	0.49	11.26
2015	97.12	1.25	3.88356E-05	22.97	0.07	0.0026	0.47	10.10
2016	94.60	1.06	4.66284E-05	23.28	0.06	0.0032	0.49	12.27
2017	90.80	0.96	5.57206E-05	18.70	0.06	0.0039	0.48	14.72
2018	87.88	0.23	2.6362E-05	17.93	0.01	0.0017	0.47	6.77
2019	85.03	0.18	4.73302E-05	16.02	0.01	0.0033	0.46	12.60
2020	82.29	0.22	0.000451603	15.89	0.01	0.0334	0.46	123.29
2021	79.85	0.28	2.96838E-05	17.67	0.02	0.0010	0.45	5.71
2022	77.23	0.30	1.80008E-05	17.55	0.02	0.0009	0.43	11.86
2023	75.04	0.32	0,00002616	16.70	0.02	0.0018	0.47	6.79

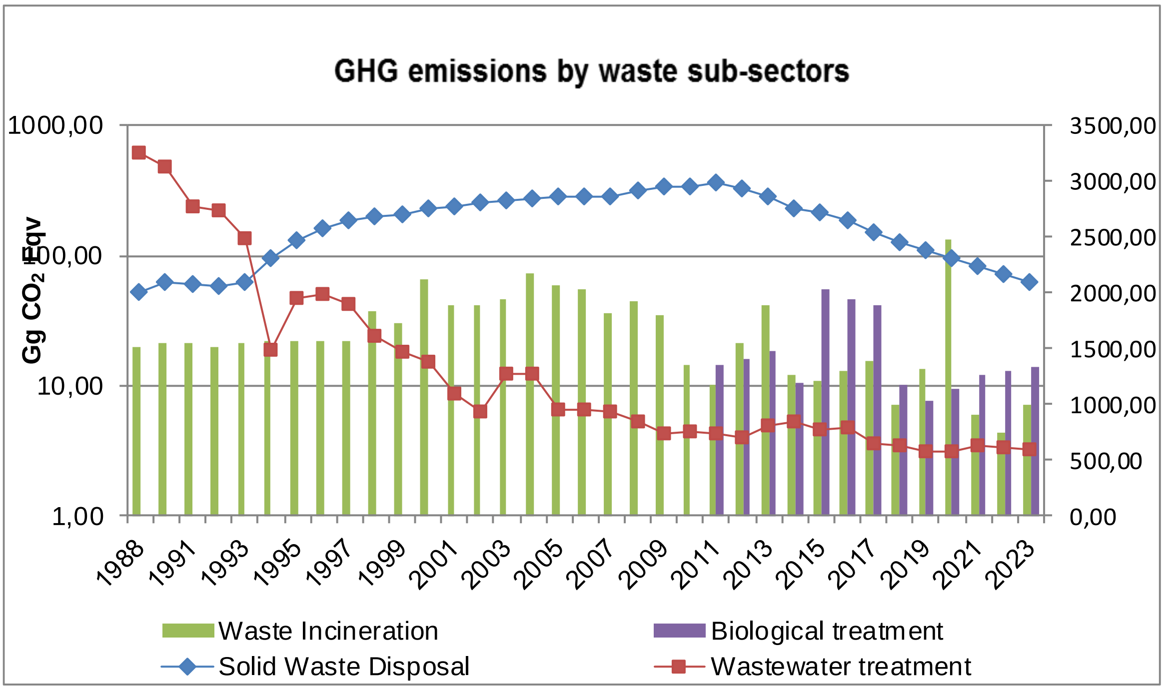


Figure 162 Emissions by waste sub-sectors

Emissions from the waste sector in 2023 decreased by 48.64% (2 714,19Gg CO_2-eq in 2023 compared to 5284.33Gg CO_2-eq in 1988) compared to the base year.
Figure below presents the total CO_2 eqv from the whole waste sector.

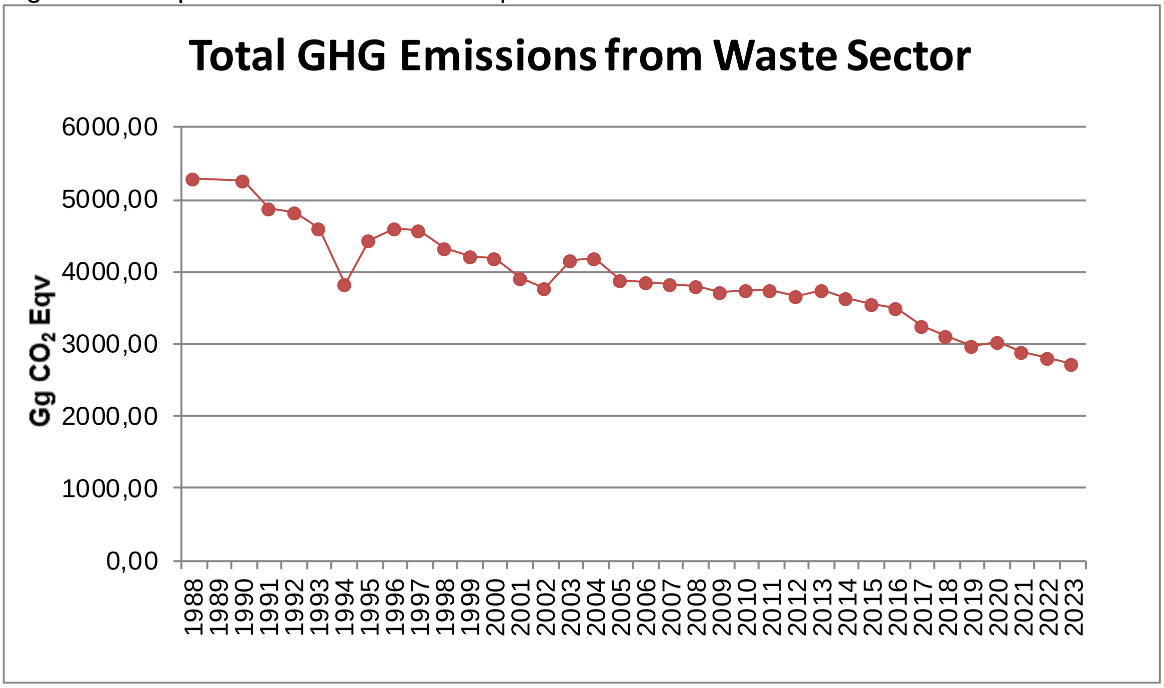


Figure 163 GHG emissions from Waste sector

7.1.2 KEY CATEGORIES

Table 212 describes the key categories of the waste sector and type of emitted greenhouse emissions.

Table 253 Key categories, Waste sector (Tier 1)

CRT 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 254 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 (CRT 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 (2014-2020)

Ordinance for the treatment of bio-waste and separate bio-waste collection (2017, last amendment 2021)

Third National Action Plan on Climate Change (2013-2020)

National Waste Management Plan (2021-2028)

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.

Under regulation 1 of 9 February 2015 on the requirements for activities involving the collection and treatment of waste on the premises of medical and health institutions, clinical waste is identified as hazardous and therefore incinerated - all clinical waste is considered hazardous waste by law and is therefore incinerated.

7.2.2 EMISSION TREND

Methane emissions are shown in the Table 211, Table 219 and Figure 108 CH4 Emissions from SWDS from managed and unmanaged sites.

Total CO_2 eq. from Solid waste disposal for 2023 are 2101,09Gg CO_2 eqv. In 2023 emissions decrease with 2,08% 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 77.01%% in 2009 to 43,91% in 2023). 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 2023 is 3138 kt which is in average 1.33 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 MemberStates 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 (the following figure).

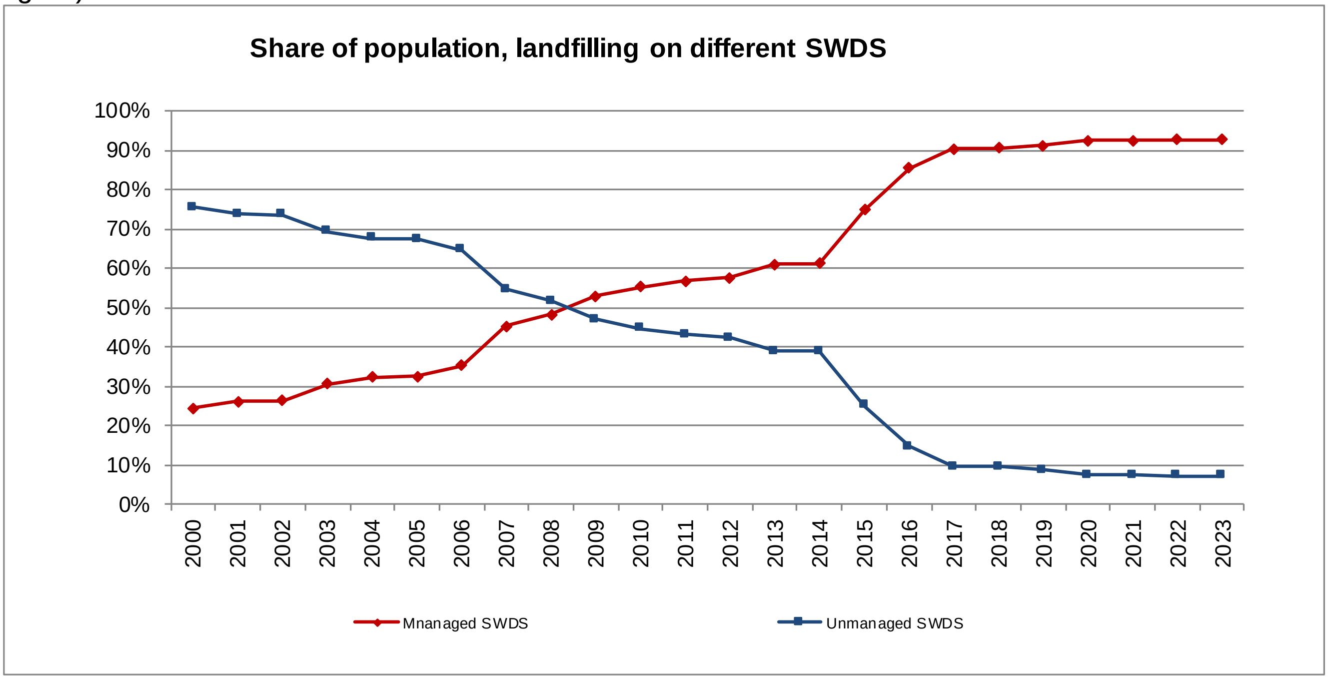


Figure 164 Share of population, landfilling on different SWDS

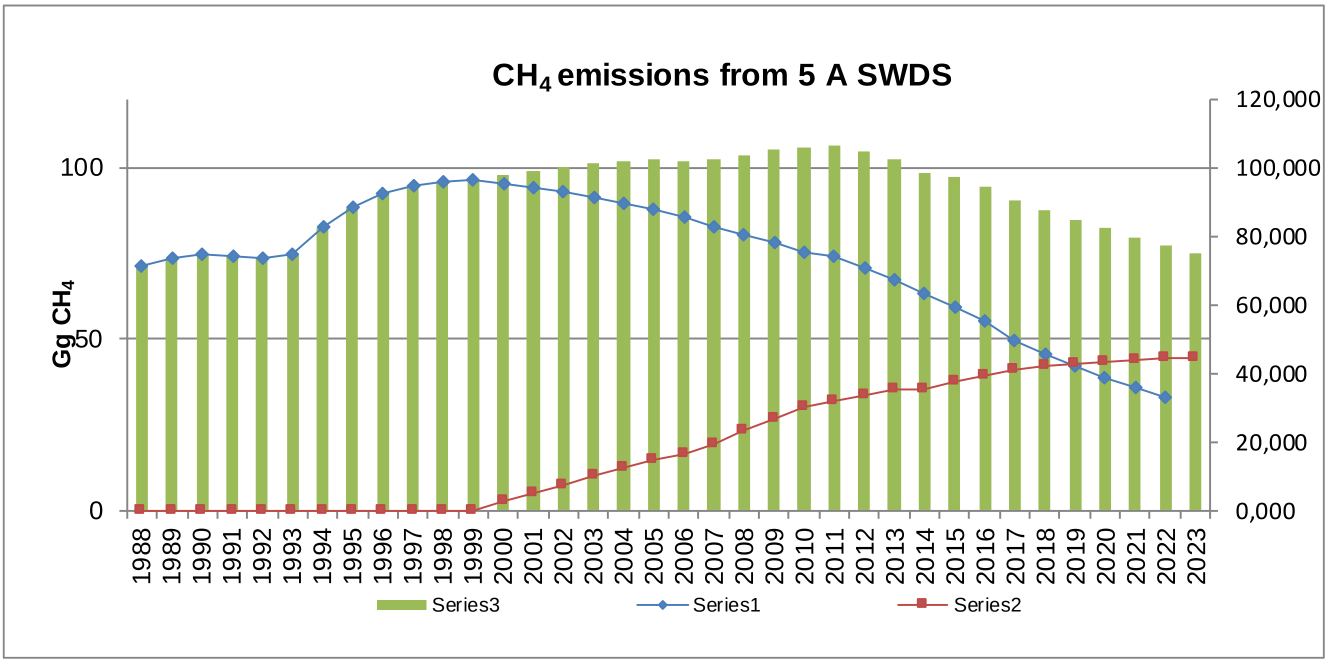


Figure 165 CH_4 Emissions from SWDS

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.
As there are not available good quality country-specific activity data on historical waste disposal and the SWD is a key category, the current waste disposal data were collected and the historical data were estimated trough a regression analysis.
The preparation of a new regression analysis was necessary due to the revision in time of part of the data on the generated, collected and disposed waste for the period 1995-2012, reported to EUROSTAT. The new regression model repeats the steps of the old one and the assessment was made for the same

period 1950-2008. The use of the same period is due to the fact that not very remote data (more than 20 years) from the transition of the country from centralized to market base economy are used.
For the regression model, natural / actual data on the generated and deposited waste in the country for the period 1979-2008 were used and natural /activity data on the collected waste for the period 1994-2008.
For the period 1950-1978 the generated waste is considered as a function of the total population of the country on the basis of the generated waste for the period 1979-2008.
The collected waste for the period 1950-1993 are considered as a function of the relative share of the collected to the generated waste and the relative share of the urban population to the total population of the country for the period 1994-2008.
The deposited waste for the period 1950-1978 are considered as a function of the relative share (%) of the deposited waste from the collected waste, as the latter are a function of the urban population.
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

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 22.53 Gg in 1988 (extrapolated value) decreasing to 2.14 Gg in 2023 (decrased by 90.52%). In current submission (2025) the amount of sludge have been extrapolated for the years from 1988 to 2003 (Table 214).
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).
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 255 Time series of sewage sludge production and landfilling

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996
Sewage sludge production Gg	47,48	46,32	45,80	45,41	44,83	44,69	44,52	44,30	44,07
Sewage sludge landfilled Gg	22,53	21,98	21,73	21,55	21,27	21,21	21,12	21,02	20,91

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sewage sludge production Gg	43,76	43,48	43,27	43,06	41,69	41,45	41,22	40,38	41,70
Sewage sludge landfilled Gg	20,76	20,63	20,53	20,43	19,78	19,67	19,55	17,90	23,40

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Sewage sludge production Gg	38,00	39,90	42,90	39,40	49,80	51,40	59,30	60,30	54,94
Sewage sludge landfilled Gg	16,40	20,80	17,80	11,10	13,97	7,05	6,64	10,49	8,47

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023
Sewage sludge production Gg	57,36	65,79	68,72	53,08	44,43	33,47	45,38	57,51	51,57
Sewage sludge landfilled Gg	8,54	6,18	6,91	3,74	1,88	1,60	1,58	1,45	2,14

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).The share industrial waste disposed in landfill is very small and it is moste composed of inert sybstances.

✓ 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. Hazardous 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 256 Represents the trend in AMSW, disposed of to landfills.

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023
Assimilated municipal solid waste disposed in landfills (Gg)	2196	1823	1716	1519	1464	1434	1458	1327	1378

The table below presents the summarized sources of initial activity data.

Table 257 Source of Activity data by year

Year	Parameters										
	generated waste	Source of information	waste generation rate	Source of information	land filling waste	Source of information	waste composition	Source of information	type of landfill		Source of information
									managed	unmanaged	
1950-1998	CS	NSI	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
2000-2002	CS	NSI	CS	NSI	CS	NSI	D	IPCC 2006	CS	CS	MOEW
2002-2023	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 1950-2023, 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 217 shows the morphological composition of the waste allocated according to distribution of population.

Table 258 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 2020 as a whole:

DOC = 12.51%

DOC was estimated by using country-specific data on waste composition and quantities based on compiled data from 2002 to 2023 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 1950-1988: Paper/paperboard-**21.80%**; Food waste-**31.10%**; Wood waste-**7.50%**; Textile-**4.70%**; Rubber/leather-**1.40%.** The default value for DOC**-0.18134,** is used for 1950-1988 for all waste composition.

Table 259 Components of waste composition 1989-2023

Year	Waste composition, %							Degradable waste, %	DOC
	Paper/ paperboard	Garden and park waste	Food waste	Wood waste	Textile	Rubber and leather	Sludge		
1989	12,94%	10,22%	18,05%	1,76%	3,58%	1,90%	0,78%	**49,22%**	**0,1267**
1990	12,94%	10,22%	18,05%	1,76%	3,58%	1,90%	0,82%	**49,26%**	**0,1269**
1995	12,94%	10,22%	18,05%	1,76%	3,58%	1,90%	0,47%	**48,91%**	**0,1252**
2000	12,94%	10,22%	18,05%	1,76%	3,58%	1,90%	0,63%	**49,07%**	**0,1260**
2001	12,94%	10,22%	18,05%	1,76%	3,58%	1,90%	0,62%	**49,07%**	**0,1259**
2002	12,94%	10,22%	18,05%	1,76%	3,58%	1,90%	0,62%	**49,06%**	**0,1259**
2003	12,95%	10,22%	18,05%	1,75%	3,58%	1,90%	0,62%	**49,07%**	**0,1229**
2004	12,96%	10,23%	18,07%	1,76%	3,58%	1,89%	0,58%	**49,08%**	**0,1259**
2005	13,00%	10,21%	18,11%	1,75%	3,58%	1,89%	0,75%	**49,29%**	**0,1268**
2006	13,04%	10,19%	18,18%	1,75%	3,58%	1,89%	0,60%	**49,23%**	**0,1263**
2007	13,04%	10,21%	18,17%	1,75%	3,58%	1,88%	0,70%	**49,35%**	**0,1268**
2008	13,05%	10,17%	18,21%	1,75%	3,58%	1,89%	0,53%	**49,19%**	**0,1260**
2009	13,03%	10,15%	18,23%	1,75%	3,58%	1,90%	0,33%	**48,97%**	**0,1249**
2010	13,08%	10,13%	18,28%	1,75%	3,58%	1,90%	0,46%	**49,17%**	**0,1258**
2011	13,26%	10,04%	18,55%	1,74%	3,57%	1,88%	0,28%	**49,32%**	**0,1257**
2012	13,30%	10,02%	18,60%	1,73%	3,57%	1,88%	0,29%	**49,39%**	**0,1259**
2013	13,34%	10,01%	18,64%	1,73%	3,57%	1,88%	0,49%	**49,64%**	**0,1271**
2014	13,30%	9,99%	18,61%	1,73%	3,56%	1,89%	0,53%	**43,63%**	**0,1271**
2015	13,31%	9,99%	18,60%	1,73%	3,56%	1,89%	0,39%	**49,47%**	**0,1264**
2016	13,35%	9,97%	18,66%	1,73%	3,56%	1,89%	0,34%	**49,49%**	**0,1264**
2017	13,38%	9,98%	18,69%	1,73%	3,56%	1,88%	0,40%	**49,61%**	**0,1268**
2018	13,42%	9,96%	18,75%	1,73%	3,56%	1,88%	0,25%	**49,54%**	**0,1262**
2019	13,42%	9,98%	18,74%	1,73%	3,56%	1,87%	0,13%	**49,43%**	**0,1257**
2020	13,22%	10,07%	18,47%	1,74%	3,57%	1,89%	0,11%	**49,06%**	**0,1247**
2021	13,26%	10,05%	18,52%	1,74%	3,57%	1,88%	0,11%	**49,13%**	**0,1248**

2022	13,26%	10,03%	18,54%	1,73%	3,57%	1,89%	0,11%	**49,12%**	**0,1248**
2023	13,27%	10,03%	18,54%	1,73%	3,57%	1,89%	0,16%	**49,18%**	**0,1251**

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 2023 inventory year the values are:

$$\mathbf{Lo}_{\text{managed landfills}} = 0{,}041697514 \text{Gg } CH_4$$

$$\mathbf{Lo}_{\text{unmanaged landfills}} = 0{,}033358 \text{Gg } CH_4$$

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 2011 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.
The resulting emissions for the period 2011-2022 (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 219.
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). In 2023, the only installation for the recovery of methane from landfills in Sofia ceased operations.

Oxidation factor (OX). Country uses OX=0.1 for managed and OX=0 for unmanaged landfills.

Table 260 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	8986.64	2.36	0.355	0.1269	0.01	0.5	0.090	38	71.464	NO
1989	8767.30	2.63	0.339	0.1267	0.01	0.5	0.090	39	73.575	NO
1990	8669.27	2.53	0.334	0.1269	0.01	0.5	0.090	40	74.983	NO
1991	8595.47	2.71	0.240	0.1281	0.01	0.5	0.090	41	74.441	NO
1992	8484.86	2.60	0.246	0.1282	0.01	0.5	0.090	42	73.780	NO
1993	8459.76	2.38	0.340	0.1271	0.01	0.5	0.090	43	74.661	NO
1994	8427.42	2.21	0.725	0.1250	0.01	0.5	0.090	44	82.544	NO
1995	8384.72	1.90	0.765	0.1252	0.01	0.5	0.090	45	88.358	NO
1996	8340.94	1.69	0.774	0.1254	0.01	0.5	0.090	46	92.309	NO
1997	8283.20	1.59	0.752	0.1257	0.01	0.5	0.090	47	94.815	NO
1998	8230.37	1.62	0.649	0.1261	0.01	0.5	0.090	48	95.813	NO
1999	8190.88	1.64	0.651	0.1261	0.01	0.5	0.090	49	96.812	NO
2000	8149.47	1.68	0.654	0.1260	0.01	0.5	0.090	50	98.230	NO
2001	7891.10	1.65	0.670	0.1259	0.01	0.5	0.090	51	99.326	NO
2002	7845.84	1.64	0.676	0.1259	0.01	0.5	0.090	52	100.264	NO
2003	7801.27	1.64	0.681	0.1229	0.01	0.5	0.090	53	101.219	NO
2004	7761.05	1.63	0.669	0.1259	0.01	0.5	0.090	54	101.829	NO
2005	7718.75	1.60	0.698	0.1268	0.01	0.5	0.090	55	102.590	NO
2006	7679.29	1.57	0.627	0.1263	0.01	0.5	0.090	56	102.088	NO
2007	7640.24	1.50	0.714	0.1268	0.01	0.5	0.090	57	102.469	NO
2008	7606.55	1.62	0.749	0.1260	0.01	0.5	0.090	58	103.951	NO
2009	7563.71	1.61	0.770	0.1249	0.01	0.5	0.090	59	105.465	NO
2010	7504.87	1.48	0.748	0.1258	0.01	0.5	0.090	60	105.777	NO
2011	7327.22	1.34	0.719	0.1257	0.01	0.5	0.090	61	106.504	0.239
2012	7284.55	1.22	0.715	0.1259	0.01	0.5	0.090	62	104.607	0.138
2013	7245.68	1.19	0.693	0.1271	0.01	0.5	0.090	63	102.458	0.084
2014	7202.20	1.21	0.501	0.1271	0.01	0.5	0.090	64	98.661	0.079
2015	7153.78	1.15	0.729	0.1264	0.01	0.5	0.090	65	97.115	0.097
2016	7101.86	1.11	0.633	0.1264	0.01	0.5	0.090	66	94.604	0.092
2017	7050.03	1.19	0.557	0.1268	0.01	0.5	0.090	67	90.803	0.070
2018	7000.04	1.12	0.531	0.1262	0.01	0.5	0.090	68	87.882	0.070
2019	6951.48	1.12	0.516	0.1257	0.01	0.5	0.090	69	85.028	0.059
2020	6916.55	1.12	0.507	0.1247	0.01	0.5	0.090	70	82.287	0.053
2021	6838.94	1.12	0.477	0.1248	0.01	0.5	0.090	71	79.851	0.066
2022	6447.71	1.34	0.420	0.1248	0.01	0.5	0.090	72	77.225	0.055
2023	6445.48	1.33	0.439	0.1251	0.01	0.05	0.090	73	75.04	NO

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 261 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

There is no source-specific recalculations.

7.2.7 SOURCE-SPECIFIC IMPROVEMENT PLAN

There is no plan improvement.

7.3 BIOLOGICAL TREATMENT OF WASTE (CRT 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) and Anaerobic Digestion at Biogas Facilities. Calculation of the emissions depends on the quality of collected data, amount and type of solid waste, treated biologically and Anaerobic digested at biogas facilities 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.

During the UNFCCC Centralized review of the 2022 submission of Bulgaria, ERT noted that Bulgaria reported CH4 emissions from category 5.B.2 anaerobic digestion at biogas facilities as not estimated (NE) emissions in 2014-2020. Bulgaria has provided an excel spreadsheet containing activity data for anaerobic digestion at biogas facilities for the period of 2014-2020 and CH4 emissions calculations for this category using Tier 1 method from the 2006 IPCC Guidelines (vol. 5; chap. 4.1.3.1, table 4.1, p.4.6). The source of activity data is the annual report according to IPPC pertmits of Installation for biological treatment at the site "Khan Bogrov“

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.

Table 262 Default emission factors for CH4 and N2O 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)

Table 263 Default emission factors for CH4 and N2O emissions from anaerobic digestion at biogas facilities

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
Anaerobic digestion at biogas facilities	2 (0-20)	1 (0-8)	assumed negligible	assumed negligible

7.3.1.2 Activity data

The source of activity data is National statiscal institute and Executive environment agency.
The emissions from composting and anaerobic digestion at biogas facilities are given in the tables below.

Table 264 CH_4 and N_2O emissions from composting

Year	Total annual amount (dry matter) treated by composing (Gg)	CH_4 emissions (kt)	N_2O emissions (kt)
2011	33.474	0.335	0.020
2012	36.800	0.368	0.022
2013	42.597	0.426	0.026
2014	23.451	0.235	0.014
2015	124.400	1.244	0.075
2016	105.200	1.052	0.063
2017	95.200	0.952	0.057
2018	22.780	0.228	0.014
2019	17.326	0.173	0.010
2020	21.014	0.210	0.013
2021	27.111	0.271	0.016
2022	29.803	0.298	0.018
2023	31.682	0.317	0.019

Table 265 CH_4 emissions from anaerobic digestion at biogas facilities

Year	Total annual amount (dry matter) treated at biological treatment facilities (Gg)	CH_4 emissions (kt)	N_2O emissions (kt)
2014	1.999	0.004	NE
2015	2.937	0.006	NE
2016	3.624	0.007	NE
2017	3.423	0.007	NE
2018	1.316	0.003	NE
2019	3.686	0.007	NE
2020	3.541	0.007	NE
2021	2.020	0.004	NE
2022	2.992	0.006	NE
2023	2.506	0.005	NE

During the 2020 review TERT noted that there is an important reduction of the amount of waste composted between 2017 and 2018. The reduction was in accordance with the implementation of an ordinance for the separate collection of biowaste and treatment of biodegradable waste, which introduced more stringent requirements for the fraction of separated waste to be composted.

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.

Default emission factors (on a dry weight basis) are used for emission estimation of CH4 from anaerobic digestion at biogas facilities. 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. EF used for N_2O is 30% and for CH_4 - 400%.

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

There is no source-specific recalculations

7.3.5 SOURCE-SPECIFIC IMPROVEMENT PLAN

There are no planed source specific improvements.

7.4 WASTE INCINERATION (CRT CATEGORY 5C)

7.4.1 OVERVIEW OF THE SECTOR

Emissions from waste incineration without energy recovery are reported in Waste sector, while emissions from incineration with energy recovery are reported in 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 is applied TIER 1 method. This report includes emissions from incinerated in the country clinical and hazardous waste.

7.4.1.1 Emission trend

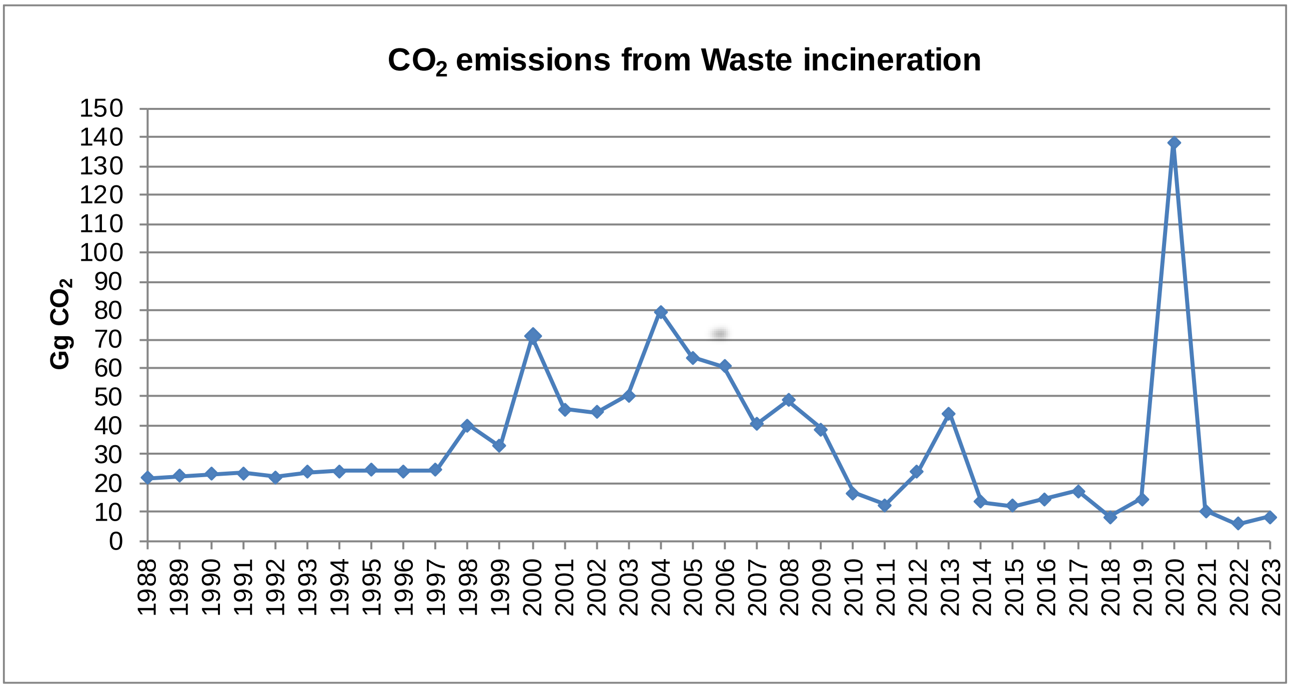


Figure 166 CO_2 Eqv emissions from Waste incineration

Table 266 CO_2, CH_4 and N_2O emissions from incineration of clinical and hazardous waste

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	0.859	5.854E-06	4.878E-05	10.70	17.66	0.0000642	0.005
1990	0.977	0.860	5.86E-06	4.884E-05	11.50	18.98	0.0000690	0.005
1995	1.070	0.941	6.419E-06	5.349E-05	12.10	19.97	0.0000726	0.005
2000	1.124	0.989	6.742E-06	5.618E-05	37.33	61.59	0.000224	0.017
2005	2.353	2.071	1.412E-05	0.0001177	31.97	52.76	0.0001918	0.014
2006	2.579	2.269	1.547E-05	0.0001289	29.88	49.30	0.0001793	0.013
2007	2.035	1.791	1.221E-05	0.0001018	19.66	32.43	0.0001179	0.009
2008	1.440	1.267	8.64E-06	7.2E-05	24.93	41.13	0.0001496	0.011
2009	1.301	1.145	7.805E-06	6.504E-05	19.48	32.13	0.0001169	0.009
2010	1.285	1.131	7.71E-06	6.425E-05	7.47	12.32	4.481E-05	0.003
2011	1.244	1.095	7.466E-06	6.222E-05	5.22	8.61	3.132E-05	0.002
2012	1.355	1.193	8.133E-06	6.777E-05	11.45	18.90	6.871E-05	0.005
2013	0.892	0.785	5.353E-06	4.461E-05	23.10	38.12	0.0001386	0.010
2014	0.744	0.655	4.466E-06	3.722E-05	6.43	10.61	3.858E-05	0.003
2015	0.751	0.661	4.504E-06	3.753E-05	5.72	9.44	3.433E-05	0.003
2016	0.715	0.629	4.29E-06	3.575E-05	7.06	11.64	4.234E-05	0.003
2017	0.788	0.693	4.728E-06	3.94E-05	8.50	14.02	5.099E-05	0.004
2018	0.626	0.551	3.757E-06	3.131E-05	3.77	6.22	2.261E-05	0.002
2019	0.542	0.477	3.254E-06	2.711E-05	7.35	12.12	4.408E-05	0.003
2020	1.171	1.030	2.810E-06	2.342E-05	74.10	122.26	4.446E-05	0.030
2021	3.181	2.800	7.635E-06	6.363E-05	1.77	2.91	1.060E-06	0.001
2022	1.005	0.884	2.41E-06	2.01E-05	2.00	3.29	1.1972E-06	0.001
2023	0.524	0.461	1.25778E-06	1,04815E-05	3.84	6.33	2,301E-06	0,002

Reduced incineration of hazardous waste in the installation of LukOil 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 LukOil 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 2010/75/EU 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. Now all clinical waste are considered hazardous waste by law and therefore are incinerated.

7.4.2 INCINERATION OF CLINICAL WASTE (CRT 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.

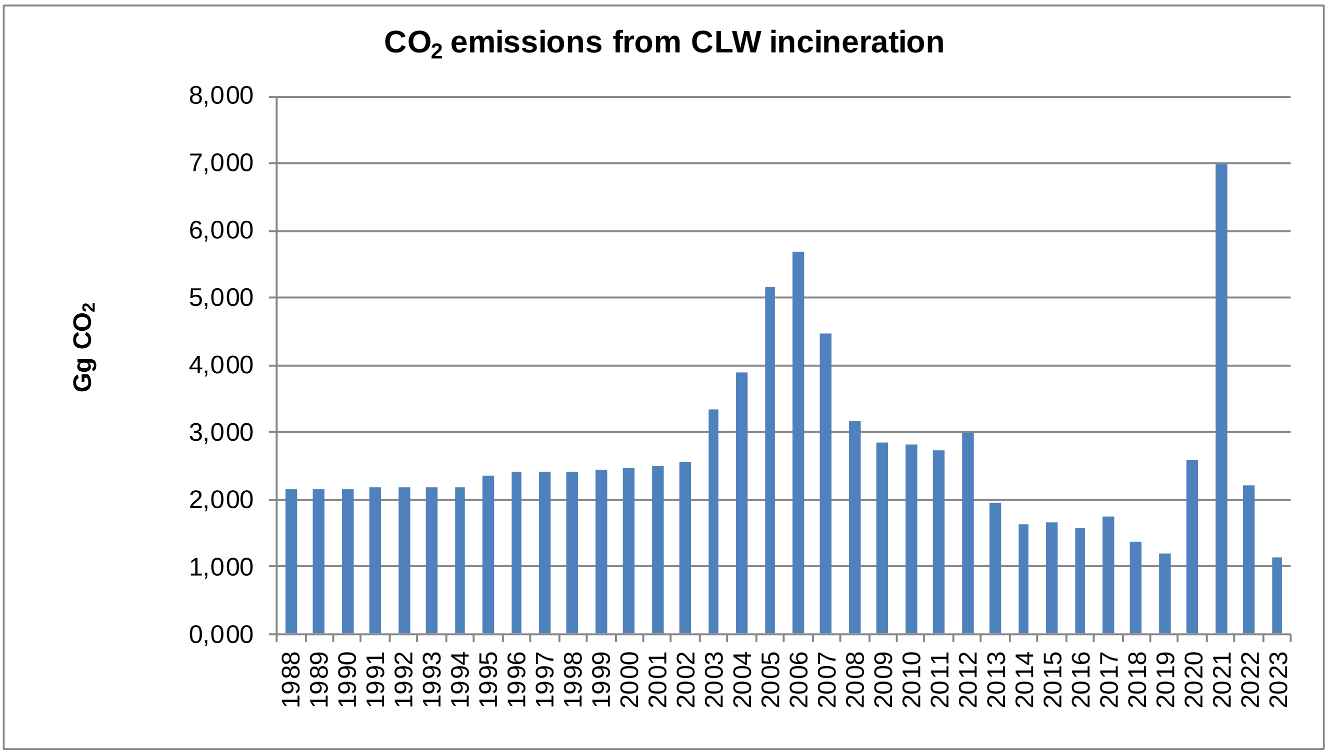


Figure 167 CO_2 emissions from clinical waste incineration

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)

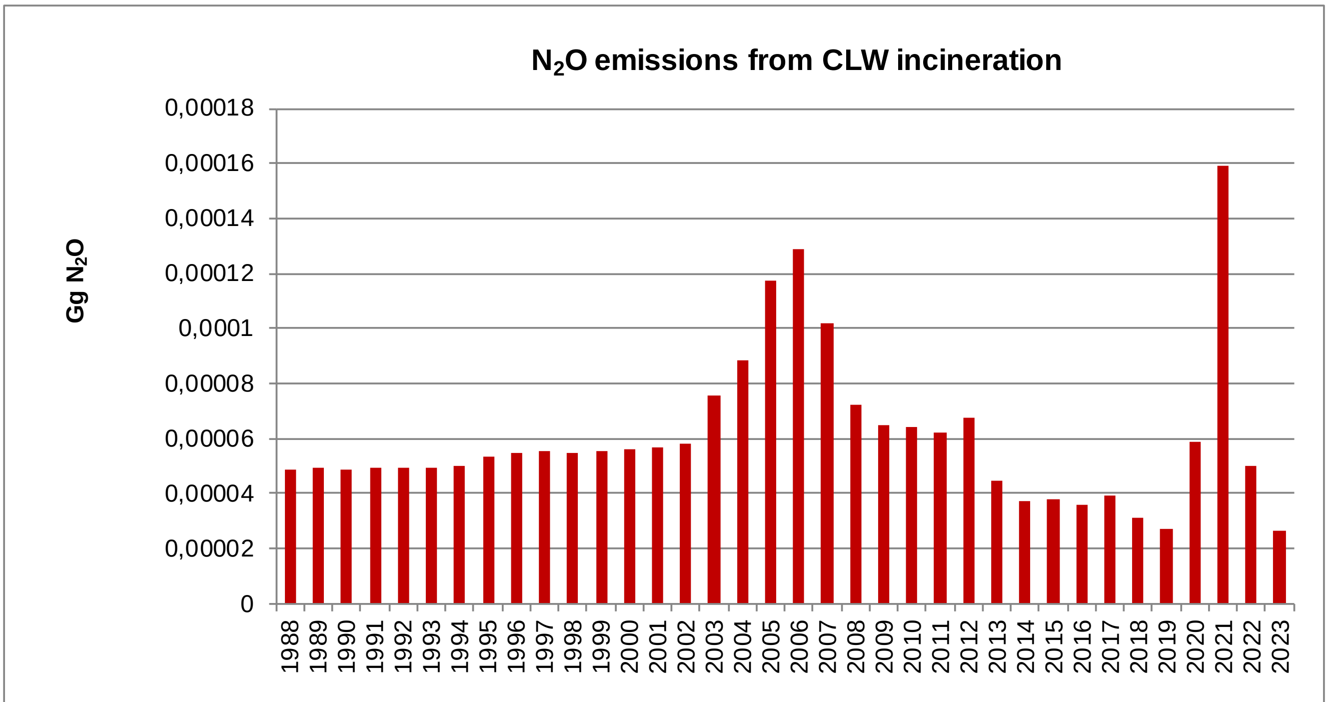


Figure 168 N2O emissions from clinical waste incineration

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)

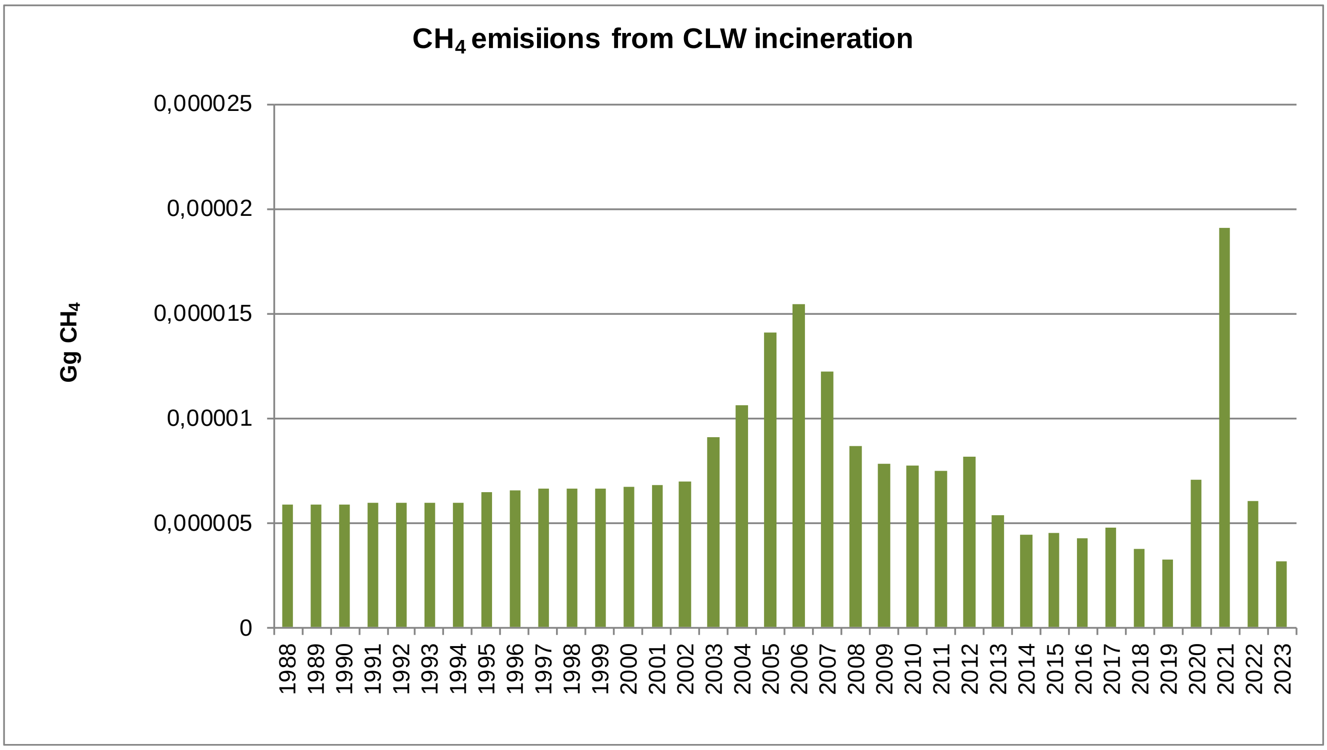


Figure 169 CH4 emissions from clinical waste incineration

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. If site-specific emissions factors are not available, default factors can be used.

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)

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)

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 (CRT CATEGORY 5C)

7.4.5.1 Category description

In the installation of LukOil 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.

In 2020 CO2 emissions from 5C1 "Waste incineration and open burning of waste" increase due to burning 74 096,22 t dry substance of waste with code 190811*(sludge containing hazardous substances from biological treatment of industrial wastewater) from Lukoil Neftohim Burgas at an industrial unit for incineration of oil and biological sludge and solid technological waste.

This was reported by Lukoil Neftohim Burgas in an Annual report on the implementation of the activities for which it has a Complex Permit for 2020.

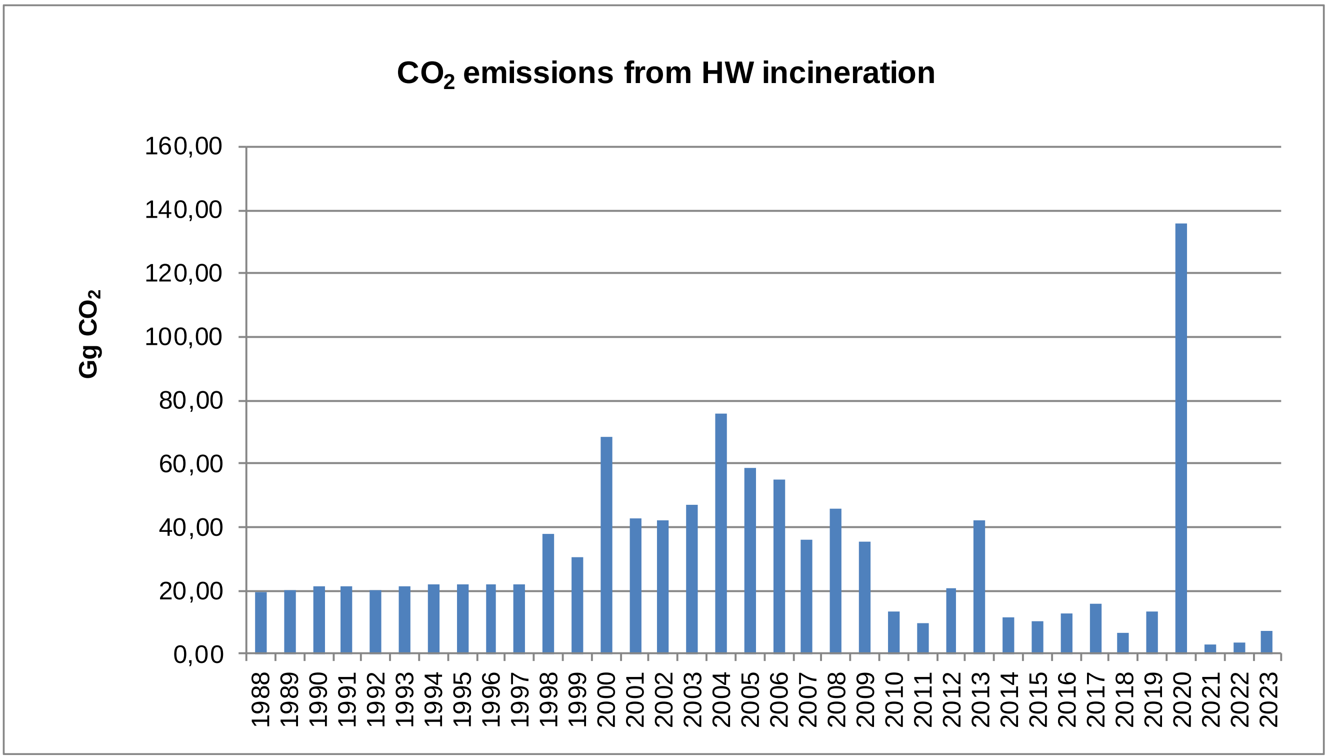


Figure 170 CO_2 emissions from hazardous waste incineration

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)

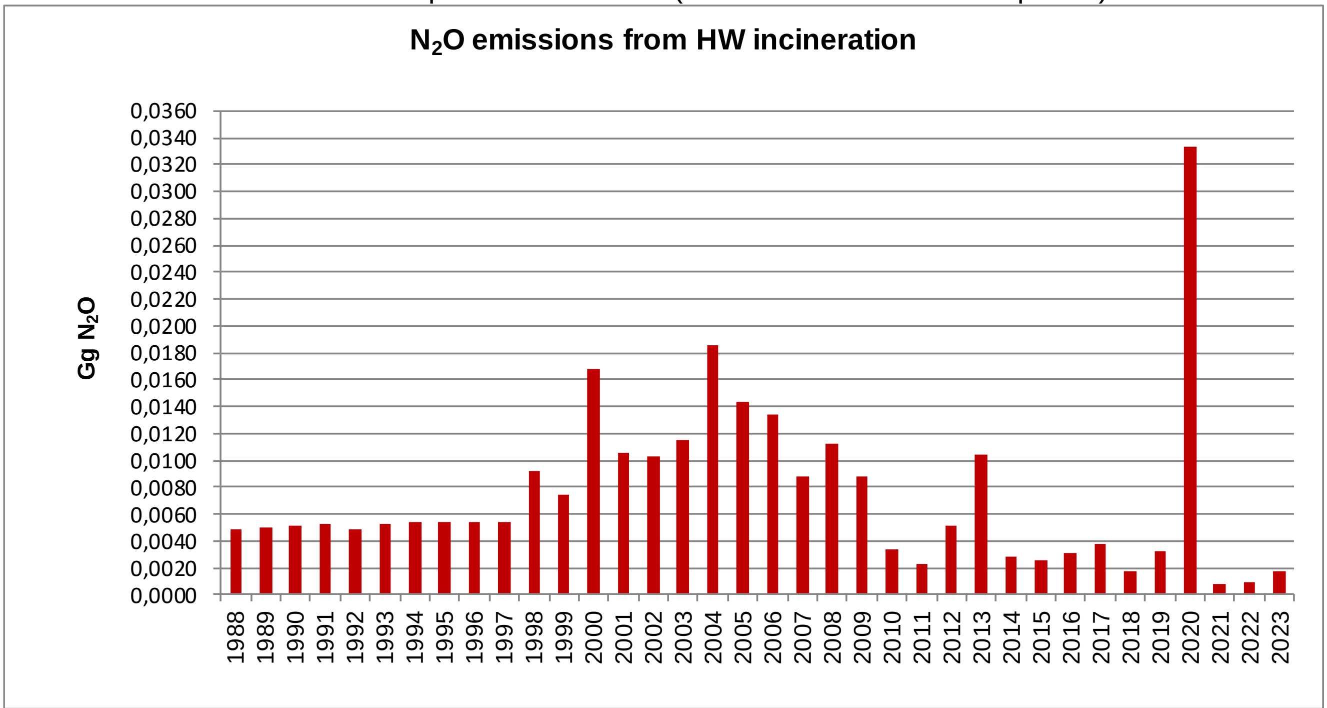


Figure 171 N2O emissions from hazardous waste incineration

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).

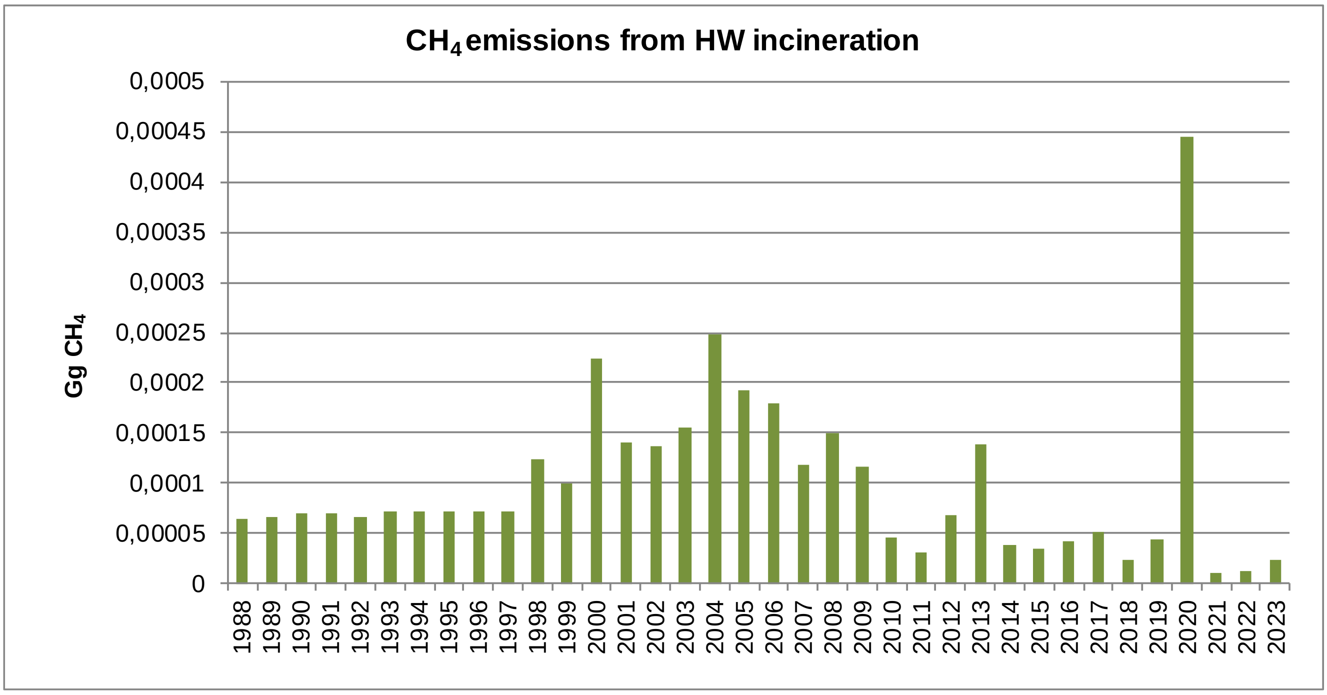


Figure 172 CH_4 emissions from hazardous waste incineration

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.

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)

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

There is no source-specific recalculations for this subsector.

7.4.10 SOURCE-SPECIFIC IMPROVEMENT PLAN

Improvements are not planned.

7.5 WASTEWATER HANDLING (CRT 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 1988-2023. 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 2023 are 591,80Gg CO_2 eq. In 2023 emissions decrease with 3.88% in comparison with 2022.

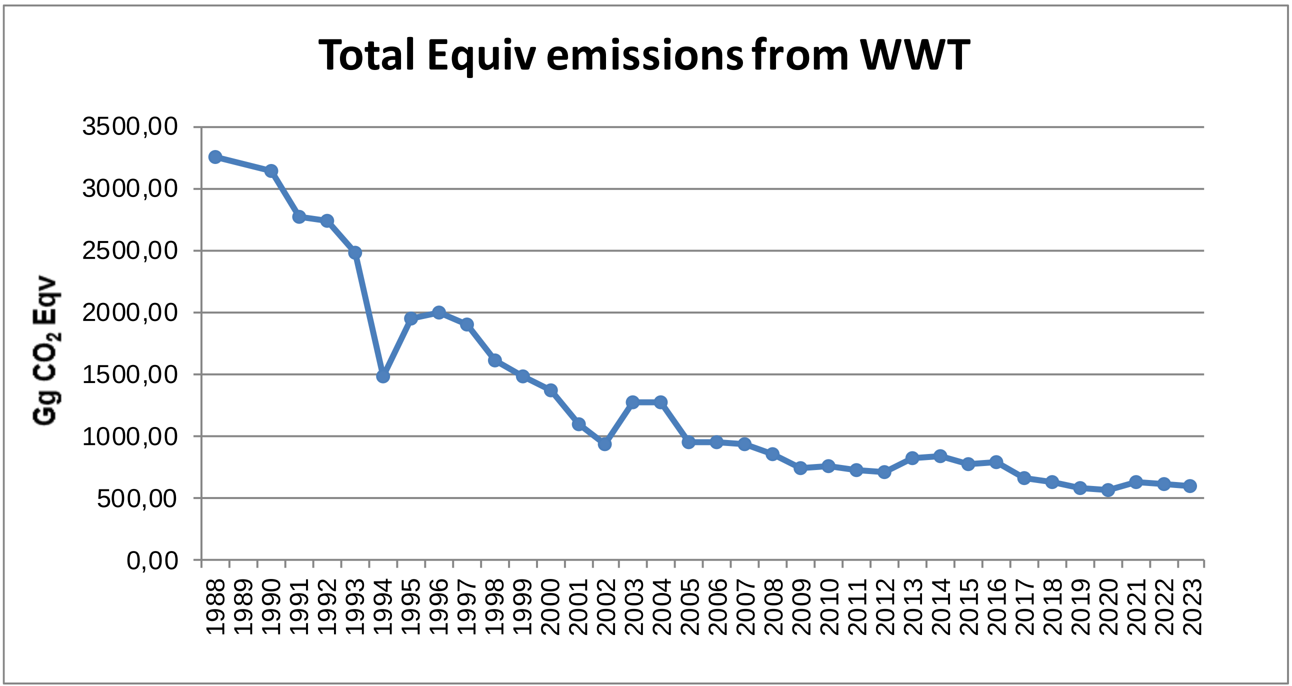


Figure 173 CO_2 eqv emissions from Wastewater treatment

TIER 2 is applied in the calculation of the CH4 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.

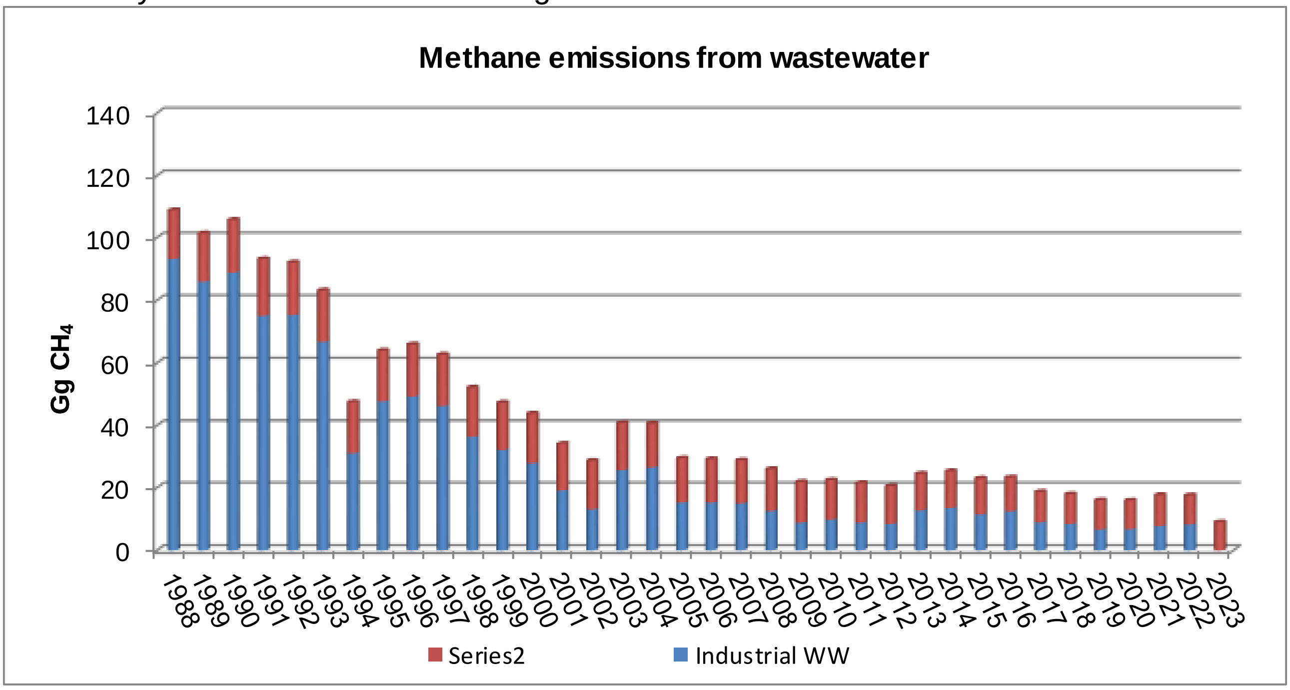


Figure 174 CH4 emissions from wastewater handling

7.5.3 DOMESTIC WASTEWATER HANDLING (CRT 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, 73.52% of the population is classified as urban income group and 26.48 % - as rural income group (NSI data). Degree of utilization (T) of treatment and discharge pathways for each income group are shown in Table 228.
Total methane emissions from domestic wastewater treatment for 2023 are 8,99 Gg. Significant contribution to these emissions have septic systems – 4.64 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 267 Total organically degradable material (TOW) in domestic wastewater

Year	Total organic product	Year	Total organic product	Year	Total organic product
	kg BOD/year		kg BOD/year		kg BOD/year
1988	246009161	**2000**	223091687	**2012**	199414611
1989	240005057	**2001**	216018726	**2013**	198350408
1990	237321239	**2002**	214779897	**2014**	197160170
1991	235300854	**2003**	213559848	**2015**	195834837
1992	232273125	**2004**	212458716	**2016**	194413390
1993	231586012	**2005**	211300781	**2017**	192994681
1994	230700568	**2006**	210220564	**2018**	191626068
1995	229531573	**2007**	209151515	**2019**	190296820
1996	228333123	**2008**	208229334	**2020**	189340502
1997	226752600	**2009**	207056561	**2022**	176506061
1998	225306406	**2010**	205445762	**2021**	187215900
1999	224225231	**2011**	200582757	**2023**	176445042

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 = 0.03
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 268 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**	**0.03**	**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%
2009	41.41%	40.28%	14.10%	4.21%

	Discharged into sea. river. lake	Centralized. aerobic not well managed treatment plant	Septic systems	Latrines
2010	41.20%	41.55%	13.50%	3.75%
2011	39.01%	42.76%	14.49%	3.74%
2012	35.57%	47.22%	13.90%	3.31%
2013	37.49%	46.42%	11.19%	2.90%
2014	35.58%	48.07%	13.61%	2.74%
2015	34.65%	49.46%	13.43%	2.47%
2016	30.24%	54.97%	12.68%	2.11%
2017	32.11%	56.13%	10.22%	1.53%
2018	32.33%	56.59%	9.77%	1.31%
2019	31.79%	57.36%	9.70%	1.14%
2020	32.24%	57.60%	9.22%	0.94%
2021	30.70%	56.75%	11.54%	1,01%
2022	31.38%	56.47%	11.33%	0.83%
2023	28.15%	60.23%	10.97%	0.65%

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 1988-2022 are shown in figure below

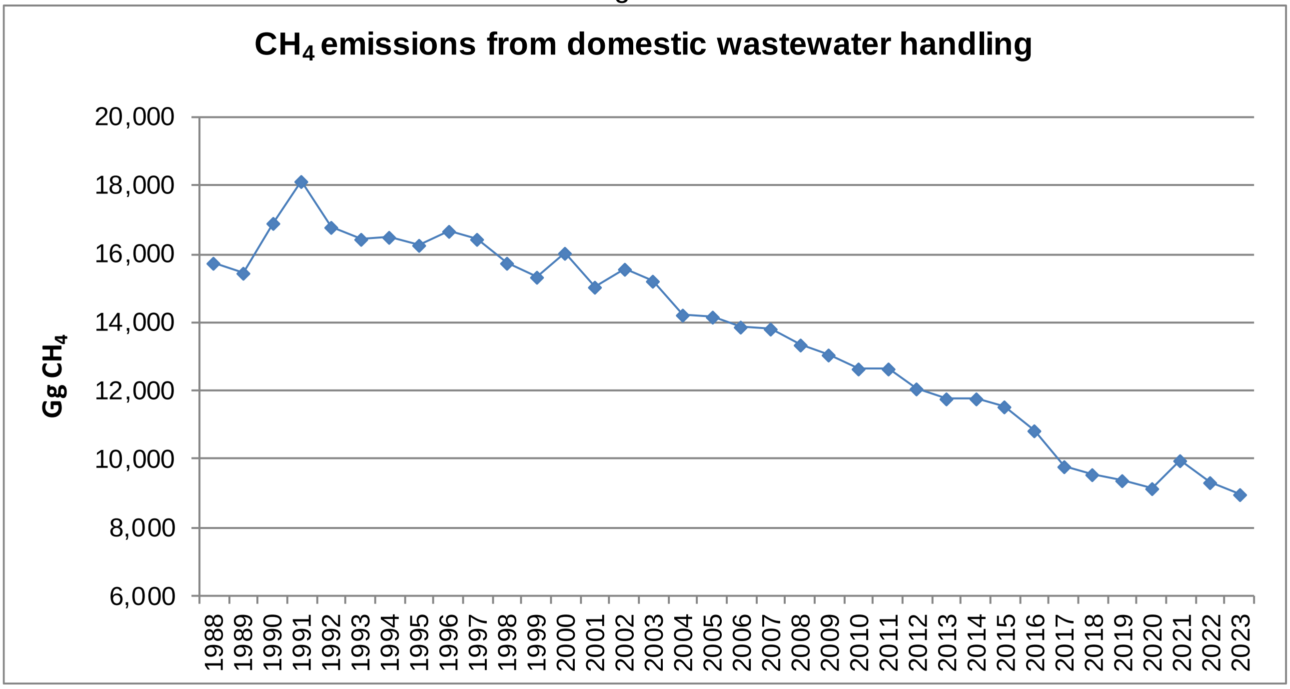


Figure 175 CH4 emissions from domestic wastewater handling

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 269 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 = 0.03

The methodology applies the MCF value (0.03) for centralized wastewater treatment plants (WWTP) from the 2019 IPCC Refinement (Table 6.3 updated) across the time series, replacing Bulgaria's previous methodology that adopted the 2006 IPCC default MCF for WWTP that are poorly managed / overloaded (0.3). This change was made to better account for information on implementation of the Urban Waste Water Directive (UWWTD) showing that the majority of WWTP in Bulgaria are in compliance with the legislation on remaining BOD in effluent and can therefore be considered as well managed / not overloaded.

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 because of climate conditions in Bulgaria and the average number of persons per family (which is three, according to the National Statistical Institute). Therefore, it used a methane correction factor value of 0.1 for dry climates and small families (3–5 persons) and BOD value of 60 g/person/day in accordance with the 2006 IPCC Guidelines (vol. 5, chap. 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 2023 the quantity of recovered methane is 1.18 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.

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).. 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 2023 the quantity of sludge, used in agriculture is 21.55 kt.

7.5.3.4 Methodology for calculation of the methane emissions of industrial wastewater handling (CRT 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 270 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%
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	151 742	69 720	45.95%	82 022	54.05%
2012	132 543	69 526	52.46 %	63 017	47.54%
2013	129 229	74 043	57.30 %	55 186	42.70 %
2014	126 183	74 743	59.23%	51 440	40.77%
2015	110 518	65 976	59.70%	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%
2020	92 637	54 031	58.33%	38 606	41.67%
2021	95 650	59 789	62.51%	35 861	37.49%
2022	100 758	61 208	60.75%	39 550	39.25%
2023	95 088	59 975	63.07%	35 113	36.93%

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 1988-2023 are shown in figure below.

Figure 176 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.

Table 271 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
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	223990129	0.04	8.86
2012	226922449	0.04	8.41
2013	266197205	0.05	12.71
2014	278433815	0.05	13.52
2015	236732556	0.05	11.42
2016	286189751	0.04	12.42
2017	241114483	0.04	8.90
2018	211831635	0.04	8.39
2019	175876911	0.04	6.62
2020	159370144	0.04	6.73
2021	175726890	0.04	7.72
2022	187038130	0.04	8.23
2023	172589680	0.04	7.71

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.

Quantity of wastewater

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 272 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%
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	58.32%	39.66%	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%
2020	53.05%	46.23%	0.71%
2021	50.07%	49.47%	0.47%
2022	49.87%	49.75%	0.38%
2023	48.85%	50.77%	0.37%

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 273 Uncertainty of sub-sector Wastewater handling

CRT 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

There is recalculation for 2022 due to new activity data provided by National statistical institute.

7.5.7 SOURCE-SPECIFIC IMPROVEMENT PLAN

There is no planed of 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 TIER 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.

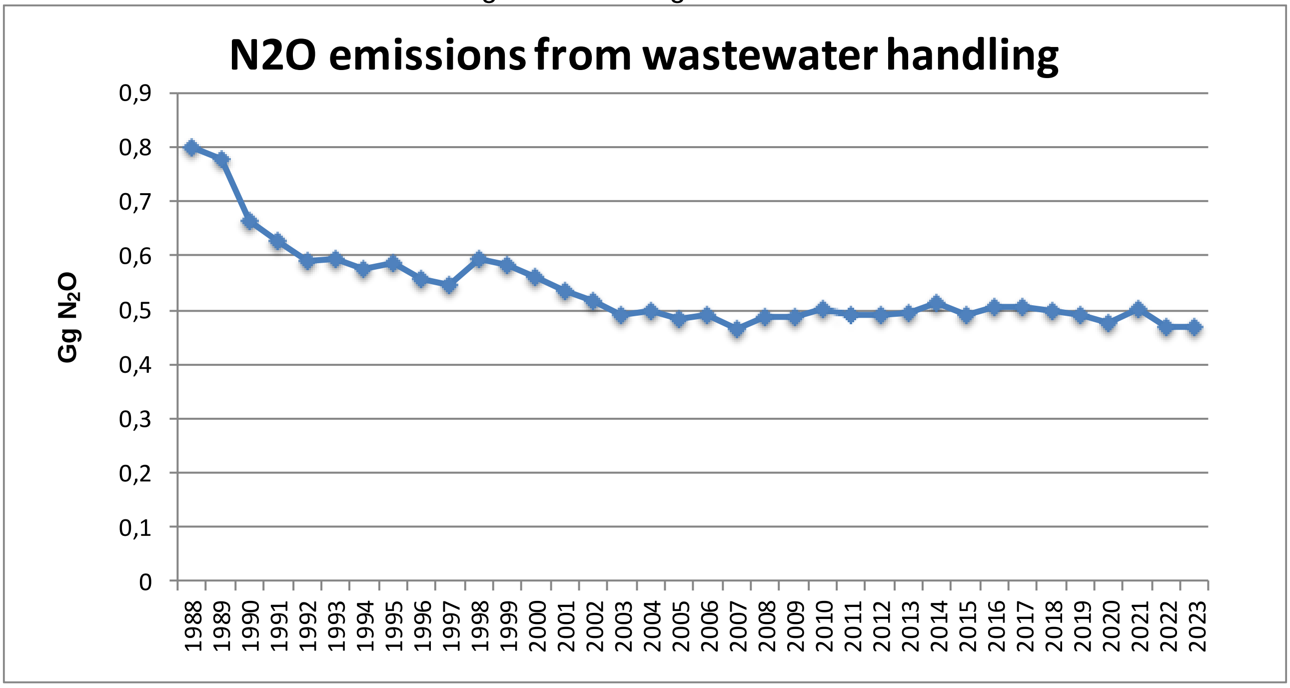


Figure 177 N_2O emissions from wastewater handling

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:

$$N_{Effluent} = (P \bullet \text{Protein} \bullet F_{NPR} \bullet F_{NON\text{-}CON} \bullet F_{IND\text{-}COM}) - N \text{ sludge}.$$

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
$F_{NON-CON}$ – factor for none-consumed protein added to the wastewater (1.4)
$F_{IND-COM}$ – 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

Source-specific recalculations were made due to revised activity data of domestic/industrial wastewater provided by the National Statistical Institute for 2022.

7.5.11 SOURCE-SPECIFIC IMPROVEMENT PLAN

Improvements are not planned.

8 OTHER (CRT 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 1988-2023 (emission data 1988-2023) 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 274 Summary of GHG emission recalculations in submission 2025

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
1. Energy			
A. Fuel combustion (sectoral approach)	-	-	-
2. Manufacturing industries and construction	-	-	-
3. Transport	Revised EF Revised AD	1.A.3.b - New COPERT v. 5.8.1 led to recalculation of the entire time series, incl. updated EFs for CH4 emissions. 1.A.3.b - Improvements in the vehicle fleet matrix regarding electric vehicles and busses, which lead to recalculation of the emissions for the entire timeseries.	See Chapter 3.3.12.3.8
4. Other sectors	-	-	-
5. Other	-	-	-
B. Fugitive emissions from fuels	-	-	-
1. Solid fuels	-	-	-
2. Oil and natural gas	-	-	-
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	-	-	-
E. Electronic Industry	-	-	-
F. Product uses as ODS substitutes	Recalculation, due to technical mistake	In submission 2025 in 2F a technical mistake was corrected.	Please see chapter 2F
G. Other product manufacture and use	Recalculation, due to need of consistency with the AQ inventory and change of method.	2G4i Domestic solvent use – recalculation for the whole time series	Please see chapter 2G4i.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
H. Other	-	-	-
3. Agriculture			
A. Enteric fermentation	Recalculations, due to technical mistake	• In submission 2025 there is revised avtivity data for livestock population mature non-dairy cattle female (female cattle over 2 years) for 2022 due to a technical mistake. • In submission 2025 there is revised avtivity data for live body weight of Young Cattle - Calves (calves for slaughtering & other calves) for 2015 and 2016 due to a technical mistake • In submission 2025 there is revised avtivity data for live body weight of Young Cattle - Growing Heifers (cattle from 1 to 2 years (male/female) for 2002, 2015 and 2016 due to a technical mistake. • In submission 2025 there is revised avtivity data for annual wool production from sheep for the period 1988-2016 due to a technical mistake • In submission 2025 there is revised avtivity data for annual milk yield from sheeps for the period 1988-2001 due to a technical mistake	Please see chapter 5 Enteric fermentation.
B. Manure management			
C. Rice cultivation			
D. Agricultural soils			
F. 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		The recalculations in FL are small and are due to recalculation of losses in biomass of perennials converted to forests and refinement of the estimates of direct and indirect N2O emissions associated with N mineralization due to land use change. For this submission new, country specific C/N ratio were derived.	Please see chapter 6
B. Cropland		The recalculations in CL category are related mainly to the following: 1. The recalculations are related to changes in area representations, and more specifically – improved estimates of LUC conversions between annual and perennial crops and vice versa over the time series. 2. Recalculations in carbon stock changes in living biomass and soils of perennials remaining perennials by including reporting of gains and losses in both above and belowground biomass. 3. Improving the estimates in the soil pool of perennials remaining perennials. Data on management practices on soil disturbance (till and non-till) and input	Please see chapter 6

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
		(mineral and organic fertilizers) have been derived from agronomic reports on perennial crops in Bulgaria for different years. This information was used to develop a consistent time series on soil related management practices and to recalculate the CSC from the soil pool in perennials remaining perennials. 4. In addition, there are small recalculations in direct and indirect N2O emissions associated with N mineralization due to land use changes, because of refinement of the C/N ratio data.	
C. Grassland		The recalculations in GL category are related to the following: 1. Changes in reporting biomass sotck in perennial crops. The change affects the conversion of perennials to grasslands. This involves the reporting of losses in both aboveground and belowground biomass, which results in increased emissions in grassland areas. 2. Soils related N2O emissions by updating the C/N ratio consistently with the methodology applied in CSC estimates in soil pool.	Please see chapter 6
D. Wetlands		The changes in WL category are related to refine estimates of N2O emissions from soils by updating the C/N ratio consistently with the methodology applied in CSC estimates in soil pool.	Please see chapter 6
E. Settlements		The changes in SM category are due to the following: 1. Changes in reporting of biomass sotck in perennial crops. The change affects the conversion of perennials to settlements. This involves reporting of losses in both aboveground and belowground biomass, which results in increased emissions in settlements area. Soils related N2O emissions by updating the C/N ratio consistently with the methodology applied in CSC estimates in soil pool.	Please see chapter 6
F. Other land			
G. Harvested wood products			
H. Other			
5. Waste			
A. Solid waste disposal			
B. Biological treatment of solid waste			
C. Incineration and open burning of waste			
D. Waste water treatment and discharge	Revised activity data.	Source-specific recalculations were made due to revised activity data of domestic/industrial wastewater provided by the National Statistical Institute for 2022.	Please see chapter 7
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 2023 which are submitted this year differ slightly from data reported previously.

Table 275 Recalculation Difference of National Total GHG Emissions.

Year	National Total GHG emissions without LULUCF		
	Submission 2024 [Gg CO_2e]	Submission 2025 [Gg CO_2e]	Recalculation Difference [%] **
1988*	96026,9	96564,5	0,56
1990	81112,4	81762,0	0,79
1991	63286,7	63801,7	0,81
1992	58331,8	58874,5	0,92
1993	57430,6	58017,5	1,01
1994	53324,5	53892,5	1,05
1995	54882,0	55418,5	0,97
1996	56044,0	56584,2	0,95
1997	52718,8	53249,8	1,00
1998	49048,8	49480,3	0,87
1999	42228,8	42651,3	0,99
2000	40245,9	40813,0	1,39
2001	45879,2	46453,4	1,24
2002	43019,1	43608,6	1,35
2003	48359,5	48841,0	0,99
2004	46803,4	47310,7	1,07
2005	46132,1	46806,7	1,44
2006	50162,5	50618,0	0,90
2007	53112,1	53624,0	0,95
2008	53357,0	53781,3	0,79
2009	44322,0	44708,8	0,87
2010	47500,6	47917,2	0,87
2011	56172,4	56558,9	0,68
2012	51541,7	51924,4	0,74
2013	47195,3	47500,7	0,64
2014	48887,9	49247,3	0,73
2015	52519,0	52852,9	0,63
2016	48081,5	48418,0	0,70
2017	49900,4	50230,9	0,66
2018	45449,1	45787,3	0,74
2019	44425,1	44760,1	0,75
2020	38418,2	38716,2	0,77
2021	44519,8	44899,9	0,85
2022	48944,29	49305,7	0,73
2023	-	36763,85	

**Base year is 1988 for all gases*
***The differences can not be taken into consideration because 2023 submission is prepared under the Fifth Assessment Report (AR5).*

10.3 IMPLICATIONS FOR EMISSION TRENDS, INCLUDING TIME SERIES' CONSISTENCY

10.3.1 GHG I INVENTORY AS CAN BE SEEN IN TABLE 279 AND FIGURE 166 BULGARIA'S GREENHOUSE GAS EMISSIONS AS REPORTED IN THE UNFCCC SUBMISSION 2023 ARE DIFFERENT COMPARED TO THE VALUES REPORTED LAST YEAR DUE TO RECALCULATIONS.

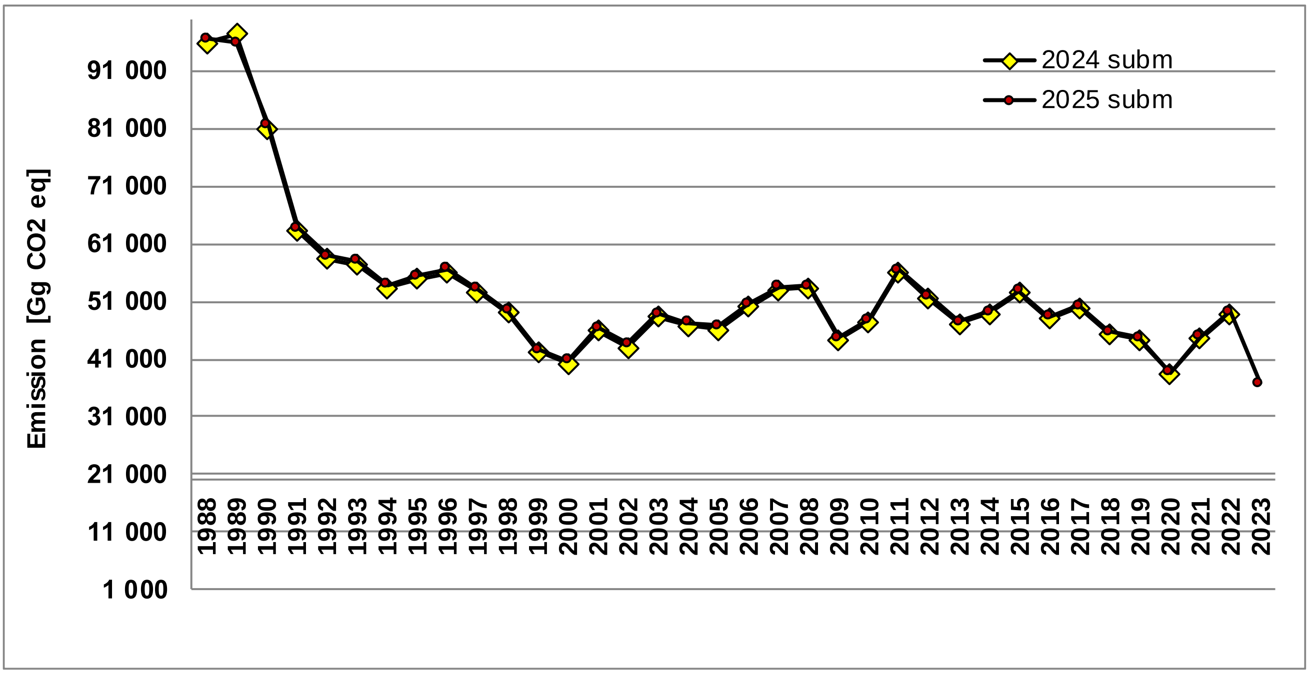


Figure 178 Emission estimates of the submission 2023 and recalculated value

***The differences can not be taken into consideration because 2023 submission is prepared under the Fifth Assessment Report (AR5).*

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 Environmental 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 INFORMATION ON CHANGES IN NATIONAL SYSTEM

No changes in national system were carried out in 2025.

PART 2: ANNEXES TO THE NATIONAL INVENTORY DOCUMENT

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.	2023 Gg CO_2-eq.	% excl. (2020)	Trend	Contribution to Trend	cumul. %
1A1	CO2	Solid fuels	25416,61	12923,55	28,10%	0,12	0,07	6,82%
1A3b	CO2	Diesel Oil	2635,81	6791,65	14,77%	0,30	0,16	23,14%
3Da	N2O	Direct N2O emissions from managed soils	4294,55	2734,50	5,95%	0,05	0,03	25,87%
1A1	CO2	Gaseous fuels	6508,60	1777,56	3,87%	0,05	0,03	28,52%
1A3b	CO2	Gasoline	4216,56	1561,29	3,39%	0,01	0,01	29,05%
1A2	CO2	Gaseous fuels	0,00	1440,54	3,13%	0,08	0,04	33,18%
1A2	CO2	Liquid fuels	7319,76	1387,86	3,02%	0,09	0,05	37,90%
1A3b	CO2	LPG	0,00	1266,94	2,75%	0,07	0,04	41,53%
3A1	CH4	Cattle	3446,23	1261,78	2,74%	0,01	0,00	42,01%
4G	CO2	Harvested wood products	-583,29	-1242,19	2,70%	0,05	0,03	44,88%
2A1	CO2	Cement Production	2454,46	1045,91	2,27%	0,00	0,00	44,96%
1A1	CO2	Liquid fuels	10099,15	971,37	2,11%	0,17	0,09	54,18%
3Db	N2O	Indirect N2O Emissions from managed soils	1304,84	746,76	1,62%	0,01	0,01	54,77%
1B1	CH4	Solid fuel	2329,19	678,49	1,48%	0,02	0,01	55,59%
1B2	CO2	Oil and Natural Gas	94,31	675,95	1,47%	0,03	0,02	57,41%
2F	CO2eq	Product uses as substitutes for ODS - HFCs and PFCs	0,00	631,39	1,37%	0,03	0,02	59,22%
1A2	CO2	Solid fuels	10047,66	627,22	1,36%	0,19	0,10	69,37%
1A4	CO2	Liquid fuel	2825,06	551,91	1,20%	0,03	0,02	71,14%
2B1	CO2	Ammonia Production	2557,47	492,94	1,07%	0,03	0,02	72,77%
2A4d	CO2	DeSOx - instalations	0,00	483,58	1,05%	0,03	0,01	74,15%
2B7	CO2	Soda ash production	397,64	460,03	1,00%	0,02	0,01	75,00%
1A4	CO2	Gaseous fuel	0,00	385,59	0,84%	0,02	0,01	76,10%
1A2	CO2	Other fossil fuels	0,00	325,36	0,71%	0,02	0,01	77,04%
1B2	CH4	Oil and Natural Gas	165,42	315,08	0,69%	0,01	0,01	77,74%

3B1	CH4	Cattle	530,22	254,61	0,55%	0,00	0,00	77,84%
3B	N2O	N2O em. from Manure Management	842,27	254,59	0,55%	0,00	0,00	78,11%
1A4	CH4	All fuel	374,82	249,84	0,54%	0,00	0,00	78,38%
3A2	CH4	Sheep	1793,88	235,66	0,51%	0,03	0,01	79,84%
2A2	CO2	Lime Production	450,07	235,38	0,51%	0,00	0,00	79,98%
1A3e	CO2	Gaseous fuel	0,00	219,92	0,48%	0,01	0,01	80,61%
2C2	CO2	Zinc production	90,47	138,21	0,30%	0,01	0,00	80,90%
1A3b	CO2	Gaseous fuel	0,00	128,63	0,28%	0,01	0,00	81,27%
3C	CH4	Rice Cultivation	142,22	113,00	0,25%	0,00	0,00	81,42%
1A4	CO2	Solid fuel	3548,08	89,68	0,20%	0,07	0,04	85,38%
1A3b	N2O	All fuel	55,47	87,31	0,19%	0,00	0,00	85,56%
3A4	CH4	Other livestock	270,38	82,47	0,18%	0,00	0,00	85,65%
2A4a	CO2	Ceramics - Bricks and Tails	522,51	81,57	0,18%	0,01	0,00	86,04%
3B3	CH4	Swine	582,32	80,90	0,18%	0,01	0,00	86,50%
2A4b	CO2	Soda ash uses	126,58	80,60	0,18%	0,00	0,00	86,58%
2B2	N2O	Nitric Acid Production	1718,08	75,19	0,16%	0,03	0,02	88,40%
1A1	N2O	All fuel	121,11	73,56	0,16%	0,00	0,00	88,47%
1A4	N2O	All fuel	186,48	71,85	0,16%	0,00	0,00	88,49%
1A3a	CO2	Liquid fuel	208,93	48,76	0,11%	0,00	0,00	88,59%
2A3	CO2	Glass production	186,24	40,84	0,09%	0,00	0,00	88,70%
1A5	CO2	Stationary - Fossil fuels	5093,82	31,22	0,07%	0,11	0,06	94,66%
1A2	N2O	All fuel	92,44	30,76	0,07%	0,00	0,00	94,68%
3F	CH4	Field burning of agricultural residues	32,55	30,42	0,07%	0,00	0,00	94,73%
1A3c	CO2	Liquid fuel	0,00	29,59	0,06%	0,00	0,00	94,82%
3A3	CH4	Swine	169,77	27,86	0,06%	0,00	0,00	94,94%
1A3b	CO2	Other fossil fuels	0,00	26,63	0,06%	0,00	0,00	95,02%

Table 277 Key category Analysis T1: Trend assessment including LULUCF

Source	Gas	Fuel/Cat.	1988 (BY) Gg CO_2-eq.	2023 Gg CO_2-eq.	% incl. (2020)	Trend	Contribution to Trend	cumul. %
1A1	CO2	Solid fuels	25416,61	12923,55	22,94%	0,07	0,04	4,43%
4A1	CO2	Forest Land remaining Forest Land	-13236,86	-8181,20	14,52%	0,10	0,06	10,30%
1A3b	CO2	Diesel Oil	2635,81	6791,65	12,06%	0,23	0,14	24,15%
3Da	N2O	Direct N2O emissions from managed soils	4294,55	2734,50	4,85%	0,03	0,02	26,25%
1A1	CO2	Gaseous fuels	6508,60	1777,56	3,16%	0,04	0,03	28,89%
1A3b	CO2	Gasoline	4216,56	1561,29	2,77%	0,01	0,01	29,58%
1A2	CO2	Gaseous fuels	0,00	1440,54	2,56%	0,06	0,04	33,12%
1A2	CO2	Liquid fuels	7319,76	1387,86	2,46%	0,07	0,04	37,59%
1A3b	CO2	LPG	0,00	1266,94	2,25%	0,05	0,03	40,70%
3A1	CH4	Cattle	3446,23	1261,78	2,24%	0,01	0,01	41,31%
4G	CO2	Harvested wood products	-583,29	-1242,19	2,21%	0,04	0,02	43,73%
2A1	CO2	Cement Production	2454,46	1045,91	1,86%	0,00	0,00	43,80%
1A1	CO2	Liquid fuels	10099,15	971,37	1,72%	0,14	0,08	52,27%
3Db	N2O	Indirect N2O Emissions from managed soils	1304,84	746,76	1,33%	0,01	0,00	52,71%
1B1	CH4	Solid fuel	2329,19	678,49	1,20%	0,01	0,01	53,54%
1B2	CO2	Oil and Natural Gas	94,31	675,95	1,20%	0,03	0,02	55,10%
2F	CO2eq	Product uses as substitutes for ODS - HFCs and PFCs	0,00	631,39	1,12%	0,03	0,02	56,66%
1A2	CO2	Solid fuels	10047,66	627,22	1,11%	0,15	0,09	65,92%
4B2	CO2	Land converted to Cropland	54,56	608,51	1,08%	0,02	0,01	67,36%
4C2	CO2	Land converted to Grassland	-905,04	-586,36	1,04%	0,01	0,00	67,83%
1A4	CO2	Liquid fuel	2825,06	551,91	0,98%	0,03	0,02	69,51%
2B1	CO2	Ammonia Production	2557,47	492,94	0,88%	0,03	0,02	71,05%
2A4d	CO2	DeSOx - instalations	0,00	483,58	0,86%	0,02	0,01	72,23%

2B7	CO2	Soda ash production	397,64	460,03	0,82%	0,01	0,01	72,94%
1A4	CO2	Gaseous fuel	0,00	385,59	0,68%	0,02	0,01	73,89%
4E2	CO2	Land converted to Settlements	108,81	328,20	0,58%	0,01	0,01	74,57%
1A2	CO2	Other fossil fuels	0,00	325,36	0,58%	0,01	0,01	75,37%
1B2	CH4	Oil and Natural Gas	165,42	315,08	0,56%	0,01	0,01	75,97%
4B1	CO2	Cropland remainig Cropland	235,20	266,74	0,47%	0,01	0,00	76,37%
3B1	CH4	Cattle	530,22	254,61	0,45%	0,00	0,00	76,43%
3B	N2O	N2O em. from Manure Management	842,27	254,59	0,45%	0,00	0,00	76,71%
1A4	CH4	All fuel	374,82	249,84	0,44%	0,00	0,00	76,92%
3A2	CH4	Sheep	1793,88	235,66	0,42%	0,02	0,01	78,27%
2A2	CO2	Lime Production	450,07	235,38	0,42%	0,00	0,00	78,36%
1A3e	CO2	Gaseous fuel	0,00	219,92	0,39%	0,01	0,01	78,91%
2C2	CO2	Zinc production	90,47	138,21	0,25%	0,00	0,00	79,15%
1A3b	CO2	Gaseous fuel	0,00	128,63	0,23%	0,01	0,00	79,46%
3C	CH4	Rice Cultivation	142,22	113,00	0,20%	0,00	0,00	79,59%
1A4	CO2	Solid fuel	3548,08	89,68	0,16%	0,06	0,04	83,18%
1A3b	N2O	All fuel	55,47	87,31	0,16%	0,00	0,00	83,34%
3A4	CH4	Other livestock	270,38	82,47	0,15%	0,00	0,00	83,43%
2A4a	CO2	Ceramics - Bricks and Tails	522,51	81,57	0,14%	0,01	0,00	83,79%
3B3	CH4	Swine	582,32	80,90	0,14%	0,01	0,00	84,22%
2A4b	CO2	Soda ash uses	126,58	80,60	0,14%	0,00	0,00	84,28%
4A2	CO2	Land converted to Forest Land	-3041,02	-79,96	0,14%	0,05	0,03	87,35%
4C1	CO2	Grassland remaining grassland	111,86	77,43	0,14%	0,00	0,00	87,42%
2B2	N2O	Nitric Acid Production	1718,08	75,19	0,13%	0,03	0,02	89,09%
1A1	N2O	All fuel	121,11	73,56	0,13%	0,00	0,00	89,14%
1A4	N2O	All fuel	186,48	71,85	0,13%	0,00	0,00	89,16%
4D2	CO2	Land converted to Wetlands	44,88	68,34	0,12%	0,00	0,00	89,28%
3H	CO2	Urea application	60,47	66,56	0,12%	0,00	0,00	89,38%
4B2	N2O	Land converted to Cropland	8,00	61,16	0,11%	0,00	0,00	89,52%
1A3a	CO2	Liquid fuel	208,93	48,76	0,09%	0,00	0,00	89,62%

2A3	CO2	Glass production	186,24	40,84	0,07%	0,00	0,00	89,72%
1A5	CO2	Stationary - Fossil fuels	5093,82	31,22	0,06%	0,09	0,05	95,13%

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	25 416,6	22,9%	22,9%
1A1	CO2	Liquid fuels	10 099,2	9,1%	32,0%
1A2	CO2	Solid fuels	10 047,7	9,1%	41,1%
1A2	CO2	Liquid fuels	7 319,8	6,6%	47,7%
1A1	CO2	Gaseous fuels	6 508,6	5,9%	53,6%
1A5	CO2	Stationary - Fossil fuels	5 093,8	4,6%	58,2%
3Da	N2O	Direct N2O emissions from managed soils	4 294,5	3,9%	62,0%
1A3b	CO2	Gasoline	4 216,6	3,8%	65,8%
1A4	CO2	Solid fuel	3 548,1	3,2%	69,0%
2C1	CO2	Iron and Steel Production	3 481,4	3,1%	72,2%
3A1	CH4	Cattle	3 446,2	3,1%	75,3%
1A4	CO2	Liquid fuel	2 825,1	2,5%	77,8%
1A3b	CO2	Diesel Oil	2 635,8	2,4%	80,2%
2B1	CO2	Ammonia Production	2 557,5	2,3%	82,5%
2A1	CO2	Cement Production	2 454,5	2,2%	84,7%
1B1	CH4	Solid fuel	2 329,2	2,1%	86,8%
5A	CH4	Solid waste disposal	2 001,0	1,8%	88,6%
3A2	CH4	Sheep	1 793,9	1,6%	90,3%
2B2	N2O	Nitric Acid Production	1 718,1	1,5%	91,8%
3Db	N2O	Indirect N2O Emissions from managed soils	1 304,8	1,2%	93,0%
3B	N2O	N2O em. from Manure Management	842,3	0,8%	93,7%
4G	CO2	Harvested wood products	-583,3	0,5%	94,3%
3B3	CH4	Swine	582,3	0,5%	94,8%
3B1	CH4	Cattle	530,2	0,5%	95,3%

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	19,7%	19,7%
4A1	CO2	Forest Land remaining Forest Land	13 236,9	10,3%	30,0%
1A1	CO2	Liquid fuels	10 099,2	7,8%	37,9%
1A2	CO2	Solid fuels	10 047,7	7,8%	45,7%
1A2	CO2	Liquid fuels	7 319,8	5,7%	51,4%
1A1	CO2	Gaseous fuels	6 508,6	5,1%	56,4%
1A5	CO2	Stationary - Fossil fuels	5 093,8	4,0%	60,4%
3Da	N2O	Direct N2O emissions from managed soils	4 294,5	3,3%	63,7%
1A3b	CO2	Gasoline	4 216,6	3,3%	67,0%
1A4	CO2	Solid fuel	3 548,1	2,8%	69,7%
2C1	CO2	Iron and Steel Production	3 481,4	2,7%	72,5%
3A1	CH4	Cattle	3 446,2	2,7%	75,1%
4A2	CO2	Land converted to Forest Land	3 041,0	2,4%	77,5%
1A4	CO2	Liquid fuel	2 825,1	2,2%	79,7%
1A3b	CO2	Diesel Oil	2 635,8	2,0%	81,7%
2B1	CO2	Ammonia Production	2 557,5	2,0%	83,7%
2A1	CO2	Cement Production	2 454,5	1,9%	85,6%
1B1	CH4	Solid fuel	2 329,2	1,8%	87,4%
5A	CH4	Solid waste disposal	2 001,0	1,6%	89,0%
3A2	CH4	Sheep	1 793,9	1,4%	90,4%
2B2	N2O	Nitric Acid Production	1 718,1	1,3%	91,7%
3Db	N2O	Indirect N2O Emissions from managed soils	1 304,8	1,0%	92,7%
4C2	CO2	Land converted to Grassland	905,0	0,7%	93,4%
3B	N2O	N2O em. from Manure Management	842,3	0,7%	94,1%
4G	CO2	Harvested wood products	583,3	0,5%	94,5%
3B3	CH4	Swine	582,3	0,5%	95,0%
3B1	CH4	Cattle	530,2	0,4%	95,4%

Table 280 Key category Analysis T1: Level Assessment excluding LULUCF 2023

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% excl.	cumul. %
1A1	CO2	Solid fuels	25 416,6	28,1%	28,1%
1A3b	CO2	Diesel Oil	2 635,8	14,8%	42,9%
3Da	N2O	Direct N2O emissions from managed soils	4 294,5	5,9%	48,8%
5A	CH4	Solid waste disposal	2 001,0	4,6%	53,4%
1A1	CO2	Gaseous fuels	6 508,6	3,9%	57,3%
1A3b	CO2	Gasoline	4 216,6	3,4%	60,6%
1A2	CO2	Gaseous fuels	-	3,1%	63,8%
1A2	CO2	Liquid fuels	7 319,8	3,0%	66,8%
1A3b	CO2	LPG	-	2,8%	69,6%
3A1	CH4	Cattle	3 446,2	2,7%	72,3%
4G	CO2	Harvested wood products	-583,3	2,7%	75,0%
2A1	CO2	Cement Production	2 454,5	2,3%	77,3%
1A1	CO2	Liquid fuels	10 099,2	2,1%	79,4%
3Db	N2O	Indirect N2O Emissions from managed soils	1 304,8	1,6%	81,0%
1B1	CH4	Solid fuel	2 329,2	1,5%	82,5%
1B2	CO2	Oil and Natural Gas	94,3	1,5%	84,0%
2F	CO2eq	Product uses as substitutes for ODS - HFCs and PFCs	-	1,4%	85,3%
1A2	CO2	Solid fuels	10 047,7	1,4%	86,7%
1A4	CO2	Liquid fuel	2 825,1	1,2%	87,9%
2B1	CO2	Ammonia Production	2 557,5	1,1%	89,0%
2A4d	CO2	DeSOx - instalations	-	1,1%	90,0%
2B7	CO2	Soda ash production	397,6	1,0%	91,0%
1A4	CO2	Gaseous fuel	-	0,8%	91,8%
1A2	CO2	Other fossil fuels	-	0,7%	92,6%
1B2	CH4	Oil and Natural Gas	165,4	0,7%	93,2%
3B1	CH4	Cattle	530,2	0,6%	93,8%
3B	N2O	N2O em. from Manure Management	842,3	0,6%	94,3%
1A4	CH4	All fuel	374,8	0,5%	94,9%
3A2	CH4	Sheep	1 793,9	0,5%	95,4%

Table 281 Key category Analysis T1: Level Assessment including LULUCF 2023

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% incl.	cumul. %
1A1	CO2	Solid fuels	12 923,5	22,9%	22,9%
4A1	CO2	Forest Land remaining Forest Land	8 181,2	14,5%	37,5%
1A3b	CO2	Diesel Oil	6 791,7	12,1%	49,5%
3Da	N2O	Direct N2O emissions from managed soils	2 734,5	4,9%	54,4%
5A	CH4	Solid waste disposal	2 101,1	3,7%	58,1%
1A1	CO2	Gaseous fuels	1 777,6	3,2%	61,3%
1A3b	CO2	Gasoline	1 561,3	2,8%	64,0%
1A2	CO2	Gaseous fuels	1 440,5	2,6%	66,6%
1A2	CO2	Liquid fuels	1 387,9	2,5%	69,1%
1A3b	CO2	LPG	1 266,9	2,2%	71,3%
3A1	CH4	Cattle	1 261,8	2,2%	73,5%
4G	CO2	Harvested wood products	1 242,2	2,2%	75,8%
2A1	CO2	Cement Production	1 045,9	1,9%	77,6%
1A1	CO2	Liquid fuels	971,4	1,7%	79,3%
3Db	N2O	Indirect N2O Emissions from managed soils	746,8	1,3%	80,7%
1B1	CH4	Solid fuel	678,5	1,2%	81,9%
1B2	CO2	Oil and Natural Gas	675,9	1,2%	83,1%
2F	CO2eq	Product uses as substitutes for ODS - HFCs and PFCs	631,4	1,1%	84,2%
1A2	CO2	Solid fuels	627,2	1,1%	85,3%
4B2	CO2	Land converted to Cropland	608,5	1,1%	86,4%
4C2	CO2	Land converted to Grassland	586,4	1,0%	87,4%
1A4	CO2	Liquid fuel	551,9	1,0%	88,4%
2B1	CO2	Ammonia Production	492,9	0,9%	89,3%
2A4d	CO2	DeSOx - instalations	483,6	0,9%	90,1%
2B7	CO2	Soda ash production	460,0	0,8%	90,9%
1A4	CO2	Gaseous fuel	385,6	0,7%	91,6%
4E2	CO2	Land converted to Settlements	328,2	0,6%	92,2%
1A2	CO2	Other fossil fuels	325,4	0,6%	92,8%

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% incl.	cumul. %
1B2	CH4	Oil and Natural Gas	315,1	0,6%	93,4%
4B1	CO2	Cropland remainig Cropland	266,7	0,5%	93,8%
3B1	CH4	Cattle	254,6	0,5%	94,3%
3B	N2O	N2O em. from Manure Management	254,6	0,5%	94,7%
1A4	CH4	All fuel	249,8	0,4%	95,2%

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 286 and
Table 288 for 2022, while in Table 287 and
Table 289 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
1	2	3	4	5	6	7	8	9	10
3	3Da	Direct N2O emissions from managed soils	N2O	0,03	200,02	5,46	0,23	0,23	1,00
13	3Db	Indirect N2O Emissions from managed soils	N2O	0,01	500,01	2,94	0,13	0,36	2,00
10	4G	Harvested wood products	CO2	0,03	98,51	2,82	0,12	0,48	3,00
15	1B2	Oil and Natural Gas	CO2	0,02	100,12	1,83	0,08	0,56	4,00
14	1B1	Solid fuel	CH4	0,01	200,25	1,65	0,07	0,63	5,00
2	1A3b	Diesel Oil	CO2	0,16	5,83	0,95	0,04	0,67	6,00
16	2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0,02	50,99	0,92	0,04	0,71	7,00
26	3B	N2O em. from Manure Management	N2O	0,00	300,01	0,81	0,03	0,74	8,00
24	1B2	Oil and Natural Gas	CH4	0,01	100,12	0,71	0,03	0,77	9,00
12	1A1	Liquid fuels	CO2	0,09	7,62	0,70	0,03	0,80	10,00
45	1A5	Stationary - Fossil fuels	CO2	0,06	8,60	0,51	0,02	0,82	11,00
7	1A2	Liquid fuels	CO2	0,05	7,62	0,36	0,02	0,84	12,00
28	3A2	Sheep	CH4	0,01	20,07	0,29	0,01	0,85	13,00
63	2C1	Iron and Steel Production	CO2	0,04	7,07	0,29	0,01	0,86	14,00
17	1A2	Solid fuels	CO2	0,10	2,24	0,23	0,01	0,87	15,00
34	1A4	Solid fuel	CO2	0,04	5,39	0,21	0,01	0,88	16,00
8	1A3b	LPG	CO2	0,04	5,83	0,21	0,01	0,89	17,00
40	2B2	Nitric Acid Production	N2O	0,02	10,20	0,19	0,01	0,90	18,00
18	1A4	Liquid fuel	CO2	0,02	8,60	0,15	0,01	0,91	19,00
1	1A1	Solid fuels	CO2	0,07	2,24	0,15	0,01	0,91	20,00
38	3B3	Swine	CH4	0,00	32,02	0,15	0,01	0,92	21,00
27	1A4	All fuel	CH4	0,00	50,25	0,14	0,01	0,93	22,00
41	1A1	All fuel	N2O	0,00	200,02	0,13	0,01	0,93	23,00
19	2B1	Ammonia Production	CO2	0,02	7,28	0,12	0,01	0,94	24,00
33	3C	Rice Cultivation	CH4	0,00	63,25	0,10	0,00	0,94	25,00
9	3A1	Cattle	CH4	0,00	20,01	0,10	0,00	0,94	26,00
6	1A2	Gaseous fuels	CO2	0,04	2,24	0,09	0,00	0,95	27,00
35	1A3b	All fuel	N2O	0,00	40,11	0,07	0,00	0,95	28,00
51	4(IV)A1	Forest Land remaining Forest Land - biomass burning	CH4	0,00	103,04	0,07	0,00	0,95	29,00

56	1B1	Solid fuel	CO2	0,00	200,25	0,07	0,00	0,96	30,00
49	3A3	Swine	CH4	0,00	50,00	0,06	0,00	0,96	31,00
22	1A4	Gaseous fuel	CO2	0,01	5,39	0,06	0,00	0,96	32,00
4	1A1	Gaseous fuels	CO2	0,03	2,24	0,06	0,00	0,97	33,00
23	1A2	Other fossil fuels	CO2	0,01	5,39	0,05	0,00	0,97	34,00
31	2C2	Zinc production	CO2	0,00	15,81	0,05	0,00	0,97	35,00
46	1A2	All fuel	N2O	0,00	200,02	0,04	0,00	0,97	36,00
36	3A4	Other livestock	CH4	0,00	50,04	0,04	0,00	0,97	37,00
61	2D	Non-energy products from fuels and solvent use	CO2	0,00	31,62	0,04	0,00	0,97	38,00
30	1A3e	Gaseous fuel	CO2	0,01	5,10	0,03	0,00	0,98	39,00
25	3B1	Cattle	CH4	0,00	32,02	0,03	0,00	0,98	40,00
42	1A4	All fuel	N2O	0,00	200,06	0,03	0,00	0,98	41,00
5	1A3b	Gasoline	CO2	0,01	5,83	0,03	0,00	0,98	42,00
62	4(IV)A1	Forest Land remaining Forest Land - biomass burning	N2O	0,00	83,05	0,03	0,00	0,98	43,00
20	2A4d	DeSOx - instalations	CO2	0,01	2,12	0,03	0,00	0,98	44,00
60	4E2	Land converted to Settlements	N2O	0,00	100,50	0,03	0,00	0,98	45,00
66	2C2	Lead production	CO2	0,00	15,81	0,03	0,00	0,98	46,00
54	2G1	Electrical equipment - SF6	CO2eq	0,00	50,99	0,03	0,00	0,99	47,00
47	3F	Field burning of agricultural residues	CH4	0,00	50,09	0,02	0,00	0,99	48,00
21	2B7	Soda ash production	CO2	0,01	2,83	0,02	0,00	0,99	49,00
67	3B2	Sheep	CH4	0,00	53,85	0,02	0,00	0,99	50,00
37	2A4a	Ceramics - Bricks and Tails	CO2	0,00	5,83	0,02	0,00	0,99	51,00
32	1A3b	Gaseous fuel	CO2	0,00	5,83	0,02	0,00	0,99	52,00
65	4D2	Land converted to Wetlands	N2O	0,00	110,45	0,02	0,00	0,99	53,00
59	4C1	Grassland remaining grassland	N2O	0,00	92,14	0,02	0,00	0,99	54,00
79	1A5	Stationary - Fossil fuels	N2O	0,00	200,06	0,02	0,00	0,99	55,00
52	1A1	All fuel	CH4	0,00	50,09	0,02	0,00	0,99	56,00
53	2G	Other product manufacture and use	CO2	0,00	31,62	0,02	0,00	1,00	57,00
72	1B2	Oil and Natural Gas	N2O	0,00	1000,01	0,02	0,00	1,00	58,00
44	2A3	Glass production	CO2	0,00	14,14	0,01	0,00	1,00	59,00
55	1A3b	All fuel	CH4	0,00	40,11	0,01	0,00	1,00	60,00
58	3B4	Other livestock	CH4	0,00	58,31	0,01	0,00	1,00	61,00
69	1A3d	Gas/diesel oil	CO2	0,00	50,25	0,01	0,00	1,00	62,00
70	2B5b	Calcium Carbide	CO2	0,00	11,18	0,01	0,00	1,00	63,00
43	1A3a	Liquid fuel	CO2	0,00	7,07	0,01	0,00	1,00	64,00

48	1A3c	Liquid fuel	CO2	0,00	7,07	0,01	0,00	1,00	65,00
71	1A3c	Liquid fuel	N2O	0,00	60,21	0,01	0,00	1,00	66,00
50	1A3b	Other fossil fuels	CO2	0,00	5,83	0,00	0,00	1,00	67,00
29	2A2	Lime Production	CO2	0,00	2,83	0,00	0,00	1,00	68,00
82	1A5	Stationary - Fossil fuels	CH4	0,00	50,25	0,00	0,00	1,00	69,00
57	1A2	All fuel	CH4	0,00	50,09	0,00	0,00	1,00	70,00
39	2A4b	Soda ash uses	CO2	0,00	2,24	0,00	0,00	1,00	71,00
68	3F	Field burning of agricultural residues	N2O	0,00	20,22	0,00	0,00	1,00	72,00
11	2A1	Cement Production	CO2	0,00	2,12	0,00	0,00	1,00	73,00
73	4(IV)A2	Land converted to Forest Land - biomass burning	CH4	0,00	103,48	0,00	0,00	1,00	74,00
76	4(IV)A2	Land converted to Forest Land - biomass burning	N2O	0,00	83,60	0,00	0,00	1,00	75,00
78	1A3e	Gaseous fuel	N2O	0,00	150,00	0,00	0,00	1,00	76,00
75	1A3a	Liquid fuel	N2O	0,00	40,31	0,00	0,00	1,00	77,00
64	2G	Other product manufacture and use	N2O	0,00	10,05	0,00	0,00	1,00	78,00
74	1A3b	Other liquid fuels	CO2	0,00	5,83	0,00	0,00	1,00	79,00
81	1A3d	Gas/diesel oil	N2O	0,00	148,66	0,00	0,00	1,00	80,00
77	1A3e	Gaseous fuel	CH4	0,00	50,01	0,00	0,00	1,00	81,00
80	1A3c	Liquid fuel	CH4	0,00	60,21	0,00	0,00	1,00	82,00
84	1A3d	Gas/diesel oil	CH4	0,00	70,71	0,00	0,00	1,00	83,00
83	1A3a	Liquid fuel	CH4	0,00	40,31	0,00	0,00	1,00	84,00
85	2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	0,00	20,62	0,00	0,00	1,00	85,00
86	2H	Other	CO2	0,00	31,62	0,00	0,00	1,00	86,00
87	2C2	Ferroalloys Production	CH4	0,00	25,50	0,00	0,00	1,00	87,00
88	2B8	Petrochemical and carbon black production	CH4	0,00	11,18	0,00	0,00	1,00	88,00
89	2B8b	Ethylene	CO2	0,00	30,41	0,00	0,00	1,00	89,00
90	2C1	Iron and Steel Production	CH4	0,00	26,93	0,00	0,00	1,00	90,00
91	2C2	Ferroalloys Production	CO2	0,00	25,50	0,00	0,00	1,00	91,00

Table 283 Key category Analysis T2: Trend assessment including LULUCF

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment excluding LULUCF	Cumulative Percentage	T2
1	2	3	4	5	6	7	8	9	10
2	4A1	Forest Land remaining Forest Land	CO2	0,06	245,02	14,38	0,34	0,34	1
45	4A2	Land converted to Forest Land	CO2	0,03	205,24	6,31	0,15	0,49	2
4	3Da	Direct N2O emissions from managed soils	N2O	0,02	200,02	4,20	0,10	0,59	3
11	4G	Harvested wood products	CO2	0,02	98,51	2,39	0,06	0,64	4
14	3Db	Indirect N2O Emissions from managed soils	N2O	0,00	500,01	2,16	0,05	0,70	5
15	1B1	Solid fuel	CH4	0,01	200,25	1,68	0,04	0,74	6
16	1B2	Oil and Natural Gas	CO2	0,02	100,12	1,56	0,04	0,77	7
31	3B	N2O em. from Manure Management	N2O	0,00	300,01	0,84	0,02	0,79	8
3	1A3b	Diesel Oil	CO2	0,14	5,83	0,81	0,02	0,81	9
17	2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0,02	50,99	0,79	0,02	0,83	10
29	4B1	Cropland remainig Cropland	CO2	0,00	173,48	0,70	0,02	0,85	11
13	1A1	Liquid fuels	CO2	0,08	7,62	0,65	0,02	0,86	12
28	1B2	Oil and Natural Gas	CH4	0,01	100,12	0,60	0,01	0,88	13
19	4B2	Land converted to Cropland	CO2	0,01	36,59	0,53	0,01	0,89	14
55	1A5	Stationary - Fossil fuels	CO2	0,05	8,60	0,46	0,01	0,90	15
8	1A2	Liquid fuels	CO2	0,04	7,62	0,34	0,01	0,91	16
33	3A2	Sheep	CH4	0,01	20,07	0,27	0,01	0,91	17
74	2C1	Iron and Steel Production	CO2	0,04	7,07	0,26	0,01	0,92	18
18	1A2	Solid fuels	CO2	0,09	2,24	0,21	0,00	0,93	19
39	1A4	Solid fuel	CO2	0,04	5,39	0,19	0,00	0,93	20
9	1A3b	LPG	CO2	0,03	5,83	0,18	0,00	0,93	21
47	2B2	Nitric Acid Production	N2O	0,02	10,20	0,17	0,00	0,94	22
21	1A4	Liquid fuel	CO2	0,02	8,60	0,14	0,00	0,94	23
43	3B3	Swine	CH4	0,00	32,02	0,14	0,00	0,94	24
52	4B2	Land converted to Cropland	N2O	0,00	92,54	0,13	0,00	0,95	25

10	3A1	Cattle	CH4	0,01	20,01	0,12	0,00	0,95	26
22	2B1	Ammonia Production	CO2	0,02	7,28	0,11	0,00	0,95	27
32	1A4	All fuel	CH4	0,00	50,25	0,11	0,00	0,96	28
46	4C1	Grassland remaining grassland	CO2	0,00	151,08	0,11	0,00	0,96	29
20	4C2	Land converted to Grassland	CO2	0,00	22,36	0,10	0,00	0,96	30
26	4E2	Land converted to Settlements	CO2	0,01	14,79	0,10	0,00	0,96	31
48	1A1	All fuel	N2O	0,00	200,02	0,10	0,00	0,97	32
1	1A1	Solid fuels	CO2	0,04	2,24	0,10	0,00	0,97	33
7	1A2	Gaseous fuels	CO2	0,04	2,24	0,08	0,00	0,97	34
38	3C	Rice Cultivation	CH4	0,00	63,25	0,08	0,00	0,97	35
67	1B1	Solid fuel	CO2	0,00	200,25	0,06	0,00	0,97	36
40	1A3b	All fuel	N2O	0,00	40,11	0,06	0,00	0,97	37
62	4(IV)A1	Forest Land remaining Forest Land - biomass burning	CH4	0,00	103,04	0,06	0,00	0,98	38
5	1A1	Gaseous fuels	CO2	0,03	2,24	0,06	0,00	0,98	39
59	3A3	Swine	CH4	0,00	50,00	0,06	0,00	0,98	40
25	1A4	Gaseous fuel	CO2	0,01	5,39	0,05	0,00	0,98	41
51	3H	Urea application	CO2	0,00	50,04	0,05	0,00	0,98	42
49	1A4	All fuel	N2O	0,00	200,06	0,05	0,00	0,98	43
56	1A2	All fuel	N2O	0,00	200,02	0,05	0,00	0,98	44
41	3A4	Other livestock	CH4	0,00	50,04	0,04	0,00	0,98	45
27	1A2	Other fossil fuels	CO2	0,01	5,39	0,04	0,00	0,99	46
6	1A3b	Gasoline	CO2	0,01	5,83	0,04	0,00	0,99	47
36	2C2	Zinc production	CO2	0,00	15,81	0,04	0,00	0,99	48
72	2D	Non-energy products from fuels and solvent use	CO2	0,00	31,62	0,04	0,00	0,99	49
83	4A2	Land converted to Forest Land	N2O	0,00	110,45	0,03	0,00	0,99	50
35	1A3e	Gaseous fuel	CO2	0,01	5,10	0,03	0,00	0,99	51
73	4(IV)A1	Forest Land remaining Forest Land - biomass burning	N2O	0,00	83,05	0,03	0,00	0,99	52
23	2A4d	DeSOx - instalations	CO2	0,01	2,12	0,03	0,00	0,99	53
77	2C2	Lead production	CO2	0,00	15,81	0,02	0,00	0,99	54
71	4E2	Land converted to Settlements	N2O	0,00	100,50	0,02	0,00	0,99	55
65	2G1	Electrical equipment - SF6	CO2eq	0,00	50,99	0,02	0,00	0,99	56
78	3B2	Sheep	CH4	0,00	53,85	0,02	0,00	0,99	57
42	2A4a	Ceramics - Bricks and Tails	CO2	0,00	5,83	0,02	0,00	0,99	58
57	3F	Field burning of agricultural residues	CH4	0,00	50,09	0,02	0,00	0,99	59
24	2B7	Soda ash production	CO2	0,01	2,83	0,02	0,00	0,99	60

91	1A5	Stationary - Fossil fuels	N2O	0,00	200,06	0,02	0,00	0,99	61
37	1A3b	Gaseous fuel	CO2	0,00	5,83	0,02	0,00	1,00	62
30	3B1	Cattle	CH4	0,00	32,02	0,02	0,00	1,00	63
76	4D2	Land converted to Wetlands	N2O	0,00	110,45	0,02	0,00	1,00	64
70	4C1	Grassland remaining grassland	N2O	0,00	92,14	0,02	0,00	1,00	65
63	1A1	All fuel	CH4	0,00	50,09	0,02	0,00	1,00	66
64	2G	Other product manufacture and use	CO2	0,00	31,62	0,01	0,00	1,00	67
84	1B2	Oil and Natural Gas	N2O	0,00	1000,01	0,01	0,00	1,00	68
50	4D2	Land converted to Wetlands	CO2	0,00	12,04	0,01	0,00	1,00	69
66	1A3b	All fuel	CH4	0,00	40,11	0,01	0,00	1,00	70
54	2A3	Glass production	CO2	0,00	14,14	0,01	0,00	1,00	71
69	3B4	Other livestock	CH4	0,00	58,31	0,01	0,00	1,00	72
53	1A3a	Liquid fuel	CO2	0,00	7,07	0,01	0,00	1,00	73
81	2B5b	Calcium Carbide	CO2	0,00	11,18	0,01	0,00	1,00	74
80	1A3d	Gas/diesel oil	CO2	0,00	50,25	0,01	0,00	1,00	75
61	3G	Liming	CO2	0,00	20,22	0,01	0,00	1,00	76
58	1A3c	Liquid fuel	CO2	0,00	7,07	0,01	0,00	1,00	77
82	1A3c	Liquid fuel	N2O	0,00	60,21	0,00	0,00	1,00	78
60	1A3b	Other fossil fuels	CO2	0,00	5,83	0,00	0,00	1,00	79
94	1A5	Stationary - Fossil fuels	CH4	0,00	50,25	0,00	0,00	1,00	80
34	2A2	Lime Production	CO2	0,00	2,83	0,00	0,00	1,00	81
12	2A1	Cement Production	CO2	0,00	2,12	0,00	0,00	1,00	82
79	3F	Field burning of agricultural residues	N2O	0,00	20,22	0,00	0,00	1,00	83
44	2A4b	Soda ash uses	CO2	0,00	2,24	0,00	0,00	1,00	84
85	4(IV)A2	Land converted to Forest Land - biomass burning	CH4	0,00	103,48	0,00	0,00	1,00	85
68	1A2	All fuel	CH4	0,00	50,09	0,00	0,00	1,00	86
88	4(IV)A2	Land converted to Forest Land - biomass burning	N2O	0,00	83,60	0,00	0,00	1,00	87
75	2G	Other product manufacture and use	N2O	0,00	10,05	0,00	0,00	1,00	88
90	1A3e	Gaseous fuel	N2O	0,00	150,00	0,00	0,00	1,00	89
87	1A3a	Liquid fuel	N2O	0,00	40,31	0,00	0,00	1,00	90
86	1A3b	Other liquid fuels	CO2	0,00	5,83	0,00	0,00	1,00	91
93	1A3d	Gas/diesel oil	N2O	0,00	148,66	0,00	0,00	1,00	92
89	1A3e	Gaseous fuel	CH4	0,00	50,01	0,00	0,00	1,00	93
92	1A3c	Liquid fuel	CH4	0,00	60,21	0,00	0,00	1,00	94
96	1A3d	Gas/diesel oil	CH4	0,00	70,71	0,00	0,00	1,00	95
95	1A3a	Liquid fuel	CH4	0,00	40,31	0,00	0,00	1,00	96
97	4F	Other Land	CO2	0,00	0,00	0,00	0,00	1,00	97

98	2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	0,00	20,62	0,00	0,00	1,00	98
99	2H	Other	CO2	0,00	31,62	0,00	0,00	1,00	99
100	2C2	Ferroalloys Production	CH4	0,00	25,50	0,00	0,00	1,00	100
101	2B8	Petrochemical and carbon black production	CH4	0,00	11,18	0,00	0,00	1,00	101
102	2B8b	Ethylene	CO2	0,00	30,41	0,00	0,00	1,00	102
103	2C1	Iron and Steel Production	CH4	0,00	26,93	0,00	0,00	1,00	103
104	2C2	Ferroalloys Production	CO2	0,00	25,50	0,00	0,00	1,00	104

Table 284 Key category Analysis T2: Level Assessment excluding LULUCF 2023

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment excluding LULUCF	Cumulative Percentage	T2
1	2	3	4	5	6	7	8	9	10
3	3Da	Direct N2O emissions from managed soils	N2O	0,06	200,02	11,89	0,30	0,30	1
14	3Db	Indirect N2O Emissions from managed soils	N2O	0,02	500,01	8,12	0,20	0,50	2
4	5A	Solid waste disposal	CH4	0,05	85,44	3,90	0,10	0,60	3
15	1B1	Solid fuel	CH4	0,01	200,25	2,95	0,07	0,68	4
11	4G	Harvested wood products	CO2	0,03	98,51	2,66	0,07	0,74	5
27	3B	N2O em. from Manure Management	N2O	0,01	300,01	1,66	0,04	0,79	6
16	1B2	Oil and Natural Gas	CO2	0,01	100,12	1,47	0,04	0,82	7
2	1A3b	Diesel Oil	CO2	0,15	5,83	0,86	0,02	0,84	8
17	2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0,01	50,99	0,70	0,02	0,86	9
25	1B2	Oil and Natural Gas	CH4	0,01	100,12	0,69	0,02	0,88	10
1	1A1	Solid fuels	CO2	0,28	2,24	0,63	0,02	0,89	11
10	3A1	Cattle	CH4	0,03	20,01	0,55	0,01	0,91	12
42	1A1	All fuel	N2O	0,00	200,02	0,32	0,01	0,92	13
43	1A4	All fuel	N2O	0,00	200,06	0,31	0,01	0,92	14
28	1A4	All fuel	CH4	0,01	50,25	0,27	0,01	0,93	15
8	1A2	Liquid fuels	CO2	0,03	7,62	0,23	0,01	0,94	16
6	1A3b	Gasoline	CO2	0,03	5,83	0,20	0,00	0,94	17
26	3B1	Cattle	CH4	0,01	32,02	0,18	0,00	0,95	18
13	1A1	Liquid fuels	CO2	0,02	7,62	0,16	0,00	0,95	19

9	1A3b	LPG	CO2	0,03	5,83	0,16	0,00	0,95	20
34	3C	Rice Cultivation	CH4	0,00	63,25	0,16	0,00	0,96	21
47	1A2	All fuel	N2O	0,00	200,02	0,13	0,00	0,96	22
19	1A4	Liquid fuel	CO2	0,01	8,60	0,10	0,00	0,96	23
29	3A2	Sheep	CH4	0,01	20,07	0,10	0,00	0,97	24
37	3A4	Other livestock	CH4	0,00	50,04	0,09	0,00	0,97	25
5	1A1	Gaseous fuels	CO2	0,04	2,24	0,09	0,00	0,97	26
20	2B1	Ammonia Production	CO2	0,01	7,28	0,08	0,00	0,97	27
36	1A3b	All fuel	N2O	0,00	40,11	0,08	0,00	0,98	28
58	1B1	Solid fuel	CO2	0,00	200,25	0,07	0,00	0,98	29
7	1A2	Gaseous fuels	CO2	0,03	2,24	0,07	0,00	0,98	30
39	3B3	Swine	CH4	0,00	32,02	0,06	0,00	0,98	31
53	4(IV)A1	Forest Land remaining Forest Land - biomass burning	CH4	0,00	103,04	0,05	0,00	0,98	32
12	2A1	Cement Production	CO2	0,02	2,12	0,05	0,00	0,98	33
32	2C2	Zinc production	CO2	0,00	15,81	0,05	0,00	0,98	34
23	1A4	Gaseous fuel	CO2	0,01	5,39	0,05	0,00	0,99	35
24	1A2	Other fossil fuels	CO2	0,01	5,39	0,04	0,00	0,99	36
48	3F	Field burning of agricultural residues	CH4	0,00	50,09	0,03	0,00	0,99	37
18	1A2	Solid fuels	CO2	0,01	2,24	0,03	0,00	0,99	38
61	4E2	Land converted to Settlements	N2O	0,00	100,50	0,03	0,00	0,99	39
50	3A3	Swine	CH4	0,00	50,00	0,03	0,00	0,99	40
22	2B7	Soda ash production	CO2	0,01	2,83	0,03	0,00	0,99	41
31	1A3e	Gaseous fuel	CO2	0,00	5,10	0,02	0,00	0,99	42
54	1A1	All fuel	CH4	0,00	50,09	0,02	0,00	0,99	43
63	4(IV)A1	Forest Land remaining Forest Land - biomass burning	N2O	0,00	83,05	0,02	0,00	0,99	44
66	4D2	Land converted to Wetlands	N2O	0,00	110,45	0,02	0,00	0,99	45
21	2A4d	DeSOx - instalations	CO2	0,01	2,12	0,02	0,00	0,99	46
56	2G1	Electrical equipment - SF6	CO2eq	0,00	50,99	0,02	0,00	0,99	47
60	3B4	Other livestock	CH4	0,00	58,31	0,02	0,00	0,99	48
59	1A2	All fuel	CH4	0,00	50,09	0,02	0,00	0,99	49
57	1A3b	All fuel	CH4	0,00	40,11	0,02	0,00	1,00	50
41	2B2	Nitric Acid Production	N2O	0,00	10,20	0,02	0,00	1,00	51
33	1A3b	Gaseous fuel	CO2	0,00	5,83	0,02	0,00	1,00	52
73	1B2	Oil and Natural Gas	N2O	0,00	1000,01	0,02	0,00	1,00	53

55	2G	Other product manufacture and use	CO2	0,00	31,62	0,01	0,00	1,00	54
30	2A2	Lime Production	CO2	0,01	2,83	0,01	0,00	1,00	55
45	2A3	Glass production	CO2	0,00	14,14	0,01	0,00	1,00	56
52	3G	Liming	CO2	0,00	20,22	0,01	0,00	1,00	57
35	1A4	Solid fuel	CO2	0,00	5,39	0,01	0,00	1,00	58
38	2A4a	Ceramics - Bricks and Tails	CO2	0,00	5,83	0,01	0,00	1,00	59
62	2D	Non-energy products from fuels and solvent use	CO2	0,00	31,62	0,01	0,00	1,00	60
68	3B2	Sheep	CH4	0,00	53,85	0,01	0,00	1,00	61
44	1A3a	Liquid fuel	CO2	0,00	7,07	0,01	0,00	1,00	62
70	1A3d	Gas/diesel oil	CO2	0,00	50,25	0,01	0,00	1,00	63
46	1A5	Stationary - Fossil fuels	CO2	0,00	8,60	0,01	0,00	1,00	64
49	1A3c	Liquid fuel	CO2	0,00	7,07	0,00	0,00	1,00	65
72	1A3c	Liquid fuel	N2O	0,00	60,21	0,00	0,00	1,00	66
40	2A4b	Soda ash uses	CO2	0,00	2,24	0,00	0,00	1,00	67
51	1A3b	Other fossil fuels	CO2	0,00	5,83	0,00	0,00	1,00	68
67	2C2	Lead production	CO2	0,00	15,81	0,00	0,00	1,00	69
69	3F	Field burning of agricultural residues	N2O	0,00	20,22	0,00	0,00	1,00	70
65	2G	Other product manufacture and use	N2O	0,00	10,05	0,00	0,00	1,00	71
64	2C1	Iron and Steel Production	CO2	0,00	7,07	0,00	0,00	1,00	72
71	2B5b	Calcium Carbide	CO2	0,00	11,18	0,00	0,00	1,00	73
74	4(IV)A2	Land converted to Forest Land - biomass burning	CH4	0,00	103,48	0,00	0,00	1,00	74
77	4(IV)A2	Land converted to Forest Land - biomass burning	N2O	0,00	83,60	0,00	0,00	1,00	75
79	1A3e	Gaseous fuel	N2O	0,00	150,00	0,00	0,00	1,00	76
76	1A3a	Liquid fuel	N2O	0,00	40,31	0,00	0,00	1,00	77
80	1A5	Stationary - Fossil fuels	N2O	0,00	200,06	0,00	0,00	1,00	78
82	1A3d	Gas/diesel oil	N2O	0,00	148,66	0,00	0,00	1,00	79
78	1A3e	Gaseous fuel	CH4	0,00	50,01	0,00	0,00	1,00	80
81	1A3c	Liquid fuel	CH4	0,00	60,21	0,00	0,00	1,00	81
75	1A3b	Other liquid fuels	CO2	0,00	5,83	0,00	0,00	1,00	82
83	1A5	Stationary - Fossil fuels	CH4	0,00	50,25	0,00	0,00	1,00	83
85	1A3d	Gas/diesel oil	CH4	0,00	70,71	0,00	0,00	1,00	84
84	1A3a	Liquid fuel	CH4	0,00	40,31	0,00	0,00	1,00	85
90	2C2	Ferroalloys Production	CH4	0,00	25,50	0,00	0,00	1,00	86
88	2C1	Iron and Steel Production	CH4	0,00	26,93	0,00	0,00	1,00	87

89	2B8	Petrochemical and carbon black production	CH4	0,00	11,18	0,00	0,00	1,00	88
87	2C2	Ferroalloys Production	CO2	0,00	25,50	0,00	0,00	1,00	89
86	2B8b	Ethylene	CO2	0,00	30,41	0,00	0,00	1,00	90
91	2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	0,00	20,62	0,00	0,00	1,00	91

Table 285 Key category Analysis T2: Level Assessment including LULUCF 2023

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment excluding LULUCF	Cumulative Percentage	T2
1	2	3	4	5	6	7	8	9	10
2	4A1	Forest Land remaining Forest Land	CO2	0,15	245,02	35,59	0,51	0,51	1
4	3Da	Direct N2O emissions from managed soils	N2O	0,05	200,02	9,71	0,14	0,64	2
15	3Db	Indirect N2O Emissions from managed soils	N2O	0,01	500,01	6,63	0,09	0,74	3
5	5A	Solid waste disposal	CH4	0,04	85,44	3,19	0,05	0,78	4
16	1B1	Solid fuel	CH4	0,01	200,25	2,41	0,03	0,82	5
12	4G	Harvested wood products	CO2	0,02	98,51	2,17	0,03	0,85	6
32	3B	N2O em. from Manure Management	N2O	0,00	300,01	1,36	0,02	0,87	7
17	1B2	Oil and Natural Gas	CO2	0,01	100,12	1,20	0,02	0,89	8
30	4B1	Cropland remainig Cropland	CO2	0,00	173,48	0,82	0,01	0,90	9
3	1A3b	Diesel Oil	CO2	0,12	5,83	0,70	0,01	0,91	10
18	2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2 eq	0,01	50,99	0,57	0,01	0,92	11
29	1B2	Oil and Natural Gas	CH4	0,01	100,12	0,56	0,01	0,92	12
1	1A1	Solid fuels	CO2	0,23	2,24	0,51	0,01	0,93	13
11	3A1	Cattle	CH4	0,02	20,01	0,45	0,01	0,94	14
20	4B2	Land converted to Cropland	CO2	0,01	36,59	0,40	0,01	0,94	15
46	4A2	Land converted to Forest Land	CO2	0,00	205,24	0,29	0,00	0,95	16
49	1A1	All fuel	N2O	0,00	200,02	0,26	0,00	0,95	17
50	1A4	All fuel	N2O	0,00	200,06	0,26	0,00	0,95	18

21	4C2	Land converted to Grassland	CO2	0,01	22,36	0,23	0,00	0,96	19
33	1A4	All fuel	CH4	0,00	50,25	0,22	0,00	0,96	20
47	4C1	Grassland remaining grassland	CO2	0,00	151,08	0,21	0,00	0,96	21
9	1A2	Liquid fuels	CO2	0,02	7,62	0,19	0,00	0,97	22
7	1A3b	Gasoline	CO2	0,03	5,83	0,16	0,00	0,97	23
31	3B1	Cattle	CH4	0,00	32,02	0,14	0,00	0,97	24
14	1A1	Liquid fuels	CO2	0,02	7,62	0,13	0,00	0,97	25
10	1A3b	LPG	CO2	0,02	5,83	0,13	0,00	0,98	26
39	3C	Rice Cultivation	CH4	0,00	63,25	0,13	0,00	0,98	27
57	1A2	All fuel	N2O	0,00	200,02	0,11	0,00	0,98	28
53	4B2	Land converted to Cropland	N2O	0,00	92,54	0,10	0,00	0,98	29
27	4E2	Land converted to Settlements	CO2	0,01	14,79	0,09	0,00	0,98	30
22	1A4	Liquid fuel	CO2	0,01	8,60	0,08	0,00	0,98	31
34	3A2	Sheep	CH4	0,00	20,07	0,08	0,00	0,98	32
42	3A4	Other livestock	CH4	0,00	50,04	0,07	0,00	0,98	33
6	1A1	Gaseous fuels	CO2	0,03	2,24	0,07	0,00	0,99	34
23	2B1	Ammonia Production	CO2	0,01	7,28	0,06	0,00	0,99	35
41	1A3b	All fuel	N2O	0,00	40,11	0,06	0,00	0,99	36
68	1B1	Solid fuel	CO2	0,00	200,25	0,06	0,00	0,99	37
52	3H	Urea application	CO2	0,00	50,04	0,06	0,00	0,99	38
8	1A2	Gaseous fuels	CO2	0,03	2,24	0,06	0,00	0,99	39
44	3B3	Swine	CH4	0,00	32,02	0,05	0,00	0,99	40
63	4(IV)A1	Forest Land remaining Forest Land - biomass burning	CH4	0,00	103,04	0,04	0,00	0,99	41
13	2A1	Cement Production	CO2	0,02	2,12	0,04	0,00	0,99	42
37	2C2	Zinc production	CO2	0,00	15,81	0,04	0,00	0,99	43
26	1A4	Gaseous fuel	CO2	0,01	5,39	0,04	0,00	0,99	44
28	1A2	Other fossil fuels	CO2	0,01	5,39	0,03	0,00	0,99	45
58	3F	Field burning of agricultural residues	CH4	0,00	50,09	0,03	0,00	0,99	46
19	1A2	Solid fuels	CO2	0,01	2,24	0,02	0,00	0,99	47
72	4E2	Land converted to Settlements	N2O	0,00	100,50	0,02	0,00	0,99	48
60	3A3	Swine	CH4	0,00	50,00	0,02	0,00	0,99	49
71	4C1	Grassland remaining grassland	N2O	0,00	92,14	0,02	0,00	0,99	50
25	2B7	Soda ash production	CO2	0,01	2,83	0,02	0,00	1,00	51
36	1A3e	Gaseous fuel	CO2	0,00	5,10	0,02	0,00	1,00	52
64	1A1	All fuel	CH4	0,00	50,09	0,02	0,00	1,00	53

74	4(IV)A1	Forest Land remaining Forest Land - biomass burning	N2O	0,00	83,05	0,02	0,00	1,00	54
77	4D2	Land converted to Wetlands	N2O	0,00	110,45	0,02	0,00	1,00	55
24	2A4d	DeSOx - instalations	CO2	0,01	2,12	0,02	0,00	1,00	56
66	2G1	Electrical equipment - SF6	CO2 eq	0,00	50,99	0,02	0,00	1,00	57
70	3B4	Other livestock	CH4	0,00	58,31	0,02	0,00	1,00	58
51	4D2	Land converted to Wetlands	CO2	0,00	12,04	0,01	0,00	1,00	59
69	1A2	All fuel	CH4	0,00	50,09	0,01	0,00	1,00	60
67	1A3b	All fuel	CH4	0,00	40,11	0,01	0,00	1,00	61
48	2B2	Nitric Acid Production	N2O	0,00	10,20	0,01	0,00	1,00	62
38	1A3b	Gaseous fuel	CO2	0,00	5,83	0,01	0,00	1,00	63
85	1B2	Oil and Natural Gas	N2O	0,00	1000,01	0,01	0,00	1,00	64
65	2G	Other product manufacture and use	CO2	0,00	31,62	0,01	0,00	1,00	65
35	2A2	Lime Production	CO2	0,00	2,83	0,01	0,00	1,00	66
55	2A3	Glass production	CO2	0,00	14,14	0,01	0,00	1,00	67
62	3G	Liming	CO2	0,00	20,22	0,01	0,00	1,00	68
40	1A4	Solid fuel	CO2	0,00	5,39	0,01	0,00	1,00	69
43	2A4a	Ceramics - Bricks and Tails	CO2	0,00	5,83	0,01	0,00	1,00	70
73	2D	Non-energy products from fuels and solvent use	CO2	0,00	31,62	0,01	0,00	1,00	71
79	3B2	Sheep	CH4	0,00	53,85	0,01	0,00	1,00	72
54	1A3a	Liquid fuel	CO2	0,00	7,07	0,01	0,00	1,00	73
84	4A2	Land converted to Forest Land	N2O	0,00	110,45	0,01	0,00	1,00	74
81	1A3d	Gas/diesel oil	CO2	0,00	50,25	0,01	0,00	1,00	75
56	1A5	Stationary - Fossil fuels	CO2	0,00	8,60	0,00	0,00	1,00	76
59	1A3c	Liquid fuel	CO2	0,00	7,07	0,00	0,00	1,00	77
83	1A3c	Liquid fuel	N2O	0,00	60,21	0,00	0,00	1,00	78
45	2A4b	Soda ash uses	CO2	0,00	2,24	0,00	0,00	1,00	79
61	1A3b	Other fossil fuels	CO2	0,00	5,83	0,00	0,00	1,00	80
78	2C2	Lead production	CO2	0,00	15,81	0,00	0,00	1,00	81
80	3F	Field burning of agricultural residues	N2O	0,00	20,22	0,00	0,00	1,00	82
76	2G	Other product manufacture and use	N2O	0,00	10,05	0,00	0,00	1,00	83
75	2C1	Iron and Steel Production	CO2	0,00	7,07	0,00	0,00	1,00	84
82	2B5b	Calcium Carbide	CO2	0,00	11,18	0,00	0,00	1,00	85
86	4(IV)A2	Land converted to Forest Land - biomass burning	CH4	0,00	103,48	0,00	0,00	1,00	86

89	4(IV)A2	Land converted to Forest Land - biomass burning	N2O	0,00	83,60	0,00	0,00	1,00	87
91	1A3e	Gaseous fuel	N2O	0,00	150,00	0,00	0,00	1,00	88
88	1A3a	Liquid fuel	N2O	0,00	40,31	0,00	0,00	1,00	89
92	1A5	Stationary - Fossil fuels	N2O	0,00	200,06	0,00	0,00	1,00	90
94	1A3d	Gas/diesel oil	N2O	0,00	148,66	0,00	0,00	1,00	91
90	1A3e	Gaseous fuel	CH4	0,00	50,01	0,00	0,00	1,00	92
93	1A3c	Liquid fuel	CH4	0,00	60,21	0,00	0,00	1,00	93
87	1A3b	Other liquid fuels	CO2	0,00	5,83	0,00	0,00	1,00	94
95	1A5	Stationary - Fossil fuels	CH4	0,00	50,25	0,00	0,00	1,00	95
97	1A3d	Gas/diesel oil	CH4	0,00	70,71	0,00	0,00	1,00	96
96	1A3a	Liquid fuel	CH4	0,00	40,31	0,00	0,00	1,00	97
98	4F	Other Land	CO2	0,00	0,00	0,00	0,00	1,00	98
99	2B8	Petrochemical and carbon black production	CH4	0,00	11,18	0,00	0,00	1,00	99
100	2B8b	Ethylene	CO2	0,00	30,41	0,00	0,00	1,00	100
101	2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	0,00	20,62	0,00	0,00	1,00	101
102	2C1	Iron and Steel Production	CH4	0,00	26,93	0,00	0,00	1,00	102
103	2C2	Ferroalloys Production	CO2	0,00	25,50	0,00	0,00	1,00	103
104	2C2	Ferroalloys Production	CH4	0,00	25,50	0,00	0,00	1,00	104

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 have been described in detail by IPCC (IPCC 2006). Two different approaches may be used in order to achieve the 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 a reliable assessment of inventory uncertainty. More flexibility is available with "Approach 2" method. The Monte-Carlo approach allows any probability distribution of input parameters, and it also allows 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 an error in one of the values would be fully reflected in the other value. While "full dependency" theoretically can be covered with error propagation, this is normally not done and only in a very limited occasions possible in the IPCC spreadsheets.

The general properties of an 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 would result in 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 often uncertainty data may not be available, or a "balance" approach (energy balance, solvent balance) will allow more reliable at 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 assessment of emission uncertainty at any level where the most reasonable uncertainty data are available. Very detailed information can be entered directly, for aggregating 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 (e.g. in the IPCC reports) from variation presented in literature, and by contacting national experts. Structured interviews were held. The difference between Approach 1 and Approach 2 uncertainty can be explained by covariance of uncertainties between (key) source categories, which occurs when data are statistically dependent. The Approach 1 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 value.

Detailed Results of Approach 1 Uncertainty Analysis

The tables 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 2022.

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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	10099,15	1103,48	3	7	7,6	0,144	-0,036	0,010	-0,252	0,041	0,255
1A1	Solid fuels	CO2	25416,61	23891,70	1	2	2,2	0,914	0,095	0,210	0,190	0,297	0,353
1A1	Gaseous fuels	CO2	6508,60	1877,09	1	2	2,2	0,072	-0,013	0,017	-0,026	0,023	0,035
1A1	All fuel	CH4	21,11	28,02	3	50	50,1	0,024	0,000	0,000	0,008	0,001	0,008
1A1	All fuel	N2O	121,11	120,46	3	200	200,0	0,412	0,001	0,001	0,102	0,004	0,103
1A2	Liquid fuels	CO2	7319,76	1748,38	3	7	7,6	0,228	-0,018	0,015	-0,124	0,065	0,140
1A2	Solid fuels	CO2	10047,66	649,00	1	2	2,2	0,025	-0,040	0,006	-0,079	0,008	0,080
1A2	Gaseous fuels	CO2	0,00	1634,60	1	2	2,2	0,063	0,014	0,014	0,029	0,020	0,035
1A2	Other fossil fuels	CO2	0,00	277,52	5	2	5,4	0,026	0,002	0,002	0,005	0,017	0,018
1A2	All fuel	CH4	35,55	17,52	3	50	50,1	0,015	0,000	0,000	0,000	0,001	0,001
1A2	All fuel	N2O	92,44	32,55	3	200	200,0	0,111	0,000	0,000	-0,026	0,001	0,026
1A3a	Liquid fuel	CO2	208,93	55,85	5	5	7,1	0,007	0,000	0,000	-0,002	0,003	0,004
1A3a	Liquid fuel	CH4	0,04	0,02	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3a	Liquid fuel	N2O	1,56	0,41	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Gasoline	CO2	4216,56	1575,17	3	5	5,8	0,157	-0,005	0,014	-0,026	0,059	0,064
1A3b	Diesel Oil	CO2	2635,81	6620,16	3	5	5,8	0,661	0,046	0,058	0,232	0,247	0,339
1A3b	All fuel	CH4	78,16	20,76	3	40	40,1	0,014	0,000	0,000	-0,007	0,001	0,007
1A3b	All fuel	N2O	54,58	84,58	3	40	40,1	0,058	0,000	0,001	0,020	0,003	0,020
1A3b	LPG	CO2	0,00	1208,92	3	5	5,8	0,121	0,011	0,011	0,053	0,045	0,070
1A3b	Gaseous fuel	CO2	0,00	150,28	3	5	5,8	0,015	0,001	0,001	0,007	0,006	0,009
1A3b	Other liquid fuels	CO2	4,39	0,41	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Other fossil fuels	CO2	0,00	28,18	3	5	5,8	0,003	0,000	0,000	0,001	0,001	0,002
1A3c	Liquid fuel	CO2	0,00	32,23	5	5	7,1	0,004	0,000	0,000	0,001	0,002	0,002

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%							
1A3c	Liquid fuel	CH4	0,00	0,05	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	N2O	0,00	3,30	5	60	60,2	0,003	0,000	0,000	0,002	0,000	0,002
1A3d	Gas/diesel oil	CO2	0,00	4,62	50	5	50,2	0,004	0,000	0,000	0,000	0,003	0,003
1A3d	Gas/diesel oil	CH4	0,00	0,01	50	50	70,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3d	Gas/diesel oil	N2O	0,00	0,03	50	140	148,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	CO2	0,00	194,42	1	5	5,1	0,017	0,002	0,002	0,009	0,002	0,009
1A3e	Gaseous fuel	CH4	0,00	0,10	1	50	50,0	0,000	0,000	0,000	0,000	0,000	0,000
1A3e	Gaseous fuel	N2O	0,00	0,09	1	150	150,0	0,000	0,000	0,000	0,000	0,000	0,000
1A4	Liquid fuel	CO2	2825,06	555,83	5	7	8,6	0,082	-0,008	0,005	-0,055	0,035	0,065
1A4	Solid fuel	CO2	3548,08	216,44	2	5	5,4	0,020	-0,014	0,002	-0,071	0,005	0,071
1A4	Gaseous fuel	CO2	0,00	456,16	5	2	5,4	0,042	0,004	0,004	0,008	0,028	0,029
1A4	All fuel	CH4	374,82	299,71	5	50	50,2	0,258	0,001	0,003	0,047	0,019	0,051
1A4	All fuel	N2O	186,48	77,65	5	200	200,1	0,266	0,000	0,001	-0,032	0,005	0,032
1A5	Stationary - Fossil fuels	CO2	5093,82	0,00	5	7	8,6	0,000	-0,023	0,000	-0,161	0,000	0,161
1A5	Stationary - Fossil fuels	CH4	5,39	0,00	5	50	50,2	0,000	0,000	0,000	-0,001	0,000	0,001
1A5	Stationary - Fossil fuels	N2O	8,71	0,00	5	200	200,1	0,000	0,000	0,000	-0,008	0,000	0,008
1B1	Solid fuel	CO2	68,81	28,75	10	200	200,2	0,099	0,000	0,000	-0,012	0,004	0,012
1B1	Solid fuel	CH4	2329,19	1045,52	10	200	200,2	3,584	-0,001	0,009	-0,267	0,130	0,297
1B2	Oil and Natural Gas	CO2	94,31	752,03	5	100	100,1	1,289	0,006	0,007	0,619	0,047	0,621
1B2	Oil and Natural Gas	CH4	165,42	301,47	5	100	100,1	0,517	0,002	0,003	0,190	0,019	0,191
1B2	Oil and Natural Gas	N2O	0,36	0,84	5	1000	1000,0	0,014	0,000	0,000	0,006	0,000	0,006
2A1	Cement Production	CO2	2454,46	1039,99	1,5	1,5	2,12	0,038	-0,002	0,009	-0,003	0,019	0,020
2A2	Lime Production	CO2	450,07	324,61	2	2	2,8	0,016	0,001	0,003	0,002	0,008	0,008
2A3	Glass production	CO2	186,24	90,77	10	10	14,1	0,022	0,000	0,001	0,000	0,011	0,011
2A4a	Ceramics - Bricks and Tails	CO2	522,51	88,38	3	5	5,8	0,009	-0,002	0,001	-0,008	0,003	0,009

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%							
2A4b	Soda ash uses	CO2	126,58	217,07	2	1	2,2	0,008	0,001	0,002	0,001	0,005	0,006
2A4d	DeSOx - instalations	CO2	0,00	890,44	1,5	1,5	2,1	0,032	0,008	0,008	0,012	0,017	0,020
2B1	Ammonia Production	CO2	2557,47	485,63	2	7	7,3	0,061	-0,007	0,004	-0,051	0,012	0,052
2B2	Nitric Acid Production	N2O	1718,08	58,76	2	10	10,2	0,010	-0,007	0,001	-0,073	0,001	0,073
2B5b	Calcium Carbide	CO2	73,94	1,11	5	10	11,2	0,000	0,000	0,000	-0,003	0,000	0,003
2B7	Soda ash production	CO2	397,64	450,68	2	2	2,8	0,022	0,002	0,004	0,004	0,011	0,012
2B8	Petrochemical and carbon black production	CH4	19,52	0,00	5	10	11,2	0,000	0,000	0,000	-0,001	0,000	0,001
2B8b	Ethylene	CO2	442,12	0,00	5	30	30,4	0,000	-0,002	0,000	-0,060	0,000	0,060
2B8c	Ethylene dichloride and vinyl chloride monomer	CO2	1,89	0,00	5	20	20,6	0,000	0,000	0,000	0,000	0,000	0,000
2C1	Iron and Steel Production	CO2	3481,44	10,55	5	5	7,1	0,001	-0,016	0,000	-0,078	0,001	0,078
2C1	Iron and Steel Production	CH4	36,31	0,00	10	25	26,9	0,000	0,000	0,000	-0,004	0,000	0,004
2C2	Ferroalloys Production	CO2	254,94	0,00	5	25	25,5	0,000	-0,001	0,000	-0,029	0,000	0,029
2C2	Ferroalloys Production	CH4	2,55	0,00	5	25	25,5	0,000	0,000	0,000	0,000	0,000	0,000
2C2	Lead production	CO2	162,82	9,15	5	15	15,8	0,002	-0,001	0,000	-0,010	0,001	0,010
2C2	Zinc production	CO2	90,47	131,52	5	15	15,8	0,036	0,001	0,001	0,011	0,008	0,014
2D	Non-energy products from fuels and solvent use	CO2	138,57	15,98	10	30	31,6	0,009	0,000	0,000	-0,015	0,002	0,015
2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0,00	701,86	10	50	51,0	0,613	0,006	0,006	0,309	0,087	0,321
2G	Other product manufacture and use	N2O	28,99	12,26	10	1	10,0	0,002	0,000	0,000	0,000	0,002	0,002
2G	Other product manufacture and use	CO2	26,73	22,18	10	30	31,6	0,012	0,000	0,000	0,002	0,003	0,004
2G1	Electrical equipment - SF6	CO2eq	3,40	23,96	10	50	51,0	0,021	0,000	0,000	0,010	0,003	0,010
2H	Other	CO2	0,00	0,00	10	30	31,6	0,000	0,000	0,000	0,000	0,000	0,000

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%							
3A1	Cattle	CH4	3443,83	1312,39	0,64	20	20,0	0,450	-0,004	0,012	-0,081	0,010	0,081
3A2	Sheep	CH4	1795,76	246,86	1,63	20	20,1	0,085	-0,006	0,002	-0,119	0,005	0,119
3A3	Swine	CH4	169,77	27,22	0,51	50	50,0	0,023	-0,001	0,000	-0,026	0,000	0,026
3A4	Other livestock	CH4	270,38	83,42	2	50	50,0	0,071	0,000	0,001	-0,024	0,002	0,025
3B	N2O em. from Manure Management	N2O	842,27	258,19	2	300	300,0	1,326	-0,002	0,002	-0,461	0,006	0,461
3B1	Cattle	CH4	530,01	265,01	25	20	32,0	0,145	0,000	0,002	-0,001	0,082	0,082
3B2	Sheep	CH4	52,43	7,16	50	20	53,9	0,007	0,000	0,000	-0,003	0,004	0,006
3B3	Swine	CH4	582,32	76,29	25	20	32,0	0,042	-0,002	0,001	-0,039	0,024	0,046
3B4	Other livestock	CH4	49,26	14,74	50	30	58,3	0,015	0,000	0,000	-0,003	0,009	0,010
3C	Rice Cultivation	CH4	142,22	106,69	20	60	63,2	0,115	0,000	0,001	0,018	0,027	0,032
3Da	Direct N2O emissions from managed soils	N2O	4303,96	2690,03	3	200	200,0	9,210	0,004	0,024	0,840	0,100	0,846
3Db	Indirect N2O Emissions from managed soils	N2O	1306,95	738,44	3	500	500,0	6,320	0,001	0,006	0,293	0,028	0,294
3F	Field burning of agricultural residues	CH4	32,55	30,43	3	50	50,1	0,026	0,000	0,000	0,006	0,001	0,006
3F	Field burning of agricultural residues	N2O	7,41	6,49	3	20	20,2	0,002	0,000	0,000	0,000	0,000	0,001
3G	Liming	CO2	29,14	24,40	3	20	20,2	0,008	0,000	0,000	0,002	0,001	0,002
3H	Urea application	CO2	60,47	55,45	2	50	50,0	0,047	0,000	0,000	0,011	0,001	0,011
5A	Solid waste disposal	CH4	2000,99	2162,31	30	80	85,4	3,162	0,010	0,019	0,798	0,807	1,135
5B	Biological treatment of solid waste	CH4	0,00	8,51	30	400	401,1	0,058	0,000	0,000	0,030	0,003	0,030
5B	Biological treatment of solid waste	N2O	0,00	4,74	30	30	42,4	0,003	0,000	0,000	0,001	0,002	0,002

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%							
5C	Incineration and open burning of waste	CO2	18,51	11,86	10	100	100,5	0,020	0,000	0,000	0,002	0,001	0,003
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	1,29	0,25	10	100	100,5	0,000	0,000	0,000	0,000	0,000	0,000
5D	Wastewater treatment and discharge	CH4	3050,95	507,89	67	52	84,8	0,737	-0,009	0,004	-0,485	0,423	0,644
5D	Wastewater treatment and discharge	N2O	212,59	112,84	20	50	53,9	0,104	0,000	0,001	0,002	0,028	0,028
Total					113642,3	58420,9				**12,419**			**1,94**
%					100,0	100,0							
National Total					113642,3	58420,9							

Table 287 Approach 1 Uncertainty Calculation and Reporting, Gg CO2-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 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	10099,15	10099,15	3	7	7,6	0,677	0,000	0,089	0,000	0,377	0,377
1A1	Solid fuels	CO2	25416,61	25416,61	1	2	2,2	0,500	0,000	0,224	0,000	0,316	0,316
1A1	Gaseous fuels	CO2	6508,60	6508,60	1	2	2,2	0,128	0,000	0,057	0,000	0,081	0,081
1A1	All fuel	CH4	21,11	21,11	3	50	50,1	0,009	0,000	0,000	0,000	0,001	0,001
1A1	All fuel	N2O	121,11	121,11	3	200	200,0	0,213	0,000	0,001	0,000	0,005	0,005
1A2	Liquid fuels	CO2	7319,76	7319,76	3	7	7,6	0,491	0,000	0,064	0,000	0,273	0,273
1A2	Solid fuels	CO2	10047,66	10047,66	1	2	2,2	0,198	0,000	0,088	0,000	0,125	0,125
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	35,55	35,55	3	50	50,1	0,016	0,000	0,000	0,000	0,001	0,001
1A2	All fuel	N2O	92,44	92,44	3	200	200,0	0,163	0,000	0,001	0,000	0,003	0,003
1A3 a	Liquid fuel	CO2	208,93	208,93	5	5	7,1	0,013	0,000	0,002	0,000	0,013	0,013
1A3 a	Liquid fuel	CH4	0,04	0,04	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3 a	Liquid fuel	N2O	1,56	1,56	5	40	40,3	0,001	0,000	0,000	0,000	0,000	0,000
1A3 b	Gasoline	CO2	4216,56	4216,56	3	5	5,8	0,216	0,000	0,037	0,000	0,157	0,157
1A3 b	Diesel Oil	CO2	2635,81	2635,81	3	5	5,8	0,135	0,000	0,023	0,000	0,098	0,098
1A3 b	All fuel	CH4	78,16	78,16	3	40	40,1	0,028	0,000	0,001	0,000	0,003	0,003

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.		%	%	%	%	%	%	%	%	%
1A3 b	All fuel	N2O	54,58	54,58	3	40	40,1	0,019	0,000	0,000	0,000	0,002	0,002
1A3 b	LPG	CO2	0,00	0,00	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3 b	Gaseous fuel	CO2	0,00	0,00	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3 b	Other liquid fuels	CO2	4,39	4,39	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3 b	Other fossil fuels	CO2	0,00	0,00	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3 c	Liquid fuel	CO2	0,00	0,00	5	5	7,1	0,000	0,000	0,000	0,000	0,000	0,000
1A3 c	Liquid fuel	CH4	0,00	0,00	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3 c	Liquid fuel	N2O	0,00	0,00	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3 d	Gas/diesel oil	CO2	0,00	0,00	50	5	50,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3 d	Gas/diesel oil	CH4	0,00	0,00	50	50	70,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3 d	Gas/diesel oil	N2O	0,00	0,00	50	140	148,7	0,000	0,000	0,000	0,000	0,000	0,000
1A3 e	Gaseous fuel	CO2	0,00	0,00	1	5	5,1	0,000	0,000	0,000	0,000	0,000	0,000
1A3 e	Gaseous fuel	CH4	0,00	0,00	1	50	50,0	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-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.		%	%	%	%	%	%	%	%	%
1A3 e	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	0,214	0,000	0,025	0,000	0,176	0,176
1A4	Solid fuel	CO2	3548,08	3548,08	2	5	5,4	0,168	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	374,82	374,82	5	50	50,2	0,166	0,000	0,003	0,000	0,023	0,023
1A4	All fuel	N2O	186,48	186,48	5	200	200,1	0,328	0,000	0,002	0,000	0,012	0,012
1A5	Stationary - Fossil fuels	CO2	5093,82	5093,82	5	7	8,6	0,386	0,000	0,045	0,000	0,317	0,317
1A5	Stationary - Fossil fuels	CH4	5,39	5,39	5	50	50,2	0,002	0,000	0,000	0,000	0,000	0,000
1A5	Stationary - Fossil fuels	N2O	8,71	8,71	5	200	200,1	0,015	0,000	0,000	0,000	0,001	0,001
1B1	Solid fuel	CO2	68,81	68,81	10	200	200,2	0,121	0,000	0,001	0,000	0,009	0,009
1B1	Solid fuel	CH4	2329,19	2329,19	10	200	200,2	4,104	0,000	0,020	0,000	0,290	0,290
1B2	Oil and Natural Gas	CO2	94,31	94,31	5	100	100,1	0,083	0,000	0,001	0,000	0,006	0,006
1B2	Oil and Natural Gas	CH4	165,42	165,42	5	100	100,1	0,146	0,000	0,001	0,000	0,010	0,010
1B2	Oil and Natural Gas	N2O	0,36	0,36	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	0,046	0,000	0,022	0,000	0,046	0,046
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
2A4 a	Ceramics - Bricks and Tails	CO2	522,51	522,51	3	5	5,8	0,027	0,000	0,005	0,000	0,020	0,020
2A4 b	Soda ash uses	CO2	126,58	126,58	2	1	2,2	0,002	0,000	0,001	0,000	0,003	0,003
2A4 d	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
2B1	Ammonia Production	CO2	2557,47	2557,47	2	7	7,3	0,164	0,000	0,023	0,000	0,064	0,064
2B2	Nitric Acid Production	N2O	1718,08	1718,08	2	10	10,2	0,154	0,000	0,015	0,000	0,043	0,043

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.		%	%	%	%	%	%	%	%	%
2B5 b	Calcium Carbide	CO2	73,94	73,94	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	19,52	19,52	5	10	11,2	0,002	0,000	0,000	0,000	0,001	0,001
2B8 b	Ethylene	CO2	442,12	442,12	5	30	30,4	0,118	0,000	0,004	0,000	0,028	0,028
2B8 c	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	0,217	0,000	0,031	0,000	0,217	0,217
2C1	Iron and Steel Production	CH4	36,31	36,31	10	25	26,9	0,009	0,000	0,000	0,000	0,005	0,005
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	2,55	2,55	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	0,023	0,000	0,001	0,000	0,010	0,010
2C2	Zinc production	CO2	90,47	90,47	5	15	15,8	0,013	0,000	0,001	0,000	0,006	0,006
2D	Non-energy products from fuels and solvent use	CO2	138,57	138,57	10	30	31,6	0,039	0,000	0,001	0,000	0,017	0,017
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	28,99	28,99	10	1	10,0	0,003	0,000	0,000	0,000	0,004	0,004
2G	Other product manufacture and use	CO2	26,73	26,73	10	30	31,6	0,007	0,000	0,000	0,000	0,003	0,003
2G1	Electrical equipment - SF6	CO2eq	3,40	3,40	10	50	51,0	0,002	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	3443,83	3443,83	0,64	20	20,0	0,606	0,000	0,030	0,000	0,027	0,027
3A2	Sheep	CH4	1795,76	1795,76	1,63	20	20,1	0,317	0,000	0,016	0,000	0,036	0,036
3A3	Swine	CH4	169,77	169,77	0,51	50	50,0	0,075	0,000	0,001	0,000	0,001	0,001

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.		%	%	%	%	%	%	%	%	%
3A4	Other livestock	CH4	270,38	270,38	2	50	50,0	0,119	0,000	0,002	0,000	0,007	0,007
3B	N2O em. from Manure Management	N2O	842,27	842,27	2	300	300,0	2,224	0,000	0,007	0,000	0,021	0,021
3B1	Cattle	CH4	530,01	530,01	25	20	32,0	0,149	0,000	0,005	0,000	0,165	0,165
3B2	Sheep	CH4	52,43	52,43	50	20	53,9	0,025	0,000	0,000	0,000	0,033	0,033
3B3	Swine	CH4	582,32	582,32	25	20	32,0	0,164	0,000	0,005	0,000	0,181	0,181
3B4	Other livestock	CH4	49,26	49,26	50	30	58,3	0,025	0,000	0,000	0,000	0,031	0,031
3C	Rice Cultivation	CH4	142,22	142,22	20	60	63,2	0,079	0,000	0,001	0,000	0,035	0,035
3Da	Direct N2O emissions from managed soils	N2O	4303,96	4303,96	3	200	200,0	7,575	0,000	0,038	0,000	0,161	0,161
3Db	Indirect N2O Emissions from managed soils	N2O	1306,95	1306,95	3	500	500,0	5,750	0,000	0,012	0,000	0,049	0,049
3F	Field burning of agricultural residues	CH4	32,55	32,55	3	50	50,1	0,014	0,000	0,000	0,000	0,001	0,001
3F	Field burning of agricultural residues	N2O	7,41	7,41	3	20	20,2	0,001	0,000	0,000	0,000	0,000	0,000
3G	Liming	CO2	29,14	29,14	3	20	20,2	0,008	0,000	0,000	0,002	0,001	0,002
3H	Urea application	CO2	60,47	60,47	2	50	50,0	0,027	0,000	0,001	0,000	0,002	0,002
5A	Solid waste disposal	CH4	2000,99	2000,99	30	80	85,4	1,504	0,000	0,018	0,000	0,747	0,747
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	1,29	1,29	10	100	100,5	0,001	0,000	0,000	0,000	0,000	0,000
5D	Wastewater treatment and discharge	CH4	3050,95	3050,95	67	52	84,8	2,277	0,000	0,027	0,000	2,544	2,544
5D	Wastewater treatment and discharge	N2O	212,59	212,59	20	50	53,9	0,101	0,000	0,002	0,000	0,053	0,053

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.		%	%	%	%	%	%	%	%	%
Total					113642,3	113642,3				**11,04**			**2,79**
%					100,0	100,0							
National Total					113642,3	113642,3							

Table 288 Tier 1 Uncertainty Calculation and Reporting, Gg CO_2-eq.(Including LULUCF) for 2022.

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%	%	%	%	%	%	%	%
1A1	Liquid fuels	CO2	10099,2	1103,5	3	7	7,6	0,172	-0,042	0,012	-0,295	0,049	0,299
1A1	Solid fuels	CO2	25416,6	23891,7	1	2	2,2	1,093	0,114	0,249	0,227	0,352	0,419
1A1	Gaseous fuels	CO2	6508,6	1877,1	1	2	2,2	0,086	-0,015	0,020	-0,030	0,028	0,041
1A1	All fuel	CH4	21,1	28,0	3	50	50,1	0,029	0,000	0,000	0,009	0,001	0,009
1A1	All fuel	N2O	121,1	120,5	3	200	200,0	0,493	0,001	0,001	0,122	0,005	0,123
1A2	Liquid fuels	CO2	7319,8	1748,4	3	7	7,6	0,272	-0,021	0,018	-0,144	0,077	0,164
1A2	Solid fuels	CO2	10047,7	649,0	1	2	2,2	0,030	-0,047	0,007	-0,093	0,010	0,094
1A2	Gaseous fuels	CO2	0,0	1634,6	1	2	2,2	0,075	0,017	0,017	0,034	0,024	0,042

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%	%	%	%	%	%	%	%
1A2	Other fossil fuels	CO2	0,0	277,5	5	2	5,4	0,031	0,003	0,003	0,006	0,020	0,021
1A2	All fuel	CH4	35,5	17,5	3	50	50,1	0,018	0,000	0,000	0,000	0,001	0,001
1A2	All fuel	N2O	92,4	32,6	3	200	200,0	0,133	0,000	0,000	-0,030	0,001	0,030
1A3a	Liquid fuel	CO2	208,9	55,9	5	5	7,1	0,008	-0,001	0,001	-0,003	0,004	0,005
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	1,6	0,4	5	40	40,3	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Gasoline	CO2	4216,6	1575,2	3	5	5,8	0,188	-0,006	0,016	-0,030	0,070	0,076
1A3b	Diesel Oil	CO2	2635,8	6620,2	3	5	5,8	0,790	0,055	0,069	0,275	0,293	0,402
1A3b	All fuel	CH4	78,2	20,8	3	40	40,1	0,017	0,000	0,000	-0,008	0,001	0,008
1A3b	All fuel	N2O	54,6	84,6	3	40	40,1	0,069	0,001	0,001	0,024	0,004	0,024
1A3b	LPG	CO2	0,0	1208,9	3	5	5,8	0,144	0,013	0,013	0,063	0,053	0,083
1A3b	Gaseous fuel	CO2	0,0	150,3	3	5	5,8	0,018	0,002	0,002	0,008	0,007	0,010
1A3b	Other liquid fuels	CO2	4,4	0,4	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Other fossil fuels	CO2	0,0	28,2	3	5	5,8	0,003	0,000	0,000	0,001	0,001	0,002
1A3c	Liquid fuel	CO2	0,0	32,2	5	5	7,1	0,005	0,000	0,000	0,002	0,002	0,003
1A3c	Liquid fuel	CH4	0,0	0,1	5	60	60,2	0,000	0,000	0,000	0,000	0,000	0,000
1A3c	Liquid fuel	N2O	0,0	3,3	5	60	60,2	0,004	0,000	0,000	0,002	0,000	0,002
1A3d	Gas/diesel oil	CO2	0,0	4,6	50	5	50,2	0,005	0,000	0,000	0,000	0,003	0,003
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
1A3e	Gaseous fuel	CO2	0,0	194,4	1	5	5,1	0,020	0,002	0,002	0,010	0,003	0,011
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	555,8	5	7	8,6	0,098	-0,009	0,006	-0,064	0,041	0,076
1A4	Solid fuel	CO2	3548,1	216,4	2	5	5,4	0,024	-0,017	0,002	-0,083	0,006	0,083

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%	%	%	%	%	%	%	%
1A4	Gaseous fuel	CO2	0,0	456,2	5	2	5,4	0,050	0,005	0,005	0,010	0,034	0,035
1A4	All fuel	CH4	374,8	299,7	5	50	50,2	0,308	0,001	0,003	0,057	0,022	0,061
1A4	All fuel	N2O	186,5	77,7	5	200	200,1	0,318	0,000	0,001	-0,036	0,006	0,037
1A5	Stationary - Fossil fuels	CO2	5093,8	0,0	5	7	8,6	0,000	-0,027	0,000	-0,189	0,000	0,189
1A5	Stationary - Fossil fuels	CH4	5,4	0,0	5	50	50,2	0,000	0,000	0,000	-0,001	0,000	0,001
1A5	Stationary - Fossil fuels	N2O	8,7	0,0	5	200	200,1	0,000	0,000	0,000	-0,009	0,000	0,009
1B1	Solid fuel	CO2	68,8	28,8	10	200	200,2	0,118	0,000	0,000	-0,013	0,004	0,014
1B1	Solid fuel	CH4	2329,2	1045,5	10	200	200,2	4,283	-0,001	0,011	-0,294	0,154	0,332
1B2	Oil and Natural Gas	CO2	94,3	752,0	5	100	100,1	1,540	0,007	0,008	0,734	0,055	0,736
1B2	Oil and Natural Gas	CH4	165,4	301,5	5	100	100,1	0,618	0,002	0,003	0,226	0,022	0,227
1B2	Oil and Natural Gas	N2O	0,4	0,8	5	1000	1000,0	0,017	0,000	0,000	0,007	0,000	0,007
2A1	Cement Production	CO2	2454,5	1040,0	1,5	1,5	2,1	0,045	-0,002	0,011	-0,003	0,023	0,023
2A2	Lime Production	CO2	450,1	324,6	2	2	2,8	0,019	0,001	0,003	0,002	0,010	0,010
2A3	Glass production	CO2	186,2	90,8	10	10	14,1	0,026	0,000	0,001	0,000	0,013	0,013
2A4a	Ceramics - Bricks and Tails	CO2	522,5	88,4	3	5	5,8	0,011	-0,002	0,001	-0,009	0,004	0,010
2A4b	Soda ash uses	CO2	126,6	217,1	2	1	2,2	0,010	0,002	0,002	0,002	0,006	0,007
2A4d	DeSOx - instalations	CO2	0,0	890,4	1,5	1,5	2,1	0,039	0,009	0,009	0,014	0,020	0,024
2B1	Ammonia Production	CO2	2557,5	485,6	2	7	7,3	0,072	-0,009	0,005	-0,060	0,014	0,061
2B2	Nitric Acid Production	N2O	1718,1	58,8	2	10	10,2	0,012	-0,009	0,001	-0,085	0,002	0,085
2B5b	Calcium Carbide	CO2	73,9	1,1	5	10	11,2	0,000	0,000	0,000	-0,004	0,000	0,004
2B7	Soda ash production	CO2	397,6	450,7	2	2	2,8	0,026	0,003	0,005	0,005	0,013	0,014
2B8	Petrochemical and carbon black production	CH4	19,5	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	-0,070	0,000	0,070
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

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%	%	%	%	%	%	%	%
2C1	Iron and Steel Production	CO2	3481,4	10,5	5	5	7,1	0,002	-0,018	0,000	-0,092	0,001	0,092
2C1	Iron and Steel Production	CH4	36,3	0,0	10	25	26,9	0,000	0,000	0,000	-0,005	0,000	0,005
2C2	Ferroalloys Production	CO2	254,9	0,0	5	25	25,5	0,000	-0,001	0,000	-0,034	0,000	0,034
2C2	Ferroalloys Production	CH4	2,6	0,0	5	25	25,5	0,000	0,000	0,000	0,000	0,000	0,000
2C2	Lead production	CO2	162,8	9,2	5	15	15,8	0,003	-0,001	0,000	-0,012	0,001	0,012
2C2	Zinc production	CO2	90,5	131,5	5	15	15,8	0,043	0,001	0,001	0,013	0,010	0,017
2D	Non-energy products from fuels and solvent use	CO2	138,6	16,0	10	30	31,6	0,010	-0,001	0,000	-0,017	0,002	0,017
2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0,0	701,9	10	50	51,0	0,732	0,007	0,007	0,366	0,103	0,380
2G	Other product manufacture and use	N2O	29,0	12,3	10	1	10,0	0,003	0,000	0,000	0,000	0,002	0,002
2G	Other product manufacture and use	CO2	26,7	22,2	10	30	31,6	0,014	0,000	0,000	0,003	0,003	0,004
2G1	Electrical equipment - SF6	CO2eq	3,4	24,0	10	50	51,0	0,025	0,000	0,000	0,012	0,004	0,012
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	3443,8	1312,4	0,64	20	20,0	0,537	-0,005	0,014	-0,092	0,012	0,093
3A2	Sheep	CH4	1795,8	246,9	1,63	20	20,1	0,101	-0,007	0,003	-0,139	0,006	0,139
3A3	Swine	CH4	169,8	27,2	0,51	50	50,0	0,028	-0,001	0,000	-0,031	0,000	0,031
3A4	Other livestock	CH4	270,4	83,4	2	50	50,0	0,085	-0,001	0,001	-0,028	0,002	0,028
3B	N2O em. from Manure Management	N2O	842,3	258,2	2	300	300,0	1,585	-0,002	0,003	-0,535	0,008	0,535
3B1	Cattle	CH4	530,0	265,0	25	20	32,0	0,174	0,000	0,003	-0,001	0,098	0,098
3B2	Sheep	CH4	52,4	7,2	50	20	53,9	0,008	0,000	0,000	-0,004	0,005	0,007
3B3	Swine	CH4	582,3	76,3	25	20	32,0	0,050	-0,002	0,001	-0,046	0,028	0,054
3B4	Other livestock	CH4	49,3	14,7	50	30	58,3	0,018	0,000	0,000	-0,003	0,011	0,011

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%	%	%	%	%	%	%	%
3C	Rice Cultivation	CH4	142,2	106,7	20	60	63,2	0,138	0,000	0,001	0,021	0,031	0,038
3Da	Direct N2O emissions from managed soils	N2O	4304,0	2690,0	3	200	200,0	11,008	0,005	0,028	1,036	0,119	1,043
3Db	Indirect N2O Emissions from managed soils	N2O	1307,0	738,4	3	500	500,0	7,554	0,001	0,008	0,378	0,033	0,379
3F	Field burning of agricultural residues	CH4	32,6	30,4	3	50	50,1	0,031	0,000	0,000	0,007	0,001	0,007
3F	Field burning of agricultural residues	N2O	7,4	6,5	3	20	20,2	0,003	0,000	0,000	0,001	0,000	0,001
3G	Liming	CO2	29,1	24,4	3	20	20,2	0,010	0,000	0,000	0,002	0,001	0,002
3H	Urea application	CO2	60,5	55,5	2	50	50,0	0,057	0,000	0,001	0,013	0,002	0,013
4A1	Forest Land remaining Forest Land	CO2	-13236,9	-8188,6	3	240	240,0	-40,208	-0,015	-0,085	-3,618	-0,362	3,636
4A2	Land converted to Forest Land	CO2	-3018,8	-189,1	3	43	43,1	-0,167	0,014	-0,002	0,605	-0,008	0,605
4A1 (V)	Forest fires	CO2eq	1,6	31,7	10	102,89	103,4	0,067	0,000	0,000	0,033	0,005	0,033
4A2 (V)	Forest fires	CO2eq	0,2	0,6	10	83,36	84,0	0,001	0,000	0,000	0,000	0,000	0,000
4B1	Cropland remainig Cropland	CO2	-232,3	-107,5	3	207	207,0	-0,455	0,000	-0,001	0,024	-0,005	0,024
4B2	Land converted to Cropland	CO2	60,3	453,3	10	12,3	15,9	0,147	0,004	0,005	0,054	0,067	0,086
4C1	Grassland remaining grassland	CO2	125,4	90,4	5	143	143,1	0,265	0,000	0,001	0,040	0,007	0,040
4C2	Land converted to Grassland	CO2	-998,8	-927,9	10	28	29,7	-0,564	-0,004	-0,010	-0,122	-0,137	0,183
4D2	Land converted to Wetlands	CO2	49,5	79,4	10	11	14,9	0,024	0,001	0,001	0,006	0,012	0,013
4E2	Land converted to Settlements	CO2	112,7	171,0	10	9	13,5	0,047	0,001	0,002	0,011	0,025	0,027
4F	Land converted to other land	CO2	0,0	0,0	10	0	10,0	0,000	0,000	0,000	0,000	0,000	0,000
4G	Harvested wood products	CO2	-583,3	-970,3	10	98	98,5	-1,955	-0,007	-0,010	-0,688	-0,143	0,702

IPCC Source category		GHG	Base year emissions (1988)	Year 2022 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.		%	%	%	%	%	%	%	%	%
4	Indirect N2O Emissions from managed soils	N2O	12,4	17,0	3	500	500,0	0,174	0,000	0,000	0,055	0,001	0,055
5A	Solid waste disposal	CH4	2001,0	2162,3	30	80	85,4	3,162	0,010	0,019	0,798	0,807	1,135
5B	Biological treatment of solid waste	CH4	0,0	8,5	30	400	401,1	0,058	0,000	0,000	0,030	0,003	0,030
5B	Biological treatment of solid waste	N2O	0,0	4,7	30	30	42,4	0,003	0,000	0,000	0,001	0,002	0,002
5C	Incineration and open burning of waste	CO2	18,5	11,9	10	100	100,5	0,020	0,000	0,000	0,002	0,001	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	1,3	0,3	10	100	100,5	0,000	0,000	0,000	0,000	0,000	0,000
5D	Wastewater treatment and discharge	CH4	3051,0	507,9	67	52	84,8	0,737	-0,009	0,004	-0,485	0,423	0,644
5D	Wastewater treatment and discharge	N2O	212,6	112,8	20	50	53,9	0,104	0,000	0,001	0,002	0,028	0,028
Total			**95934,3**	**48880,8**				**42,86**					**4,34**
%			**100,0**	**100,0**									
National total			**95934,3**	**48880,8**									

** 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	0,802	0,000	0,105	0,000	0,447	0,447
1A1	Solid fuels	CO2	25416,6	25416,6	1	2	2,2	0,592	0,000	0,265	0,000	0,375	0,375
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	21,1	21,1	3	50	50,1	0,011	0,000	0,000	0,000	0,001	0,001
1A1	All fuel	N2O	121,1	121,1	3	200	200,0	0,253	0,000	0,001	0,000	0,005	0,005
1A2	Liquid fuels	CO2	7319,8	7319,8	3	7	7,6	0,581	0,000	0,076	0,000	0,324	0,324
1A2	Solid fuels	CO2	10047,7	10047,7	1	2	2,2	0,234	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	35,5	35,5	3	50	50,1	0,019	0,000	0,000	0,000	0,002	0,002
1A2	All fuel	N2O	92,4	92,4	3	200	200,0	0,193	0,000	0,001	0,000	0,004	0,004
1A3a	Liquid fuel	CO2	208,9	208,9	5	5	7,1	0,015	0,000	0,002	0,000	0,015	0,015
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	1,6	1,6	5	40	40,3	0,001	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.		%	%	%	%	%	%	%	%	%
1A3b	Gasoline	CO2	4216,6	4216,6	3	5	5,8	0,256	0,000	0,044	0,000	0,186	0,186
1A3b	Diesel Oil	CO2	2635,8	2635,8	3	5	5,8	0,160	0,000	0,027	0,000	0,117	0,117
1A3b	All fuel	CH4	78,2	78,2	3	40	40,1	0,033	0,000	0,001	0,000	0,003	0,003
1A3b	All fuel	N2O	54,6	54,6	3	40	40,1	0,023	0,000	0,001	0,000	0,002	0,002
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	4,4	4,4	3	5	5,8	0,000	0,000	0,000	0,000	0,000	0,000
1A3b	Other fossil 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
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	0,253	0,000	0,029	0,000	0,208	0,208
1A4	Solid fuel	CO2	3548,1	3548,1	2	5	5,4	0,199	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	374,8	374,8	5	50	50,2	0,196	0,000	0,004	0,000	0,028	0,028
1A4	All fuel	N2O	186,5	186,5	5	200	200,1	0,389	0,000	0,002	0,000	0,014	0,014
1A5	Stationary - Fossil fuels	CO2	5093,8	5093,8	5	7	8,6	0,457	0,000	0,053	0,000	0,375	0,375
1A5	Stationary - Fossil fuels	CH4	5,4	5,4	5	50	50,2	0,003	0,000	0,000	0,000	0,000	0,000
1A5	Stationary - Fossil fuels	N2O	8,7	8,7	5	200	200,2	0,118	0,000	0,000	-0,013	0,004	0,014
1B1	Solid fuel	CO2	68,8	68,8	10	200	200,2	0,144	0,000	0,001	0,000	0,010	0,010

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.		%	%	%	%	%	%	%	%	%
1B1	Solid fuel	CH4	2329,2	2329,2	10	200	200,2	4,862	0,000	0,024	0,000	0,343	0,343
1B2	Oil and Natural Gas	CO2	94,3	94,3	5	100	100,1	0,098	0,000	0,001	0,000	0,007	0,007
1B2	Oil and Natural Gas	CH4	165,4	165,4	5	100	100,1	0,173	0,000	0,002	0,000	0,012	0,012
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	0,027	0,000	0,002	0,000	0,027	0,027
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	0,194	0,000	0,027	0,000	0,075	0,075
2B2	Nitric Acid Production	N2O	1718,1	1718,1	2	10	10,2	0,183	0,000	0,018	0,000	0,051	0,051
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	19,5	19,5	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	0,140	0,000	0,005	0,000	0,033	0,033
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	36,3	36,3	10	25	26,9	0,010	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	2,6	2,6	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

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.		%	%	%	%	%	%	%	%	%
2D	Non-energy products from fuels and solvent use	CO2	138,6	138,6	10	30	31,6	0,046	0,000	0,001	0,000	0,020	0,020
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	29,0	29,0	10	1	10,0	0,003	0,000	0,000	0,000	0,004	0,004
2G	Other product manufacture and use	CO2	26,7	26,7	10	30	31,6	0,009	0,000	0,000	0,000	0,004	0,004
2G1	Electrical equipment - SF6	CO2eq	3,4	3,4	10	50	51,0	0,002	0,000	0,000	0,000	0,001	0,001
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	3443,8	3443,8	0,64	20	20,0	0,718	0,000	0,036	0,000	0,032	0,032
3A2	Sheep	CH4	1795,8	1795,8	1,63	20	20,1	0,376	0,000	0,019	0,000	0,043	0,043
3A3	Swine	CH4	169,8	169,8	0,51	50	50,0	0,088	0,000	0,002	0,000	0,001	0,001
3A4	Other livestock	CH4	270,4	270,4	2	50	50,0	0,141	0,000	0,003	0,000	0,008	0,008
3B	N2O em. from Manure Management	N2O	842,3	842,3	2	300	300,0	2,634	0,000	0,009	0,000	0,025	0,025
3B1	Cattle	CH4	530,0	530,0	25	20	32,0	0,177	0,000	0,006	0,000	0,195	0,195
3B2	Sheep	CH4	52,4	52,4	50	20	53,9	0,029	0,000	0,001	0,000	0,039	0,039
3B3	Swine	CH4	582,3	582,3	25	20	32,0	0,194	0,000	0,006	0,000	0,215	0,215
3B4	Other livestock	CH4	49,3	49,3	50	30	58,3	0,030	0,000	0,001	0,000	0,036	0,036
3C	Rice Cultivation	CH4	142,2	142,2	20	60	63,2	0,094	0,000	0,001	0,000	0,042	0,042
3Da	Direct N2O emissions from managed soils	N2O	4304,0	4304,0	3	200	200,0	8,974	0,000	0,045	0,000	0,190	0,190
3Db	Indirect N2O Emissions from managed soils	N2O	1307,0	1307,0	3	500	500,0	6,812	0,000	0,014	0,000	0,058	0,058
3F	Field burning of agricultural residues	CH4	32,6	32,6	3	50	50,1	0,017	0,000	0,000	0,000	0,001	0,001
3F	Field burning of agricultural residues	N2O	7,4	7,4	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 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.		%	%	%	%	%	%	%	%	%
3G	Liming	CO2	29,1	29,1	3	20	20,2	0,008	0,000	0,000	0,002	0,001	0,002
3H	Urea application	CO2	60,5	60,5	2	50	50,0	0,032	0,000	0,001	0,000	0,002	0,002
4A1	Forest Land remaining Forest Land	CO2	-13236,9	-13236,9	30	80	85,4	-11,789	0,000	-0,138	0,000	-5,854	5,854
4A2	Land converted to Forest Land	CO2	-3018,8	-3018,8	30	400	401,1	-12,622	0,000	-0,031	0,000	-1,335	1,335
4A1 (V)	Forest fires	CO2eq	1,6	1,6	30	30	42,4	0,001	0,000	0,000	0,000	0,001	0,001
4A2 (V)	Forest fires	CO2eq	0,2	0,2	10	100	100,5	0,000	0,000	0,000	0,000	0,000	0,000
4B1	Cropland remainig Cropland	CO2	-232,3	-232,3	10	100	100,5	-0,243	0,000	-0,002	0,000	-0,034	0,034
4B2	Land converted to Cropland	CO2	60,3	60,3	10	100	100,5	0,063	0,000	0,001	0,000	0,009	0,009
4C1	Grassland remaining grassland	CO2	125,4	125,4	67	52	84,8	0,111	0,000	0,001	0,000	0,124	0,124
4C2	Land converted to Grassland	CO2	-998,8	-998,8	20	50	53,9	-0,561	0,000	-0,010	0,000	-0,294	0,294
4D2	Land converted to Wetlands	CO2	49,5	49,5	10	24,5434087	26,5	0,014	0,000	0,001	0,000	0,007	0,007
4E2	Land converted to Settlements	CO2	112,7	112,7	10	74,33034374	75,0	0,088	0,000	0,001	0,000	0,017	0,017
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	-0,448	0,000	-0,006	0,000	-0,086	0,086
4	Indirect N2O Emissions from managed soils	N2O	12,4	12,4	3	500	500,0	0,065	0,000	0,000	0,000	0,001	0,001
5A	Solid waste disposal	CH4	2001,0	2001,0	30	400	401,1	8,367	0,000	0,021	0,000	0,885	0,885
5B	Biological treatment of solid waste	CH4	0,0	0,0	30	30	42,4	0,000	0,000	0,000	0,000	0,000	0,000
5B	Biological treatment of solid waste	N2O	0,0	0,0	10	100	100,5	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.		%	%	%	%	%	%	%	%	%
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	1,3	1,3	67	52	84,8	0,001	0,000	0,000	0,000	0,001	0,001
5D	Wastewater treatment and discharge	CH4	3051,0	3051,0	20	50	53,9	1,713	0,000	0,032	0,000	0,900	0,900
5D	Wastewater treatment and discharge	N2O	212,6	212,6	0	0	0,0	0,000	0,000	0,002	0,000	0,000	0,000
Total			**95934,3**	**95934,3**				**23,08**					**6,23**
%			**100,0**	**100,0**									
National Total			**95934,3**	**95934,3**									

** 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 CRT categories and by using the following corresponding NCVs in the calculation model:

Eurostat Category	CRT 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)
Chemical and petrochemical	1A2c	Used in industry (net)

Eurostat Category	CRT Category	NCV applied
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
Gaseous fuels: Natural Gas	Petroleum Coke 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/kg)

[MJ/kg]	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
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

[MJ/kg]	Anthracite	Coking Coal	Other Bituminous Coal	Sub-bituminous Coal	Lignite / Brown Coal	BKB	Coke Oven Coke
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
2020	30.109	-	24.404	-	6.995	10.683	28.500
2021	28.680	-	23.713	-	6.951	9.977	28.500
2022	25.476	-	22.273	-	6.953	9.498	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) 1988-2005

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PC Gasoline Small	PRE ECE	527486	555663	524909	486948	443517	428371	408075	379241	344811	303418	274608	254884	234492	215638	200013	193900	186203	175749
PC Gasoline Small	ECE 15/00-01	-	-	23671	49514	76264	83044	84688	84016	81287	75848	72499	70746	68068	65066	62283	61781	60077	56680
PC Gasoline Small	ECE 15/02	-	-	11836	24757	38132	55363	74323	93445	111749	126699	145437	152187	141211	129152	117017	108179	95777	79206
PC Gasoline Small	ECE 15/03	-	-	9863	20631	31777	46135	61936	77871	93124	105582	121197	140914	160772	181833	190143	179359	163375	141064
PC Gasoline Small	ECE 15/04	-	-	8507	17794	27407	39792	53420	67163	80320	91065	104533	121539	138666	156831	177665	209114	242567	275324
PC Gasoline Small	Euro 1	-	-	-	-	8623	18778	30251	42260	54148	64462	76736	91769	107081	123351	141887	169172	198416	227376
PC Gasoline Small	Euro 2	-	-	-	-	-	-	-	-	10274	20384	31198	43529	56435	70211	85656	106991	130312	154072
PC Gasoline Small	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	11786	24438	38332	55860	75595	96529
PC Gasoline Small	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11592
PC Gasoline Small	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	PRE ECE	565259	582380	538100	488281	435039	411044	383067	348282	309807	266720	236179	214480	193060	173705	157639	149521	140483	127868
PC Gasoline Medium	ECE 15/00-01	-	-	24266	49649	74806	79685	79498	77157	73035	66674	62354	59531	56042	52413	49089	47641	45325	41238
PC Gasoline Medium	ECE 15/02	-	-	12133	24825	37403	53123	69768	85817	100405	111375	125084	128063	116261	104037	92227	83420	72260	57627
PC Gasoline Medium	ECE 15/03	-	-	10111	20687	31169	44269	58140	71514	83671	92812	104236	118577	132365	146474	149861	138308	123260	102633
PC Gasoline Medium	ECE 15/04	-	-	8721	17843	26884	38182	50146	61681	72166	80051	89904	102272	114165	126333	140026	161253	183007	200315
PC Gasoline Medium	Euro 1	-	-	-	-	8458	18019	28397	38811	48652	56666	65997	77222	88161	99364	111828	130453	149697	165430
PC Gasoline Medium	Euro 2	-	-	-	-	-	-	-	-	9231	17919	26832	36629	46464	56557	67510	82503	98315	112097
PC Gasoline Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	9703	19686	30211	43075	57034	70231
PC Gasoline Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8434
PC Gasoline Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	PRE ECE	128039	131915	121884	110598	98537	93101	86763	78883	70168	60408	53490	48575	43723	39339	35700	33861	31814	28855
PC Gasoline Large	ECE 15/00-01	-	-	5496	11246	16944	18048	18006	17475	16542	15101	14122	13483	12692	11870	11117	10789	10264	9306
PC Gasoline Large	ECE 15/02	-	-	2748	5623	8472	12032	15802	19437	22740	25225	28329	29003	26330	23561	20886	18891	16364	13004
PC Gasoline Large	ECE 15/03	-	-	2290	4686	7060	10027	13168	16197	18950	21021	23608	26855	29977	33172	33938	31322	27913	23160
PC Gasoline Large	ECE 15/04	-	-	1975	4041	6089	8648	11358	13970	16345	18130	20362	23162	25855	28611	31711	36518	41443	45203
PC Gasoline Large	Euro 1	-	-	-	-	1916	4081	6432	8790	11019	12834	14947	17489	19966	22503	25325	29543	33900	37331
PC Gasoline Large	Euro 2	-	-	-	-	-	-	-	-	2091	4058	6077	8296	10523	12809	15289	18684	22264	25296
PC Gasoline Large	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	2198	4458	6842	9755	12916	15848
PC Gasoline Large	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1903
PC Gasoline Large	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Conventional	-	-	3103	6239	9276	12253	15164	18014	20534	22949	25280	27452	29042	30472	31590	32158	32392	32074
PC Diesel Small	Euro 1	-	-	-	-	130	353	672	1085	1563	2105	2701	3403	4184	5022	5999	7231	8592	10017
PC Diesel Small	Euro 2	-	-	-	-	-	-	-	-	297	666	1098	1614	2205	2858	3622	4573	5643	6788
PC Diesel Small	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	461	995	1621	2388	3274	4253
PC Diesel Small	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	511
PC Diesel Small	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PC Diesel Small	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Conventional	-	-	4775	9598	14270	18847	23324	27706	31580	35292	38874	42212	44653	46849	48566	49436	49791	49269
PC Diesel Medium	Euro 1	-	-	-	-	199	542	1034	1669	2404	3238	4153	5233	6434	7720	9223	11116	13208	15388
PC Diesel Medium	Euro 2	-	-	-	-	-	-	-	-	456	1024	1689	2482	3391	4394	5568	7030	8674	10427
PC Diesel Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	708	1530	2492	3671	5032	6533
PC Diesel Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	784
PC Diesel Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Conventional	-	-	3049	6017	8783	11386	13828	16118	18023	19756	21341	22721	23562	24228	24611	24543	24211	23194
PC Diesel Large	Euro 1	-	-	-	-	123	328	613	971	1372	1813	2280	2817	3395	3993	4674	5519	6422	7244
PC Diesel Large	Euro 2	-	-	-	-	-	-	-	-	260	573	927	1336	1789	2273	2822	3490	4218	4909
PC Diesel Large	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	374	791	1263	1822	2447	3075
PC Diesel Large	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	369
PC Diesel Large	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG	Conventional	-	-	-	-	-	-	-	-	-	6196	12074	17613	22475	26889	30729	33725	36060	37368
PC LPG	Euro 1	-	-	-	-	-	-	-	-	-	568	1290	2183	3238	4431	5836	7583	9565	11671
PC LPG	Euro 2	-	-	-	-	-	-	-	-	-	180	524	1036	1707	2522	3523	4796	6282	7908
PC LPG	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	356	878	1577	2504	3644	4955
PC LPG	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	595
PC LPG	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2978	5956
PC CNG	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline	Conventional	156706	162548	168677	177652	182050	188269	190053	189866	184080	175966	172205	171870	167508	164059	163470	164291	164216	159848
LCV Gasoline	Euro 1	-	-	-	-	4834	10337	16200	22361	28119	33516	39823	41431	41974	42815	44526	46815	49080	50254
LCV Gasoline	Euro 2	-	-	-	-	-	-	-	-	4374	8689	13274	18414	23427	28809	30100	31408	32675	33195
LCV Gasoline	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	4377	8971	14060	19802	26073	32187
LCV Gasoline	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8012
LCV Gasoline	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel	Conventional	36189	38083	40077	42897	44635	46913	47941	48407	47375	45633	45136	45499	44757	44271	44540	45232	45660	44847
LCV Diesel	Euro 1	-	-	-	-	1185	2576	4086	5701	7237	8692	10438	10968	11215	11553	12132	12889	13647	14099
LCV Diesel	Euro 2	-	-	-	-	-	-	-	-	1126	2253	3479	4875	6259	7774	8201	8647	9085	9313
LCV Diesel	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	1169	2421	3831	5452	7250	9031
LCV Diesel	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2248
LCV Diesel	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Gasoline >3,5t	Conventional	3198	3317	3442	3626	3814	4053	4209	4331	4420	4452	4598	4729	4843	4993	5146	5353	5552	5786
HDV Diesel Rigid <=7,5t	Conventional	4266	4365	4463	4640	4688	4781	4738	4636	4395	4098	3921	3820	3630	3465	3362	3289	3195	3157
HDV Diesel Rigid <=7,5t	Euro I	-	-	-	-	124	262	404	546	671	781	907	921	910	904	916	937	955	993
HDV Diesel Rigid <=7,5t	Euro II	-	-	-	-	-	-	-	-	104	202	302	409	508	608	619	629	636	656
HDV Diesel Rigid <=7,5t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	95	189	289	396	507	636
HDV Diesel Rigid <=7,5t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	158
HDV Diesel Rigid <=7,5t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid <=7,5t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5-12t	Conventional	1810	1873	1939	2041	2088	2157	2167	2151	2069	1959	1904	1886	1823	1771	1751	1746	1731	1673

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HDV Diesel Rigid 7,5-12t	Euro I	-	-	-	-	55	118	185	253	316	373	440	455	457	462	477	498	517	526
HDV Diesel Rigid 7,5-12t	Euro II	-	-	-	-	-	-	-	-	49	97	147	202	255	311	322	334	344	348
HDV Diesel Rigid 7,5-12t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	48	97	151	210	275	337
HDV Diesel Rigid 7,5-12t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	84
HDV Diesel Rigid 7,5-12t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5-12t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12-14t	Conventional	599	616	634	663	675	693	692	682	652	613	592	582	558	538	528	522	513	491
HDV Diesel Rigid 12-14t	Euro I	-	-	-	-	18	38	59	80	100	117	137	140	140	140	144	149	153	154
HDV Diesel Rigid 12-14t	Euro II	-	-	-	-	-	-	-	-	15	30	46	62	78	94	97	100	102	102
HDV Diesel Rigid 12-14t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	15	29	45	63	81	99
HDV Diesel Rigid 12-14t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25
HDV Diesel Rigid 12-14t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12-14t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 14-20t	Conventional	1960	2015	2071	2165	2199	2256	2249	2215	2113	1984	1912	1877	1798	1730	1693	1672	1640	1559
HDV Diesel Rigid 14-20t	Euro I	-	-	-	-	58	124	192	261	323	378	442	452	450	452	461	476	490	490
HDV Diesel Rigid 14-20t	Euro II	-	-	-	-	-	-	-	-	50	98	147	201	251	304	312	320	326	324
HDV Diesel Rigid 14-20t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	47	95	146	202	260	314
HDV Diesel Rigid 14-20t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78
HDV Diesel Rigid 14-20t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 14-20t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 20-26t	Conventional	1719	1762	1806	1882	1905	1948	1935	1899	1806	1688	1621	1584	1511	1447	1410	1385	1351	1262
HDV Diesel Rigid 20-26t	Euro I	-	-	-	-	51	107	165	224	276	322	375	382	379	378	384	395	404	397
HDV Diesel Rigid 20-26t	Euro II	-	-	-	-	-	-	-	-	43	83	125	170	211	254	260	265	269	262
HDV Diesel Rigid 20-26t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	39	79	121	167	215	254
HDV Diesel Rigid 20-26t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	63
HDV Diesel Rigid 20-26t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 20-26t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26-28t	Conventional	259	271	284	302	313	328	333	335	326	313	308	309	303	299	299	302	304	289
HDV Diesel Rigid 26-28t	Euro I	-	-	-	-	8	18	28	39	50	60	71	75	76	78	81	86	91	91
HDV Diesel Rigid 26-28t	Euro II	-	-	-	-	-	-	-	-	8	15	24	33	42	52	55	58	60	60
HDV Diesel Rigid 26-28t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	8	16	26	36	48	58
HDV Diesel Rigid 26-28t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
HDV Diesel Rigid 26-28t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26-28t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28-32t	Conventional	196	208	222	240	252	268	276	281	278	270	270	274	272	272	276	282	287	280
HDV Diesel Rigid 28-32t	Euro I	-	-	-	-	7	15	24	33	42	51	62	66	68	71	75	80	86	88
HDV Diesel Rigid 28-32t	Euro II	-	-	-	-	-	-	-	-	7	13	21	29	38	48	51	54	57	58
HDV Diesel Rigid 28-32t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	7	15	24	34	46	56
HDV Diesel Rigid 28-32t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
HDV Diesel Rigid 28-32t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28-32t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32t	Conventional	139	145	152	161	166	173	176	176	171	163	160	160	156	154	153	154	155	148
HDV Diesel Rigid >32t	Euro I	-	-	-	-	4	10	15	21	26	31	37	39	39	40	42	44	46	47
HDV Diesel Rigid >32t	Euro II	-	-	-	-	-	-	-	-	4	8	12	17	22	27	28	30	31	31
HDV Diesel Rigid >32t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	4	8	13	19	25	30
HDV Diesel Rigid >32t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
HDV Diesel Rigid >32t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 14-20t	Conventional	57	71	86	105	121	141	157	172	181	187	196	210	218	227	239	254	268	278
HDV Diesel Art. 14-20t	Euro I	-	-	-	-	3	8	13	20	28	36	45	51	55	59	65	73	80	87
HDV Diesel Art. 14-20t	Euro II	-	-	-	-	-	-	-	-	4	9	15	22	30	40	44	49	53	58
HDV Diesel Art. 14-20t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	6	12	21	31	43	56

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HDV Diesel Art. 14-20t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
HDV Diesel Art. 14-20t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 14-20t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 20-28t	Conventional	192	200	208	221	227	236	239	239	231	221	216	216	210	206	205	206	206	201
HDV Diesel Art. 20-28t	Euro I	-	-	-	-	6	13	20	28	35	42	50	52	53	54	56	59	61	63
HDV Diesel Art. 20-28t	Euro II	-	-	-	-	-	-	-	-	6	11	17	23	29	36	38	39	41	42
HDV Diesel Art. 20-28t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	5	11	18	25	33	40
HDV Diesel Art. 20-28t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
HDV Diesel Art. 20-28t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 20-28t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 28-34t	Conventional	302	307	312	322	323	326	321	311	293	270	256	247	231	218	209	201	192	178
HDV Diesel Art. 28-34t	Euro I	-	-	-	-	9	18	27	37	45	51	59	59	58	57	57	57	58	56
HDV Diesel Art. 28-34t	Euro II	-	-	-	-	-	-	-	-	7	13	20	26	32	38	38	38	38	37
HDV Diesel Art. 28-34t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	6	12	18	24	31	36
HDV Diesel Art. 28-34t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9
HDV Diesel Art. 28-34t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 28-34t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 34-40t	Conventional	1812	1841	1869	1929	1932	1954	1919	1860	1745	1609	1522	1464	1373	1292	1234	1187	1132	1007
HDV Diesel Art. 34-40t	Euro I	-	-	-	-	51	107	164	219	267	306	352	353	344	337	336	338	338	317
HDV Diesel Art. 34-40t	Euro II	-	-	-	-	-	-	-	-	41	79	117	157	192	227	227	227	225	209
HDV Diesel Art. 34-40t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	36	71	106	143	180	203
HDV Diesel Art. 34-40t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50
HDV Diesel Art. 34-40t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 34-40t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 40-50t	Conventional	1367	1432	1501	1599	1657	1734	1765	1774	1729	1659	1634	1640	1607	1583	1586	1604	1613	1575
HDV Diesel Art. 40-50t	Euro I	-	-	-	-	44	95	150	209	264	316	378	395	403	413	432	457	482	495
HDV Diesel Art. 40-50t	Euro II	-	-	-	-	-	-	-	-	41	82	126	176	225	278	292	307	321	327
HDV Diesel Art. 40-50t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	42	87	136	193	256	317
HDV Diesel Art. 40-50t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	79
HDV Diesel Art. 40-50t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 40-50t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 50-60t	Conventional	30	33	36	40	43	47	50	52	52	51	52	54	55	55	57	59	61	61
HDV Diesel Art. 50-60t	Euro I	-	-	-	-	1	3	4	6	8	10	12	13	14	14	15	17	18	19
HDV Diesel Art. 50-60t	Euro II	-	-	-	-	-	-	-	-	1	3	4	6	8	10	10	11	12	13
HDV Diesel Art. 50-60t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	1	3	5	7	10	12
HDV Diesel Art. 50-60t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
HDV Diesel Art. 50-60t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 50-60t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15t	Conventional	563	667	775	980	1128	1336	1449	1466	1396	1309	1347	1366	1352	1353	1356	1380	813	851
BUS Diesel Urban Midi <=15t	Euro I	-	-	-	-	30	73	122	170	210	244	304	319	315	314	314	318	187	194
BUS Diesel Urban Midi <=15t	Euro II	-	-	-	-	-	-	-	-	33	63	101	142	182	228	238	242	142	149
BUS Diesel Urban Midi <=15t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	36	76	118	168	129	170
BUS Diesel Urban Midi <=15t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45
BUS Diesel Urban Midi <=15t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Std. 15-18t	Conventional	1126	1335	1549	1960	2256	2672	2897	2932	2793	2617	2695	2731	2704	2706	2713	2759	1627	1701
BUS Diesel Urban Std. 15-18t	Euro I	-	-	-	-	60	146	245	341	419	488	607	638	630	628	628	636	373	389
BUS Diesel Urban Std. 15-18t	Euro II	-	-	-	-	-	-	-	-	65	126	202	284	365	456	476	484	285	298
BUS Diesel Urban Std. 15-18t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	73	151	237	335	258	340
BUS Diesel Urban Std. 15-18t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	90
BUS Diesel Urban Std. 15-18t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Std. 15-18t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
BUS Diesel Urban Art. >18t	Conventional	188	222	258	327	376	445	483	489	465	436	449	455	451	451	452	460	271	284
BUS Diesel Urban Art. >18t	Euro I	-	-	-	-	10	24	41	57	70	81	101	106	105	105	105	106	62	65
BUS Diesel Urban Art. >18t	Euro II	-	-	-	-	-	-	-	-	11	21	34	47	61	76	79	81	47	50
BUS Diesel Urban Art. >18t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	12	25	39	56	43	57
BUS Diesel Urban Art. >18t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
BUS Diesel Urban Art. >18t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Art. >18t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coaches Std. <=18t	Conventional	3576	4203	4840	6072	6936	8150	8765	8799	8315	7731	7898	7943	7802	7745	7705	7775	4548	4661
BUS Diesel Coaches Std. <=18t	Euro I	-	-	-	-	184	445	740	1023	1248	1441	1780	1856	1818	1799	1783	1792	1044	1065
BUS Diesel Coaches Std. <=18t	Euro II	-	-	-	-	-	-	-	-	194	374	593	825	1052	1304	1352	1363	796	815
BUS Diesel Coaches Std. <=18t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	209	432	672	944	722	931
BUS Diesel Coaches Std. <=18t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	246
BUS Diesel Coaches Std. <=18t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coaches Std. <=18t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coaches Art. >18t	Conventional	36	42	49	61	70	82	89	89	84	78	80	80	79	78	78	79	46	47
BUS Diesel Coaches Art. >18t	Euro I	-	-	-	-	2	4	7	10	13	15	18	19	18	18	18	18	11	11
BUS Diesel Coaches Art. >18t	Euro II	-	-	-	-	-	-	-	-	2	4	6	8	11	13	14	14	8	8
BUS Diesel Coaches Art. >18t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	2	4	7	10	7	9
BUS Diesel Coaches Art. >18t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
BUS Diesel Coaches Art. >18t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coaches Art. >18t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	Euro I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	42
BUS CNG Urban	Euro II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	6
BUS CNG Urban	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	7
BUS CNG Urban	EEV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
MOP 2-stroke <50cm³	Conventional	276901	279077	281270	282137	282792	283963	284571	285901	286760	288690	281749	284031	282436	280919	279343	273219	40334	42509
MOP 2-stroke <50cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	3611	7371	11288	15125	2870	3735
MOP 2-stroke <50cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4883	1483	2412
MOP 2-stroke <50cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOP 2-stroke <50cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOP 2-stroke <50cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 2-stroke >50cm³	Conventional	44998	45124	45235	44769	44324	44027	43612	43043	42578	42053	40888	40344	39277	38249	37283	35838	13084	12773
MOT 2-stroke >50cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	502	1004	1507	1984	931	1122
MOT 2-stroke >50cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	641	481	725
MOT 2-stroke >50cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 2-stroke >50cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 2-stroke >50cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke <250cm³	Conventional	51709	52888	54089	54625	55203	55982	56632	57097	57712	58262	57919	58451	58220	58028	57912	57018	21330	21784
MOT 4-stroke <250cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	744	1523	2340	3156	1518	1914
MOT 4-stroke <250cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1019	784	1236
MOT 4-stroke <250cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke <250cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke <250cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke 250-750cm³	Conventional	86181	88146	90149	91042	92005	93304	94387	95161	96186	97103	96532	97418	97033	96714	96520	95030	35550	36307
MOT 4-stroke 250-750cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	1241	2538	3900	5261	2530	3190
MOT 4-stroke 250-750cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1699	1307	2060
MOT 4-stroke 250-750cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke 250-750cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke 250-750cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke >750cm³	Conventional	34472	35258	36060	36417	36802	37322	37755	38064	38474	38841	38613	38967	38813	38686	38608	38012	14220	14523
MOT 4-stroke >750cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	496	1015	1560	2104	1012	1276
MOT 4-stroke >750cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	679	523	824

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
MOT 4-stroke >750cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke >750cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke >750cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 292 Vehicle fleet data for Road transport (number of vehicles) 2006-2023

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PC Gasoline Small	PRE ECE	96809	95716	93836	85057	75627	67190	60939	54955	48977	44545	37584	27459	23033	19778	15466	12551	10820	9528
PC Gasoline Small	ECE 15/00-01	30698	27375	22692	15460	7748	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	ECE 15/02	35084	34536	33119	28681	23575	18429	13544	8381	3031	-	-	-	-	-	-	-	-	-
PC Gasoline Small	ECE 15/03	67244	70340	72644	69023	63965	58835	54809	50284	42431	33053	18700	7346	2476	-	-	-	-	-
PC Gasoline Small	ECE 15/04	170978	187055	202840	203297	199789	196109	196431	195548	190937	185096	152714	102844	86649	73348	53706	41198	28369	18012
PC Gasoline Small	Euro 1	151288	179879	211238	228564	241843	244486	225600	204568	190269	178486	155830	112638	103978	99544	86953	82396	73759	66044
PC Gasoline Small	Euro 2	105248	127983	153241	168645	181126	193514	210238	226321	251910	257435	231888	175731	152440	141457	127872	126340	119150	114077
PC Gasoline Small	Euro 3	69936	89093	110779	125785	138696	151550	167876	183807	182679	205262	229064	223971	227264	227909	198215	192469	193246	196988
PC Gasoline Small	Euro 4	14397	24072	35474	45314	54508	63695	74434	85136	94635	104465	114598	123658	142965	157773	141053	123979	138030	151982
PC Gasoline Small	Euro 5	-	-	-	-	5483	10984	16848	22838	25631	37577	44509	45576	43056	42786	54952	52621	54696	57991
PC Gasoline Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	5067	10040	15891	17600	19737	19521	18204	21552	24388
PC Gasoline Small	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	5867	13158	18151	19186	24629	34951
PC Gasoline Medium	PRE ECE	70025	69103	64827	57608	49514	43467	38560	34010	29643	26365	21751	15538	12742	10696	8175	6484	5463	4700
PC Gasoline Medium	ECE 15/00-01	22205	19763	15677	10471	5073	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	ECE 15/02	25377	24933	22880	19426	15435	11923	8570	5187	1834	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	ECE 15/03	48640	50783	50186	46749	41878	38063	34682	31119	25681	19563	10822	4157	1370	-	-	-	-	-
PC Gasoline Medium	ECE 15/04	123675	135045	140133	137692	130804	126870	124296	121019	115563	109551	88381	58194	47934	39665	28389	21283	14322	8885
PC Gasoline Medium	Euro 1	109432	129865	145934	154805	158337	158167	142753	126601	115158	105639	90184	63736	57521	53832	45962	42567	37237	32579
PC Gasoline Medium	Euro 2	76130	92398	105867	114222	118585	125191	133032	140063	152465	152366	134202	99438	84330	76498	67592	65269	60152	56272
PC Gasoline Medium	Euro 3	50588	64321	76532	85193	90806	98043	106227	113753	110564	121487	132568	126734	125723	123250	104774	99432	97559	97171
PC Gasoline Medium	Euro 4	10414	17379	24507	30691	35687	41207	47099	52688	57277	61829	66322	69972	79089	85321	74559	64049	69684	74970
PC Gasoline Medium	Euro 5	-	-	-	-	3590	7106	10661	14134	15513	22240	25759	25789	23819	23138	29047	27185	27613	28606
PC Gasoline Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	2999	5811	8992	9737	10673	10318	9404	10880	12030
PC Gasoline Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	3246	7116	9595	9912	12434	17241
PC Gasoline Large	PRE ECE	15869	15698	14756	12978	11206	9842	8731	7700	6711	5969	4925	3518	2885	2421	1851	1468	1237	1064
PC Gasoline Large	ECE 15/00-01	5032	4490	3568	2359	1148	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	ECE 15/02	5751	5664	5208	4376	3493	2700	1940	1174	415	-	-	-	-	-	-	-	-	-
PC Gasoline Large	ECE 15/03	11023	11536	11423	10531	9478	8618	7853	7046	5814	4429	2450	941	310	-	-	-	-	-
PC Gasoline Large	ECE 15/04	28026	30677	31897	31018	29603	28727	28143	27401	26165	24803	20010	13175	10852	8980	6427	4818	3242	2011
PC Gasoline Large	Euro 1	24799	29501	33217	34874	35834	35813	32322	28665	26073	23917	20418	14430	13022	12187	10405	9636	8429	7374
PC Gasoline Large	Euro 2	17252	20989	24097	25731	26837	28347	30121	31713	34520	34497	30383	22512	19092	17318	15301	14775	13616	12738
PC Gasoline Large	Euro 3	11464	14611	17420	19192	20551	22200	24052	25756	25033	27505	30013	28692	28462	27902	23719	22509	22084	21996
PC Gasoline Large	Euro 4	2360	3948	5578	6914	8076	9330	10664	11929	12968	13998	15015	15841	17905	19315	16878	14499	15774	16970
PC Gasoline Large	Euro 5	-	-	-	-	812	1609	2414	3200	3512	5035	5832	5839	5392	5238	6576	6154	6251	6475
PC Gasoline Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	679	1316	2036	2204	2416	2336	2129	2463	2723
PC Gasoline Large	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	735	1611	2172	2244	2815	3903
PC Gasoline Hybrid Medium	Euro 4	-	-	-	6	46	102	267	423	706	896	1345	2275	3655	5227	6377	9866	15077	22333
PC Gasoline Hybrid Medium	Euro 5	-	-	-	-	5	18	61	113	191	322	522	839	1101	1418	2484	4188	5974	8522
PC Gasoline Hybrid Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	43	118	292	450	654	883	1449	2354	3584
PC Gasoline Hybrid Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	150	436	821	1527	2690	5136
PC Diesel Small	Conventional	48556	64287	76490	80631	82097	83054	87273	90544	91938	92128	83723	62435	55129	49248	42235	35871	27407	19880

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PC Diesel Small	Euro 1	18328	27864	38006	45899	53559	59623	60447	59911	61298	62596	62425	51091	51109	52642	53092	54989	51583	47675
PC Diesel Small	Euro 2	12750	19825	27571	33867	40112	47193	56331	66281	81156	90283	92893	79709	74930	74807	78076	84316	83326	82348
PC Diesel Small	Euro 3	8472	13801	19931	25260	30716	36959	44980	53830	58853	71986	91762	101590	111709	120526	121026	128449	135144	142199
PC Diesel Small	Euro 4	1744	3729	6382	9100	12071	15534	19944	24933	30488	36636	45907	56089	70273	83436	86124	82740	96529	109710
PC Diesel Small	Euro 5	-	-	-	-	1214	2679	4514	6689	8257	13178	17830	20673	21164	22627	33552	35118	38251	41862
PC Diesel Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	1777	4022	7208	8651	10437	11919	12149	15072	17605
PC Diesel Small	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	2884	6958	11083	12804	17224	25230
PC Diesel Medium	Conventional	74643	98868	117591	123885	126109	127617	134092	139110	141243	141528	128610	95904	84677	75640	64865	55088	42087	30528
PC Diesel Medium	Euro 1	28174	42852	58428	70522	82272	91614	92874	92045	94172	96160	95893	78478	78502	80852	81539	84447	79213	73208
PC Diesel Medium	Euro 2	19600	30489	42386	52034	61617	72514	86550	101833	124680	138694	142696	122437	115090	114895	119910	129486	127959	126451
PC Diesel Medium	Euro 3	13024	21224	30641	38810	47183	56789	69111	82704	90415	110586	140958	156047	171581	185114	185872	197262	207533	218356
PC Diesel Medium	Euro 4	2681	5734	9812	13981	18543	23868	30643	38307	46839	56281	70520	86156	107937	128147	132270	127066	148235	168468
PC Diesel Medium	Euro 5	-	-	-	-	1865	4116	6936	10276	12686	20245	27389	31754	32507	34752	51530	53932	58740	64282
PC Diesel Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	2730	6179	11071	13288	16031	18305	18657	23145	27033
PC Diesel Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	4429	10687	17021	19664	26450	38742
PC Diesel Large	Conventional	35004	45601	52578	53953	53595	53273	54707	55448	54985	53791	47707	34706	29884	26022	21743	17985	13376	9440
PC Diesel Large	Euro 1	13212	19764	26125	30713	34965	38244	37890	36688	36660	36548	35570	28400	27705	27815	27332	27570	25175	22638
PC Diesel Large	Euro 2	9192	14062	18952	22661	26187	30271	35310	40590	48537	52714	52932	44308	40617	39527	40195	42273	40667	39102
PC Diesel Large	Euro 3	6108	9789	13701	16902	20052	23707	28195	32965	35198	42031	52287	56471	60554	63684	62306	64400	65956	67521
PC Diesel Large	Euro 4	1257	2645	4387	6089	7881	9964	12501	15269	18234	21391	26159	31179	38093	44086	44338	41483	47111	52094
PC Diesel Large	Euro 5	-	-	-	-	793	1718	2830	4096	4938	7694	10160	11491	11472	11955	17273	17607	18668	19878
PC Diesel Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	1038	2292	4007	4690	5515	6136	6091	7356	8359
PC Diesel Large	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	1563	3677	5706	6420	8406	11980
PC LPG	Conventional	37526	37918	37853	37374	36317	33911	36824	39173	45684	46060	39958	28736	25707	22919	31727	28094	22109	16383
PC LPG	Euro 1	14164	16434	18808	21275	23693	24344	25505	25919	30459	31295	29793	23515	23832	24499	39882	43066	41613	39288
PC LPG	Euro 2	9854	11693	13644	15698	17744	19269	23768	28676	40326	45138	44334	36687	34940	34814	58650	66035	67220	67861
PC LPG	Euro 3	6548	8140	9864	11708	13588	15090	18979	23289	29244	35990	43795	46757	52090	56090	90914	100599	109023	117183
PC LPG	Euro 4	1348	2199	3159	4218	5340	6342	8415	10787	15149	18317	21910	25815	32768	38829	64696	64801	77872	90410
PC LPG	Euro 5	-	-	-	-	537	1094	1905	2894	4103	6589	8510	9515	9869	10530	25204	27504	30858	34498
PC LPG	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	888	1920	3317	4034	4857	8953	9515	12159	14508
PC LPG	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	1345	3238	8325	10028	13895	20792
PC CNG	Euro 4	8934	11912	14890	17868	20736	19381	19264	19144	19890	21004	20930	20166	22023	23851	26355	27410	25585	24271
PC CNG	Euro 5	-	-	-	-	115	214	323	433	507	783	991	1188	1283	1418	2324	2491	2484	2529
PC CNG	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	106	223	414	525	654	825	862	979	1063
PC CNG	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	175	436	768	908	1118	1524
LCV Gasoline	Conventional	49871	42540	36192	31902	28495	25229	22461	19700	16904	14586	9954	5876	4588	3604	2712	2033	1394	875
LCV Gasoline	Euro 1	16545	15772	16058	15575	14179	12396	12069	11916	11932	11934	9049	6006	5353	4891	4391	4065	3624	3209
LCV Gasoline	Euro 2	10842	11560	12277	12896	12319	11961	11481	11093	11319	11337	10196	7728	7217	6951	6458	6233	5854	5543
LCV Gasoline	Euro 3	12422	12532	12050	10993	11927	12615	13291	13197	12621	12779	11720	10107	9683	9181	8804	9225	9585	9648
LCV Gasoline	Euro 4	5301	8616	9359	8509	7123	6608	7394	7966	7362	7045	6395	6292	6678	6206	5283	4940	5597	5311
LCV Gasoline	Euro 5	-	-	3120	5672	7366	8549	9091	10344	11507	12461	11103	9278	8878	9709	9667	8506	7591	8176
LCV Gasoline	Euro 6 a/b/c	-	-	-	-	-	-	-	-	1650	3748	5218	6435	8288	9146	9213	8401	9097	9929
LCV Diesel	Conventional	64661	73141	77400	78164	79165	79089	77414	74628	69939	65600	55148	37966	31537	26292	21703	17555	12701	8330
LCV Diesel	Euro 1	21452	27117	34342	38160	39393	38859	41595	45143	49368	53673	50135	38809	36794	35683	35137	35110	33022	30543
LCV Diesel	Euro 2	14058	19876	26255	31598	34225	37497	39571	42025	46832	50990	56488	49937	49608	50707	51673	53834	53342	52754
LCV Diesel	Euro 3	16106	21547	25771	26933	33136	39545	45809	49995	52218	57476	64934	65309	66561	66976	70440	79674	87345	91818
LCV Diesel	Euro 4	6873	14813	20015	20847	19789	20716	25483	30177	30461	31685	35428	40656	45906	45275	42274	42669	51004	50550
LCV Diesel	Euro 5	-	-	6671	13898	20465	26801	31334	39187	47611	56043	61513	59951	61027	70829	77345	73463	69171	77815
LCV Diesel	Euro 6 a/b/c	-	-	-	-	-	-	-	-	6826	16858	28907	41581	56972	66724	73717	72562	82894	94496
HDV Gasoline >3,5t	Conventional	1938	1858	1817	1746	1661	1579	1547	1515	1496	1508	1299	1056	1034	1014	950	886	872	871
HDV Diesel Rigid <=7,5t	Conventional	4085	4373	4502	4365	4492	4087	3807	3485	3095	2745	2176	1408	1096	853	654	489	325	195
HDV Diesel Rigid <=7,5t	Euro I	1355	1621	1998	2131	2235	2008	2045	2108	2185	2246	1978	1439	1278	1157	1059	978	846	715

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
HDV Diesel Rigid <=7,5t	Euro II	888	1188	1527	1765	1942	1938	1946	1963	2073	2133	2228	1852	1723	1644	1557	1500	1367	1234
HDV Diesel Rigid <=7,5t	Euro III	1018	1288	1499	1504	1880	2043	2253	2335	2311	2405	2562	2422	2312	2172	2122	2220	2238	2148
HDV Diesel Rigid <=7,5t	Euro IV	434	886	1164	1164	1123	1070	1253	1409	1348	1326	1398	1508	1595	1468	1274	1189	1307	1183
HDV Diesel Rigid <=7,5t	Euro V	-	-	388	776	1161	1385	1541	1830	2107	2345	2427	2223	2120	2297	2331	2047	1772	1821
HDV Diesel Rigid <=7,5t	Euro VI	-	-	-	-	-	-	-	-	302	705	1140	1542	1979	2163	2221	2022	2124	2211
HDV Diesel Rigid 7,5-12t	Conventional	2391	2589	2727	2655	2733	2633	2528	2391	2197	2021	1666	1124	915	747	604	479	339	218
HDV Diesel Rigid 7,5-12t	Euro I	793	960	1210	1296	1360	1294	1359	1446	1551	1654	1514	1149	1068	1014	979	958	882	799
HDV Diesel Rigid 7,5-12t	Euro II	520	703	925	1073	1182	1248	1292	1346	1471	1571	1706	1478	1439	1442	1439	1468	1425	1379
HDV Diesel Rigid 7,5-12t	Euro III	596	763	908	915	1144	1317	1496	1602	1641	1771	1961	1934	1931	1904	1962	2173	2333	2401
HDV Diesel Rigid 7,5-12t	Euro IV	254	524	705	708	683	690	832	967	957	976	1070	1204	1332	1287	1177	1164	1362	1322
HDV Diesel Rigid 7,5-12t	Euro V	-	-	235	472	706	892	1023	1255	1496	1727	1858	1775	1771	2014	2154	2004	1847	2035
HDV Diesel Rigid 7,5-12t	Euro VI	-	-	-	-	-	-	-	-	214	519	873	1231	1653	1897	2053	1979	2214	2471
HDV Diesel Rigid 12-14t	Conventional	697	744	775	762	758	728	692	646	587	533	433	288	231	186	148	115	80	51
HDV Diesel Rigid 12-14t	Euro I	231	276	344	372	377	358	372	391	414	436	394	295	270	253	240	231	209	186
HDV Diesel Rigid 12-14t	Euro II	152	202	263	308	328	345	353	364	393	414	444	379	364	359	353	354	337	321
HDV Diesel Rigid 12-14t	Euro III	174	219	258	263	317	364	409	433	438	467	510	496	488	474	481	524	553	558
HDV Diesel Rigid 12-14t	Euro IV	74	151	200	203	189	191	228	261	256	257	278	309	337	320	289	281	323	307
HDV Diesel Rigid 12-14t	Euro V	-	-	67	136	196	247	280	339	399	455	483	455	448	501	528	483	438	473
HDV Diesel Rigid 12-14t	Euro VI	-	-	-	-	-	-	-	-	57	137	227	316	418	472	503	477	524	575
HDV Diesel Rigid 14-20t	Conventional	2199	2407	2471	2412	2365	2290	2168	2020	1828	1654	1340	889	710	569	451	349	242	152
HDV Diesel Rigid 14-20t	Euro I	730	892	1096	1177	1177	1125	1165	1222	1290	1353	1219	908	828	772	729	698	629	556
HDV Diesel Rigid 14-20t	Euro II	478	654	838	975	1023	1086	1108	1137	1224	1286	1373	1169	1117	1097	1073	1071	1016	960
HDV Diesel Rigid 14-20t	Euro III	548	709	823	831	990	1145	1283	1353	1365	1449	1578	1529	1498	1449	1462	1585	1663	1671
HDV Diesel Rigid 14-20t	Euro IV	234	487	639	643	591	600	714	817	796	799	861	952	1033	979	878	849	971	920
HDV Diesel Rigid 14-20t	Euro V	-	-	213	429	611	776	878	1061	1244	1413	1495	1403	1374	1532	1606	1462	1317	1416
HDV Diesel Rigid 14-20t	Euro VI	-	-	-	-	-	-	-	-	178	425	703	973	1283	1443	1530	1444	1578	1719
HDV Diesel Rigid 20-26t	Conventional	1800	1995	1963	1898	1886	1799	1689	1559	1398	1252	1003	657	518	409	319	243	165	102
HDV Diesel Rigid 20-26t	Euro I	597	740	871	927	938	884	908	943	986	1024	912	671	604	555	517	486	430	372
HDV Diesel Rigid 20-26t	Euro II	391	542	666	767	815	853	863	878	936	973	1027	864	815	789	760	746	694	643
HDV Diesel Rigid 20-26t	Euro III	448	588	654	654	789	900	1000	1045	1043	1097	1181	1130	1093	1042	1036	1104	1137	1119
HDV Diesel Rigid 20-26t	Euro IV	191	404	508	506	471	471	556	631	609	604	644	703	754	704	622	591	664	616
HDV Diesel Rigid 20-26t	Euro V	-	-	169	338	488	610	684	819	951	1069	1119	1037	1002	1102	1137	1018	900	948
HDV Diesel Rigid 20-26t	Euro VI	-	-	-	-	-	-	-	-	136	322	526	719	936	1038	1084	1005	1079	1152
HDV Diesel Rigid 26-28t	Conventional	430	494	513	513	502	512	499	479	447	418	350	240	199	165	136	109	79	52
HDV Diesel Rigid 26-28t	Euro I	143	183	228	251	250	251	268	290	316	342	318	245	232	224	220	219	205	189
HDV Diesel Rigid 26-28t	Euro II	93	134	174	208	217	243	255	270	300	325	359	316	312	318	323	335	331	326
HDV Diesel Rigid 26-28t	Euro III	107	146	171	177	210	256	295	321	334	366	412	413	419	420	440	496	542	568
HDV Diesel Rigid 26-28t	Euro IV	46	100	133	137	125	134	164	194	195	202	225	257	289	284	264	266	317	313
HDV Diesel Rigid 26-28t	Euro V	-	-	44	91	130	173	202	252	305	357	390	379	384	444	484	458	429	481
HDV Diesel Rigid 26-28t	Euro VI	-	-	-	-	-	-	-	-	44	107	183	263	359	419	461	452	514	584
HDV Diesel Rigid 28-32t	Conventional	411	484	506	507	516	524	516	501	473	446	378	262	219	183	152	124	90	59
HDV Diesel Rigid 28-32t	Euro I	136	180	224	248	257	257	277	303	334	365	343	267	255	249	247	248	234	218
HDV Diesel Rigid 28-32t	Euro II	89	132	171	205	223	248	264	282	317	347	387	344	344	354	363	380	379	377
HDV Diesel Rigid 28-32t	Euro III	102	143	168	175	216	262	306	336	353	391	445	450	462	467	494	563	620	656
HDV Diesel Rigid 28-32t	Euro IV	44	98	131	135	129	137	170	203	206	216	243	280	318	316	297	301	362	361
HDV Diesel Rigid 28-32t	Euro V	-	-	44	90	133	178	209	263	322	381	421	413	423	494	543	519	491	556
HDV Diesel Rigid 28-32t	Euro VI	-	-	-	-	-	-	-	-	46	115	198	287	395	465	517	512	589	675
HDV Diesel Rigid >32t	Conventional	217	244	259	255	252	254	247	236	219	204	170	116	96	79	65	52	38	24
HDV Diesel Rigid >32t	Euro I	72	90	115	124	125	125	133	143	155	167	155	119	112	108	105	105	98	90
HDV Diesel Rigid >32t	Euro II	47	66	88	103	109	120	126	133	147	159	175	153	151	153	155	160	158	155
HDV Diesel Rigid >32t	Euro III	54	72	86	88	105	127	146	158	164	179	201	200	203	202	211	237	258	270
HDV Diesel Rigid >32t	Euro IV	23	49	67	68	63	66	81	95	96	99	110	125	140	137	127	127	151	148

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
HDV Diesel Rigid >32t	Euro V	-	-	22	45	65	86	100	124	149	175	190	184	186	214	232	219	205	228
HDV Diesel Rigid >32t	Euro VI	-	-	-	-	-	-	-	-	21	53	89	128	174	202	221	216	245	277
HDV Diesel Art. 14-20t	Conventional	405	461	556	561	563	594	599	594	572	551	475	335	285	243	205	170	125	84
HDV Diesel Art. 14-20t	Euro I	134	171	247	274	280	292	322	359	404	451	432	343	333	330	332	339	326	307
HDV Diesel Art. 14-20t	Euro II	88	125	189	227	243	282	306	335	383	428	487	441	448	469	488	520	526	531
HDV Diesel Art. 14-20t	Euro III	101	136	185	193	236	297	355	398	427	483	559	577	602	619	666	769	861	924
HDV Diesel Art. 14-20t	Euro IV	43	93	144	150	141	156	197	240	249	266	305	359	415	419	400	412	503	508
HDV Diesel Art. 14-20t	Euro V	-	-	48	100	146	201	243	312	390	471	530	529	552	655	731	709	682	783
HDV Diesel Art. 14-20t	Euro VI	-	-	-	-	-	-	-	-	56	142	249	367	515	617	697	701	817	950
HDV Diesel Art. 20-28t	Conventional	279	323	340	330	336	332	321	307	285	264	220	150	123	102	83	67	48	31
HDV Diesel Art. 20-28t	Euro I	93	120	151	161	167	163	173	186	201	216	200	153	144	138	135	133	124	114
HDV Diesel Art. 20-28t	Euro II	61	88	115	133	145	157	164	173	191	205	225	197	194	196	198	204	200	196
HDV Diesel Art. 20-28t	Euro III	70	95	113	114	141	166	190	206	213	232	259	258	260	259	270	302	328	341
HDV Diesel Art. 20-28t	Euro IV	30	65	88	88	84	87	106	124	124	128	141	161	179	175	162	162	192	188
HDV Diesel Art. 20-28t	Euro V	-	-	29	59	87	112	130	161	194	226	245	237	239	274	296	279	260	289
HDV Diesel Art. 20-28t	Euro VI	-	-	-	-	-	-	-	-	28	68	115	164	223	258	282	275	311	351
HDV Diesel Art. 28-34t	Conventional	239	271	252	230	233	209	188	165	140	118	88	53	37	26	17	10	5	2
HDV Diesel Art. 28-34t	Euro I	79	100	112	112	116	103	101	100	99	96	80	54	44	35	28	21	13	6
HDV Diesel Art. 28-34t	Euro II	52	74	85	93	101	99	96	93	94	92	90	69	59	50	41	32	22	11
HDV Diesel Art. 28-34t	Euro III	60	80	84	79	97	105	111	111	105	103	103	91	79	66	56	48	35	20
HDV Diesel Art. 28-34t	Euro IV	25	55	65	61	58	55	62	67	61	57	56	56	55	45	33	25	21	11
HDV Diesel Art. 28-34t	Euro V	-	-	22	41	60	71	76	87	95	101	98	83	72	70	61	44	28	17
HDV Diesel Art. 28-34t	Euro VI	-	-	-	-	-	-	-	-	14	30	46	58	68	66	58	43	33	20
HDV Diesel Art. 34-40t	Conventional	1420	1622	1498	1338	1289	1197	1070	934	785	652	479	282	195	131	82	45	18	2
HDV Diesel Art. 34-40t	Euro I	471	601	665	653	641	588	575	565	554	534	435	288	228	177	132	90	46	6
HDV Diesel Art. 34-40t	Euro II	309	441	508	541	557	568	547	526	525	507	490	371	307	252	195	138	74	11
HDV Diesel Art. 34-40t	Euro III	354	478	499	461	539	599	633	626	586	572	564	485	412	333	265	205	121	19
HDV Diesel Art. 34-40t	Euro IV	151	329	387	357	322	314	352	378	342	315	308	302	284	225	159	110	71	11
HDV Diesel Art. 34-40t	Euro V	-	-	129	238	333	406	433	490	534	557	534	446	378	352	291	189	96	16
HDV Diesel Art. 34-40t	Euro VI	-	-	-	-	-	-	-	-	77	168	251	309	353	332	277	186	115	20
HDV Diesel Art. 40-50t	Conventional	2247	2533	2730	2822	2632	2720	2653	2548	2379	2223	1862	1277	1057	878	722	582	420	274
HDV Diesel Art. 40-50t	Euro I	745	939	1211	1378	1310	1336	1425	1541	1679	1819	1693	1306	1234	1192	1170	1165	1092	1006
HDV Diesel Art. 40-50t	Euro II	489	688	926	1141	1138	1290	1356	1435	1593	1728	1907	1680	1663	1694	1720	1786	1763	1738
HDV Diesel Art. 40-50t	Euro III	560	746	909	972	1102	1360	1570	1707	1776	1948	2193	2197	2231	2237	2345	2643	2887	3025
HDV Diesel Art. 40-50t	Euro IV	239	513	706	753	658	712	873	1030	1036	1074	1196	1368	1539	1512	1407	1415	1686	1665
HDV Diesel Art. 40-50t	Euro V	-	-	235	502	680	922	1074	1338	1619	1899	2077	2017	2046	2366	2575	2437	2287	2564
HDV Diesel Art. 40-50t	Euro VI	-	-	-	-	-	-	-	-	232	571	976	1399	1910	2229	2454	2407	2740	3113
HDV Diesel Art. 50-60t	Conventional	89	105	112	116	117	121	120	118	112	107	91	64	54	45	38	31	23	15
HDV Diesel Art. 50-60t	Euro I	29	39	50	57	58	59	64	71	79	87	83	65	63	62	61	62	59	56
HDV Diesel Art. 50-60t	Euro II	19	29	38	47	51	57	61	66	75	83	93	84	84	87	90	95	96	96
HDV Diesel Art. 50-60t	Euro III	22	31	37	40	49	60	71	79	84	93	107	109	113	115	123	141	157	167
HDV Diesel Art. 50-60t	Euro IV	9	21	29	31	29	32	39	48	49	52	58	68	78	78	74	76	92	92
HDV Diesel Art. 50-60t	Euro V	-	-	10	21	30	41	49	62	76	91	102	100	104	122	135	130	124	141
HDV Diesel Art. 50-60t	Euro VI	-	-	-	-	-	-	-	-	11	27	48	70	97	115	129	128	149	172
BUS Diesel Urban Midi <=15t	Conventional	1035	1023	1025	981	918	847	766	697	611	535	425	291	236	191	143	103	70	44
BUS Diesel Urban Midi <=15t	Euro I	235	275	326	353	353	328	349	380	417	438	387	298	276	259	231	206	182	161
BUS Diesel Urban Midi <=15t	Euro II	181	219	242	271	280	299	307	312	350	381	422	386	371	368	340	316	295	278
BUS Diesel Urban Midi <=15t	Euro III	253	284	307	294	337	365	391	402	379	436	489	491	493	447	457	478	512	507
BUS Diesel Urban Midi <=15t	Euro IV	115	200	262	259	217	207	256	297	294	257	262	291	338	336	273	237	325	334
BUS Diesel Urban Midi <=15t	Euro V	-	-	87	173	225	237	211	226	289	337	360	306	275	347	369	291	229	292
BUS Diesel Urban Midi <=15t	Euro VI	-	-	-	-	-	-	-	-	23	53	109	172	232	269	276	260	299	345
BUS Diesel Urban Std. 15-18t	Conventional	2070	2046	2050	1963	1837	1693	1532	1395	1223	1070	851	583	473	382	285	206	140	88

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
BUS Diesel Urban Std. 15-18t	Euro I	470	550	652	706	706	657	698	760	833	875	773	596	551	518	462	412	365	322
BUS Diesel Urban Std. 15-18t	Euro II	362	439	484	543	559	598	613	625	701	762	845	772	741	736	679	632	590	557
BUS Diesel Urban Std. 15-18t	Euro III	506	569	613	588	675	731	782	805	759	871	977	982	986	894	914	955	1024	1014
BUS Diesel Urban Std. 15-18t	Euro IV	229	400	524	519	433	413	513	594	589	513	523	582	676	673	546	474	651	669
BUS Diesel Urban Std. 15-18t	Euro V	-	-	175	346	449	475	422	452	578	673	720	612	550	694	739	582	457	584
BUS Diesel Urban Std. 15-18t	Euro VI	-	-	-	-	-	-	-	-	46	106	218	344	463	539	551	520	599	690
BUS Diesel Urban Art. >18t	Conventional	345	341	342	327	306	282	255	232	204	178	142	97	79	64	48	34	23	15
BUS Diesel Urban Art. >18t	Euro I	78	92	109	118	118	109	116	127	139	146	129	99	92	86	77	69	61	54
BUS Diesel Urban Art. >18t	Euro II	60	73	81	90	93	100	102	104	117	127	141	129	124	123	113	105	98	93
BUS Diesel Urban Art. >18t	Euro III	84	95	102	98	112	122	130	134	126	145	163	164	164	149	152	159	171	169
BUS Diesel Urban Art. >18t	Euro IV	38	67	87	86	72	69	85	99	98	86	87	97	113	112	91	79	108	111
BUS Diesel Urban Art. >18t	Euro V	-	-	29	58	75	79	70	75	96	112	120	102	92	116	123	97	76	97
BUS Diesel Urban Art. >18t	Euro VI	-	-	-	-	-	-	-	-	8	18	36	57	77	90	92	87	100	115
BUS Diesel Coaches Std. <=18t	Conventional	5646	5747	5631	5234	4854	4485	4028	3637	3164	2748	2168	1475	1187	951	705	505	342	213
BUS Diesel Coaches Std. <=18t	Euro I	1283	1544	1790	1883	1866	1739	1835	1982	2157	2248	1972	1508	1385	1290	1142	1011	889	779
BUS Diesel Coaches Std. <=18t	Euro II	986	1232	1329	1448	1478	1583	1612	1630	1814	1957	2153	1953	1862	1833	1679	1550	1436	1346
BUS Diesel Coaches Std. <=18t	Euro III	1381	1597	1684	1569	1784	1936	2057	2098	1964	2239	2491	2485	2475	2229	2260	2344	2493	2452
BUS Diesel Coaches Std. <=18t	Euro IV	625	1122	1440	1383	1145	1095	1347	1549	1524	1319	1333	1471	1697	1676	1350	1164	1585	1617
BUS Diesel Coaches Std. <=18t	Euro V	-	-	480	922	1187	1257	1110	1178	1496	1730	1835	1548	1381	1728	1826	1429	1114	1411
BUS Diesel Coaches Std. <=18t	Euro VI	-	-	-	-	-	-	-	-	120	271	555	869	1163	1342	1363	1277	1458	1669
BUS Diesel Coaches Art. >18t	Conventional	57	58	57	53	49	45	41	37	32	28	22	15	12	10	7	5	3	2
BUS Diesel Coaches Art. >18t	Euro I	13	16	18	19	19	18	19	20	22	23	20	15	14	13	12	10	9	8
BUS Diesel Coaches Art. >18t	Euro II	10	12	13	15	15	16	16	16	18	20	22	20	19	19	17	16	15	14
BUS Diesel Coaches Art. >18t	Euro III	14	16	17	16	18	20	21	21	20	23	25	25	25	23	23	24	25	25
BUS Diesel Coaches Art. >18t	Euro IV	6	11	15	14	12	11	14	16	15	13	13	15	17	17	14	12	16	16
BUS Diesel Coaches Art. >18t	Euro V	-	-	5	9	12	13	11	12	15	17	19	16	14	17	18	14	11	14
BUS Diesel Coaches Art. >18t	Euro VI	-	-	-	-	-	-	-	-	1	3	6	9	12	14	14	13	15	17
BUS CNG Urban	Euro I	59	73	84	96	108	127	140	152	173	186	149	121	123	122	111	97	75	57
BUS CNG Urban	Euro II	8	12	15	20	24	32	39	44	59	73	77	79	89	100	101	99	88	77
BUS CNG Urban	Euro III	12	16	19	21	29	40	49	57	64	84	90	100	119	122	136	150	152	140
BUS CNG Urban	EEV	5	11	22	31	37	48	59	74	102	124	134	157	204	259	273	247	254	268
MOP 2-stroke <50cm³	Conventional	27585	30629	33597	35453	36362	36549	37137	37355	38192	38482	38071	37759	37075	37150	35167	34660	31391	27958
MOP 2-stroke <50cm³	Euro 1	2912	3702	4260	4197	5039	6220	7235	7370	7172	7598	8509	9124	9273	9087	11158	14490	16903	16521
MOP 2-stroke <50cm³	Euro 2	2149	3036	4424	4558	4247	4557	5733	7037	7343	7255	7764	8825	9880	9639	9201	10333	11489	14273
MOP 2-stroke <50cm³	Euro 3	716	2024	4506	7040	9288	10627	11735	13512	15989	18205	19932	21046	22273	24304	25437	23190	23642	25372
MOP 2-stroke <50cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	842	1663	2613	3385	2462	3041	3727
MOP 2-stroke <50cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	615	1287	2106
MOT 2-stroke >50cm³	Conventional	5363	5819	6256	6177	6402	6183	6070	5962	6022	6050	5964	5850	5725	5695	5372	5256	4758	4277
MOT 2-stroke >50cm³	Euro 1	566	703	793	731	887	1052	1182	1176	1131	1195	1333	1414	1432	1393	1705	2197	2562	2527
MOT 2-stroke >50cm³	Euro 2	418	577	824	794	748	771	937	1123	1158	1141	1216	1367	1526	1478	1406	1567	1741	2183
MOT 2-stroke >50cm³	Euro 3	139	384	839	1227	1635	1798	1918	2157	2521	2862	3123	3261	3439	3726	3886	3517	3583	3881
MOT 2-stroke >50cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	130	257	401	517	373	461	570
MOT 2-stroke >50cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93	195	322
MOT 4-stroke <250cm³	Conventional	9027	10132	11072	11913	12056	12107	12227	12362	12862	13316	13540	13708	13857	14251	13912	14099	13231	12345
MOT 4-stroke <250cm³	Euro 1	953	1225	1404	1410	1671	2061	2382	2439	2415	2629	3026	3312	3466	3486	4414	5894	7125	7295
MOT 4-stroke <250cm³	Euro 2	703	1004	1458	1532	1408	1510	1888	2329	2473	2511	2761	3204	3693	3698	3640	4203	4843	6302
MOT 4-stroke <250cm³	Euro 3	234	669	1485	2365	3079	3520	3863	4472	5385	6299	7089	7641	8325	9323	10062	9433	9965	11203
MOT 4-stroke <250cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	306	622	1002	1339	1002	1282	1646
MOT 4-stroke <250cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	250	542	930
MOT 4-stroke 250-750cm³	Conventional	15044	16887	18454	19854	20094	20179	20378	20603	21436	22194	22567	22847	23095	23752	23186	23498	22052	20575
MOT 4-stroke 250-750cm³	Euro 1	1588	2041	2340	2351	2784	3434	3970	4065	4026	4382	5044	5521	5776	5810	7357	9823	11874	12158
MOT 4-stroke 250-750cm³	Euro 2	1172	1674	2430	2553	2347	2516	3146	3881	4122	4184	4602	5340	6154	6163	6067	7006	8071	10504

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
MOT 4-stroke 250-750cm³	Euro 3	391	1116	2475	3942	5132	5867	6439	7453	8974	10499	11815	12734	13874	15539	16771	15722	16609	18672
MOT 4-stroke 250-750cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	509	1036	1671	2232	1669	2136	2743
MOT 4-stroke 250-750cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	417	904	1550
MOT 4-stroke >750cm³	Conventional	6018	6755	7381	7942	8038	8072	8151	8241	8574	8877	9027	9139	9238	9501	9274	9399	8821	8230
MOT 4-stroke >750cm³	Euro 1	635	816	936	940	1114	1374	1588	1626	1610	1753	2017	2208	2311	2324	2943	3929	4750	4863
MOT 4-stroke >750cm³	Euro 2	469	670	972	1021	939	1006	1258	1553	1649	1674	1841	2136	2462	2465	2427	2802	3228	4202
MOT 4-stroke >750cm³	Euro 3	156	446	990	1577	2053	2347	2576	2981	3590	4200	4726	5094	5550	6216	6708	6289	6643	7469
MOT 4-stroke >750cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	204	414	668	893	668	854	1097
MOT 4-stroke >750cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	167	362	620

Table 293 Mileage data for Road transport (average km/year/vehicle) 1988-2005

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PC Gasoline Small	PRE ECE	9238	9905	8683	3906	4751	5213	4988	5238	4281	2725	3414	3166	2474	1994	2039	1802	1642	1482
PC Gasoline Small	ECE 15/00-01	-	-	10458	4705	5723	6280	6008	6309	5157	3283	4112	3813	2980	2402	2456	2170	1978	1786
PC Gasoline Small	ECE 15/02	-	-	10591	4764	5795	6359	6084	6389	5222	3324	4164	3861	3017	2433	2487	2198	2003	1808
PC Gasoline Small	ECE 15/03	-	-	12481	5614	6829	7494	7169	7529	6154	3917	4907	4550	3556	2867	2931	2590	2360	2131
PC Gasoline Small	ECE 15/04	-	-	16767	7542	9175	10067	9631	10115	8267	5263	6592	6113	4777	3851	3938	3479	3171	2863
PC Gasoline Small	Euro 1	-	-	-	-	11045	12119	11594	12177	9952	6335	7936	7359	5751	4636	4740	4188	3817	3446
PC Gasoline Small	Euro 2	-	-	-	-	-	-	-	-	11531	7341	9196	8527	6663	5372	5492	4853	4423	3993
PC Gasoline Small	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	7688	6198	6337	5600	5103	4607
PC Gasoline Small	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4881
PC Gasoline Small	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	PRE ECE	9901	10615	9306	4186	5092	5587	5345	5614	4588	2921	3659	3393	2651	2137	2185	1931	1760	1589
PC Gasoline Medium	ECE 15/00-01	-	-	11141	5012	6096	6689	6400	6721	5493	3497	4381	4062	3174	2559	2617	2312	2107	1902
PC Gasoline Medium	ECE 15/02	-	-	11689	5258	6396	7018	6714	7052	5763	3669	4596	4262	3330	2685	2745	2425	2211	1996
PC Gasoline Medium	ECE 15/03	-	-	13397	6027	7331	8044	7696	8082	6606	4205	5268	4885	3817	3077	3146	2780	2534	2287
PC Gasoline Medium	ECE 15/04	-	-	18018	8105	9859	10818	10350	10870	8884	5655	7084	6569	5133	4138	4231	3739	3408	3076
PC Gasoline Medium	Euro 1	-	-	-	-	12201	13388	12808	13451	10993	6999	8767	8129	6353	5121	5236	4627	4217	3807
PC Gasoline Medium	Euro 2	-	-	-	-	-	-	-	-	12397	7892	9886	9167	7164	5775	5905	5217	4755	4293
PC Gasoline Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	8266	6664	6814	6020	5487	4954
PC Gasoline Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5223
PC Gasoline Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	PRE ECE	10412	11164	9787	4402	5355	5876	5622	5904	4825	3072	3848	3568	2788	2248	2298	2031	1851	1671
PC Gasoline Large	ECE 15/00-01	-	-	11707	5266	6406	7029	6725	7063	5772	3675	4603	4268	3336	2689	2749	2429	2214	1999
PC Gasoline Large	ECE 15/02	-	-	11912	5358	6518	7152	6842	7186	5873	3739	4683	4343	3394	2736	2797	2472	2253	2034
PC Gasoline Large	ECE 15/03	-	-	14128	6355	7731	8483	8116	8523	6966	4435	5555	5151	4025	3245	3318	2932	2672	2412
PC Gasoline Large	ECE 15/04	-	-	18744	8432	10256	11254	10767	11308	9242	5883	7370	6834	5340	4305	4402	3889	3545	3200
PC Gasoline Large	Euro 1	-	-	-	-	12500	13716	13122	13781	11263	7170	8982	8328	6508	5247	5365	4740	4320	3900
PC Gasoline Large	Euro 2	-	-	-	-	-	-	-	-	13232	8423	10552	9784	7646	6164	6303	5569	5075	4582
PC Gasoline Large	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	8513	6862	7017	6200	5651	5101
PC Gasoline Large	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5735
PC Gasoline Large	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PC Gasoline Hybrid Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Hybrid Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Conventional	-	-	29632	19498	13173	11509	7071	6780	11609	20369	22997	23263	19658	20820	20213	24753	32208	33799
PC Diesel Small	Euro 1	-	-	-	-	14840	12965	7966	7638	13078	22947	25907	26207	22146	23455	22771	27886	36284	38077
PC Diesel Small	Euro 2	-	-	-	-	-	-	-	-	15404	27028	30515	30868	26084	27627	26821	32846	42737	44849
PC Diesel Small	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	29598	31348	30434	37270	48494	50890
PC Diesel Small	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	51338
PC Diesel Small	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Small	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Conventional	-	-	29632	19498	13173	11509	7071	6780	11609	20369	22997	23263	19658	20820	20213	24753	32208	33799
PC Diesel Medium	Euro 1	-	-	-	-	14840	12965	7966	7638	13078	22947	25907	26207	22146	23455	22771	27886	36284	38077
PC Diesel Medium	Euro 2	-	-	-	-	-	-	-	-	15404	27028	30515	30868	26084	27627	26821	32846	42737	44849
PC Diesel Medium	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	29598	31348	30434	37270	48494	50890
PC Diesel Medium	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	51338
PC Diesel Medium	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Conventional	-	-	32723	21532	14547	12709	7809	7487	12820	22494	25396	25690	21708	22992	22321	27335	35568	37325
PC Diesel Large	Euro 1	-	-	-	-	16481	14399	8847	8482	14524	25484	28772	29105	24594	26049	25289	30969	40296	42287
PC Diesel Large	Euro 2	-	-	-	-	-	-	-	-	16328	28649	32345	32720	27649	29284	28430	34816	45301	47539
PC Diesel Large	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	32322	34233	33235	40700	52958	55574
PC Diesel Large	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57501
PC Diesel Large	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Diesel Large	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG	Conventional	-	-	-	-	-	-	-	-	-	158584	71009	66680	117945	124405	119313	108445	87637	90247
PC LPG	Euro 1	-	-	-	-	-	-	-	-	-	180003	80600	75685	133875	141207	135428	123092	99473	102436
PC LPG	Euro 2	-	-	-	-	-	-	-	-	-	191113	85575	80357	142138	149922	143787	130689	105613	108759
PC LPG	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	148994	157154	150723	136993	110707	114005
PC LPG	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	111448
PC LPG	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC LPG	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25147	41185
PC CNG	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PC CNG	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline	Conventional	25346	27175	23823	10716	13036	14304	13685	14372	11746	7478	9367	8686	6787	5472	5595	4943	4505	4067
LCV Gasoline	Euro 1	-	-	-	-	15004	16463	15750	16541	13519	8606	10781	9997	7812	6298	6439	5690	5186	4681
LCV Gasoline	Euro 2	-	-	-	-	-	-	-	-	15123	9627	12060	11182	8739	7045	7203	6364	5801	5237
LCV Gasoline	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	9913	7992	8171	7220	6580	5941
LCV Gasoline	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6717
LCV Gasoline	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Gasoline	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel	Conventional	63635	57561	30517	20081	13566	11852	7283	6982	11956	20977	23683	23958	20245	21442	20816	25492	33169	34808
LCV Diesel	Euro 1	-	-	-	-	15738	13750	8448	8100	13870	24335	27475	27793	23486	24875	24149	29573	38480	40381
LCV Diesel	Euro 2	-	-	-	-	-	-	-	-	15257	26770	30224	30574	25836	27364	26565	32533	42330	44422
LCV Diesel	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	28189	29855	28985	35495	46185	48467
LCV Diesel	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55884
LCV Diesel	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LCV Diesel	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HDV Gasoline >3,5t	Conventional	33346	35752	31342	14099	17150	18819	18004	18908	15453	9838	12323	11427	8930	7199	7361	6504	5927	5351
HDV Diesel Rigid <=7,5t	Conventional	92123	83331	44179	29070	19639	17159	10543	10108	17308	30368	34286	34683	29308	31041	30135	36905	48019	50391
HDV Diesel Rigid <=7,5t	Euro I	-	-	-	-	23027	20118	12361	11851	20293	35606	40200	40666	34363	36395	35334	43270	56302	59083
HDV Diesel Rigid <=7,5t	Euro II	-	-	-	-	-	-	-	-	23909	41950	47362	47911	40486	42880	41629	50980	66333	69610
HDV Diesel Rigid <=7,5t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	47376	50177	48713	59655	77621	81456
HDV Diesel Rigid <=7,5t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	88083
HDV Diesel Rigid <=7,5t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid <=7,5t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5-12t	Conventional	94768	85724	45447	29905	20203	17651	10846	10398	17805	31240	35270	35679	30150	31932	31001	37964	49398	51838
HDV Diesel Rigid 7,5-12t	Euro I	-	-	-	-	25371	22166	13620	13058	22359	39230	44292	44805	37861	40100	38930	47675	62033	65097
HDV Diesel Rigid 7,5-12t	Euro II	-	-	-	-	-	-	-	-	26260	46075	52019	52622	44467	47096	45722	55993	72855	76455
HDV Diesel Rigid 7,5-12t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	52587	55697	54072	66218	86160	90417
HDV Diesel Rigid 7,5-12t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	98705
HDV Diesel Rigid 7,5-12t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 7,5-12t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12-14t	Conventional	82644	74756	39633	26079	17618	15393	9458	9068	15527	27243	30758	31114	26292	27847	27035	33107	43078	45206
HDV Diesel Rigid 12-14t	Euro I	-	-	-	-	23012	20106	12353	11844	20280	35583	40174	40640	34341	36372	35311	43243	56266	59046
HDV Diesel Rigid 12-14t	Euro II	-	-	-	-	-	-	-	-	24244	42539	48027	48583	41054	43481	42213	51695	67264	70587
HDV Diesel Rigid 12-14t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	51220	54249	52667	64497	83920	88066
HDV Diesel Rigid 12-14t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	90823
HDV Diesel Rigid 12-14t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 12-14t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 14-20t	Conventional	104012	94085	49880	32822	22174	19373	11903	11412	19542	34287	38711	39159	33090	35047	34025	41667	54216	56895
HDV Diesel Rigid 14-20t	Euro I	-	-	-	-	27805	24293	14926	14311	24504	42994	48541	49104	41494	43947	42665	52249	67984	71343
HDV Diesel Rigid 14-20t	Euro II	-	-	-	-	-	-	-	-	28239	49547	55939	56587	47817	50645	49167	60212	78345	82216
HDV Diesel Rigid 14-20t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	55440	58718	57005	69810	90834	95322
HDV Diesel Rigid 14-20t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	97410
HDV Diesel Rigid 14-20t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 14-20t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 20-26t	Conventional	104167	94225	49954	32871	22207	19402	11921	11429	19571	34338	38768	39217	33139	35099	34075	41729	54296	56979
HDV Diesel Rigid 20-26t	Euro I	-	-	-	-	28175	24616	15125	14501	24830	43567	49188	49758	42046	44532	43233	52945	68889	72293
HDV Diesel Rigid 20-26t	Euro II	-	-	-	-	-	-	-	-	28473	49958	56404	57058	48215	51066	49576	60712	78996	82899
HDV Diesel Rigid 20-26t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	57263	60649	58880	72106	93821	98456
HDV Diesel Rigid 20-26t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	89699
HDV Diesel Rigid 20-26t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 20-26t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26-28t	Conventional	103751	93849	49755	32740	22118	19324	11874	11384	19493	34201	38614	39061	33007	34959	33939	41563	54080	56752
HDV Diesel Rigid 26-28t	Euro I	-	-	-	-	27224	23786	14615	14012	23992	42096	47527	48078	40627	43029	41774	51158	66564	69853
HDV Diesel Rigid 26-28t	Euro II	-	-	-	-	-	-	-	-	27582	48394	54637	55271	46705	49466	48024	58811	76522	80303
HDV Diesel Rigid 26-28t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	54881	58126	56431	69107	89919	94361
HDV Diesel Rigid 26-28t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	96917
HDV Diesel Rigid 26-28t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 26-28t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28-32t	Conventional	103988	94063	49869	32814	22169	19368	11901	11410	19537	34279	38701	39150	33083	35039	34017	41658	54203	56881
HDV Diesel Rigid 28-32t	Euro I	-	-	-	-	27580	24096	14806	14195	24306	42647	48149	48707	41158	43592	42320	51826	67434	70766
HDV Diesel Rigid 28-32t	Euro II	-	-	-	-	-	-	-	-	27967	49069	55400	56042	47357	50157	48694	59632	77590	81424
HDV Diesel Rigid 28-32t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	56232	59557	57820	70807	92132	96683
HDV Diesel Rigid 28-32t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	91135
HDV Diesel Rigid 28-32t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid 28-32t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32t	Conventional	128120	115892	61442	40430	27313	23863	14662	14058	24071	42234	47683	48236	40760	43170	41911	51325	66782	70081
HDV Diesel Rigid >32t	Euro I	-	-	-	-	30138	26331	16179	15511	26560	46602	52614	53224	44975	47634	46245	56633	73688	77329

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HDV Diesel Rigid >32t	Euro II	-	-	-	-	-	-	-	-	32591	57183	64560	65309	55187	58450	56745	69492	90420	94887
HDV Diesel Rigid >32t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	63563	67321	65358	80039	104143	109288
HDV Diesel Rigid >32t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100115
HDV Diesel Rigid >32t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Rigid >32t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 14-20t	Conventional	135477	122547	64970	42751	28882	25234	15504	14865	25453	44659	50421	51005	43101	45649	44318	54272	70617	74106
HDV Diesel Art. 14-20t	Euro I	-	-	-	-	34901	30493	18736	17963	30758	53967	60929	61636	52083	55163	53554	65583	85335	89550
HDV Diesel Art. 14-20t	Euro II	-	-	-	-	-	-	-	-	36801	64569	72900	73745	62316	66000	64075	78468	102099	107143
HDV Diesel Art. 14-20t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	77696	82290	79890	97835	127299	133588
HDV Diesel Art. 14-20t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	141803
HDV Diesel Art. 14-20t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 14-20t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 20-28t	Conventional	150217	135880	72038	47402	32024	27979	17191	16482	28222	49518	55907	56555	47790	50615	49139	60177	78300	82168
HDV Diesel Art. 20-28t	Euro I	-	-	-	-	38043	33238	20423	19580	33527	58826	66415	67185	56773	60129	58376	71488	93018	97613
HDV Diesel Art. 20-28t	Euro II	-	-	-	-	-	-	-	-	40146	70439	79527	80449	67981	72000	69900	85601	111381	116884
HDV Diesel Art. 20-28t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	82385	87257	84712	103740	134982	141651
HDV Diesel Art. 20-28t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	141803
HDV Diesel Art. 20-28t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 20-28t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 28-34t	Conventional	161271	145880	77340	50891	34381	30038	18456	17695	30299	53162	60021	60717	51307	54340	52755	64605	84062	88215
HDV Diesel Art. 28-34t	Euro I	-	-	-	-	40343	35247	21657	20764	35554	62382	70430	71246	60204	63764	61904	75809	98640	103513
HDV Diesel Art. 28-34t	Euro II	-	-	-	-	-	-	-	-	42523	74610	84236	85212	72006	76263	74039	90670	117976	123805
HDV Diesel Art. 28-34t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	86841	91976	89293	109350	142282	149312
HDV Diesel Art. 28-34t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	162563
HDV Diesel Art. 28-34t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 28-34t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 34-40t	Conventional	153791	139113	73752	48530	32786	28645	17600	16874	28894	50696	57237	57900	48927	51820	50308	61609	80163	84123
HDV Diesel Art. 34-40t	Euro I	-	-	-	-	42149	36825	22627	21693	37146	65175	73583	74436	62900	66619	64676	79204	103057	108148
HDV Diesel Art. 34-40t	Euro II	-	-	-	-	-	-	-	-	44058	77303	87276	88288	74605	79016	76711	93942	122234	128273
HDV Diesel Art. 34-40t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	90074	95400	92617	113421	147579	154870
HDV Diesel Art. 34-40t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	164173
HDV Diesel Art. 34-40t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 34-40t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 40-50t	Conventional	177549	160604	85146	56027	37851	33070	20319	19481	33358	58528	66079	66845	56485	59825	58080	71126	92547	97119
HDV Diesel Art. 40-50t	Euro I	-	-	-	-	46430	40565	24924	23896	40918	71793	81056	81995	69288	73384	71244	87247	113522	119131
HDV Diesel Art. 40-50t	Euro II	-	-	-	-	-	-	-	-	50348	88339	99736	100892	85256	90297	87663	107354	139685	146586
HDV Diesel Art. 40-50t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	101813	107832	104687	128202	166812	175053
HDV Diesel Art. 40-50t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	164173
HDV Diesel Art. 40-50t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 40-50t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 50-60t	Conventional	163280	147697	78303	51525	34809	30412	18686	17915	30677	53824	60769	61473	51946	55017	53413	65410	85109	89314
HDV Diesel Art. 50-60t	Euro I	-	-	-	-	41342	36120	22193	21278	36434	63927	72174	73011	61695	65343	63437	77687	101083	106077
HDV Diesel Art. 50-60t	Euro II	-	-	-	-	-	-	-	-	44115	77402	87388	88401	74701	79117	76810	94063	122391	128438
HDV Diesel Art. 50-60t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	91019	96401	93589	114611	149128	156495
HDV Diesel Art. 50-60t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	164173
HDV Diesel Art. 50-60t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HDV Diesel Art. 50-60t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15t	Conventional	164699	148981	78984	51973	35112	30677	18849	18071	30943	54292	61297	62007	52397	55495	53877	65979	85849	90090
BUS Diesel Urban Midi <=15t	Euro I	-	-	-	-	43230	37770	23207	22250	38098	66846	75470	76345	64513	68327	66334	81234	105699	110921
BUS Diesel Urban Midi <=15t	Euro II	-	-	-	-	-	-	-	-	40664	71348	80553	81487	68858	72929	70802	86705	112818	118392
BUS Diesel Urban Midi <=15t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	73451	77794	75525	92490	120344	126290
BUS Diesel Urban Midi <=15t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	119304

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
BUS Diesel Urban Midi <=15t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Midi <=15t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Std. 15-18t	Conventional	174395	157751	83633	55032	37178	32482	19958	19135	32765	57488	64905	65658	55482	58762	57048	69863	90903	95394
BUS Diesel Urban Std. 15-18t	Euro I	-	-	-	-	45185	39478	24256	23256	39821	69869	78883	79798	67431	71417	69335	84909	110480	115938
BUS Diesel Urban Std. 15-18t	Euro II	-	-	-	-	-	-	-	-	44386	77878	87926	88945	75160	79604	77282	94642	123144	129228
BUS Diesel Urban Std. 15-18t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	80150	84889	82413	100925	131320	137807
BUS Diesel Urban Std. 15-18t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	133427
BUS Diesel Urban Std. 15-18t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Std. 15-18t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Art. >18t	Conventional	167068	151123	80120	52720	35616	31118	19120	18331	31388	55073	62178	62899	53151	56294	54652	66928	87084	91386
BUS Diesel Urban Art. >18t	Euro I	-	-	-	-	45438	39699	24392	23386	40044	70261	79325	80245	67808	71818	69723	85384	111099	116587
BUS Diesel Urban Art. >18t	Euro II	-	-	-	-	-	-	-	-	45105	79140	89350	90386	76378	80894	78534	96175	125139	131322
BUS Diesel Urban Art. >18t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	81062	85855	83351	102074	132814	139376
BUS Diesel Urban Art. >18t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	132327
BUS Diesel Urban Art. >18t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Urban Art. >18t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coaches Std. <=18t	Conventional	168046	152008	80589	53029	35825	31300	19232	18438	31572	55396	62542	63267	53462	56623	54972	67320	87594	91921
BUS Diesel Coaches Std. <=18t	Euro I	-	-	-	-	41888	36597	22486	21559	36915	64771	73127	73975	62510	66206	64275	78713	102418	107478
BUS Diesel Coaches Std. <=18t	Euro II	-	-	-	-	-	-	-	-	40698	71407	80620	81554	68915	72990	70861	86778	112912	118490
BUS Diesel Coaches Std. <=18t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	74598	79008	76704	93933	122223	128261
BUS Diesel Coaches Std. <=18t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	134174
BUS Diesel Coaches Std. <=18t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coaches Std. <=18t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coaches Art. >18t	Conventional	166312	150440	79757	52482	35455	30977	19033	18248	31246	54824	61897	62615	52911	56039	54405	66625	86690	90973
BUS Diesel Coaches Art. >18t	Euro I	-	-	-	-	42744	37345	22946	21999	37670	66094	74622	75487	63788	67559	65589	80321	104511	109674
BUS Diesel Coaches Art. >18t	Euro II	-	-	-	-	-	-	-	-	43029	75498	85238	86226	72863	77171	74920	91749	119380	125278
BUS Diesel Coaches Art. >18t	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	77230	81796	79410	97248	126535	132786
BUS Diesel Coaches Art. >18t	Euro IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	132653
BUS Diesel Coaches Art. >18t	Euro V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS Diesel Coaches Art. >18t	Euro VI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS CNG Urban	Euro I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43153	70674
BUS CNG Urban	Euro II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48100	78776
BUS CNG Urban	Euro III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	51293	84006
BUS CNG Urban	EEV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	98469
MOP 2-stroke <50cm^3	Conventional	3516	3769	3304	1486	1808	1984	1898	1993	1629	1037	1299	1205	941	759	776	686	625	564
MOP 2-stroke <50cm^3	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	1125	907	928	820	747	674
MOP 2-stroke <50cm^3	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1048	955	862
MOP 2-stroke <50cm^3	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOP 2-stroke <50cm^3	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOP 2-stroke <50cm^3	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 2-stroke >50cm^3	Conventional	7992	8568	7512	3379	4110	4510	4315	4532	3704	2358	2953	2739	2140	1725	1764	1559	1421	1282
MOT 2-stroke >50cm^3	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	2232	1799	1840	1626	1482	1338
MOT 2-stroke >50cm^3	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1841	1678	1515
MOT 2-stroke >50cm^3	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 2-stroke >50cm^3	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 2-stroke >50cm^3	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke <250cm^3	Conventional	10353	11100	9730	4377	5324	5842	5589	5870	4798	3054	3826	3548	2772	2235	2285	2019	1840	1661
MOT 4-stroke <250cm^3	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	3083	2485	2541	2246	2047	1848
MOT 4-stroke <250cm^3	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1989	1813	1636
MOT 4-stroke <250cm^3	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke <250cm^3	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke <250cm^3	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
MOT 4-stroke 250-750cm³	Conventional	10653	11421	10012	4504	5479	6012	5751	6040	4937	3143	3937	3650	2853	2300	2351	2078	1894	1709
MOT 4-stroke 250-750cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	3209	2587	2645	2337	2130	1923
MOT 4-stroke 250-750cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2094	1909	1723
MOT 4-stroke 250-750cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke 250-750cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke 250-750cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke >750cm³	Conventional	10814	11594	10164	4572	5562	6103	5838	6132	5011	3190	3996	3706	2896	2334	2387	2109	1922	1735
MOT 4-stroke >750cm³	Euro 1	-	-	-	-	-	-	-	-	-	-	-	-	3300	2661	2720	2404	2191	1978
MOT 4-stroke >750cm³	Euro 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2149	1959	1768
MOT 4-stroke >750cm³	Euro 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke >750cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOT 4-stroke >750cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 294 Mileage data for Road transport (average km/year/vehicle) 2006-2023

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PC Gasoline Small	PRE ECE	2919	2546	2297	2271	2088	1878	1760	1446	1666	1713	1694	1976	1921	1922	2021	2310	2389	2293
PC Gasoline Small	ECE 15/00-01	3516	3067	2766	2735	2515	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Small	ECE 15/02	3561	3106	2801	2770	2547	2291	2147	1764	2032	-	-	-	-	-	-	-	-	-
PC Gasoline Small	ECE 15/03	4196	3660	3301	3264	3001	2700	2530	2079	2395	2462	2435	2840	2761	-	-	-	-	-
PC Gasoline Small	ECE 15/04	5637	4917	4435	4385	4032	3627	3399	2793	3217	3307	3272	3815	3709	3711	3902	4461	4613	4428
PC Gasoline Small	Euro 1	6786	5919	5338	5279	4854	4366	4092	3362	3873	3982	3939	4593	4465	4468	4698	5370	5553	5330
PC Gasoline Small	Euro 2	7863	6859	6186	6116	5624	5059	4742	3895	4487	4614	4564	5322	5174	5177	5443	6222	6435	6176
PC Gasoline Small	Euro 3	9073	7914	7137	7057	6489	5837	5471	4495	5178	5323	5266	6140	5970	5973	6281	7179	7424	7126
PC Gasoline Small	Euro 4	9612	8383	7561	7476	6875	6183	5796	4761	5485	5639	5578	6505	6324	6328	6654	7605	7865	7549
PC Gasoline Small	Euro 5	-	-	-	-	7481	6729	6308	5182	5969	6137	6071	7079	6882	6886	7241	8277	8559	8215
PC Gasoline Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	6671	6599	7695	7482	7485	7871	8997	9305	8931
PC Gasoline Small	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	8081	8085	8502	9718	10050	9646
PC Gasoline Medium	PRE ECE	3129	2729	2461	2434	2238	2013	1887	1550	1786	1836	1816	2117	2059	2060	2166	2476	2560	2457
PC Gasoline Medium	ECE 15/00-01	3746	3267	2947	2914	2679	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	ECE 15/02	3930	3428	3092	3057	2811	2528	2370	1947	2243	-	-	-	-	-	-	-	-	-
PC Gasoline Medium	ECE 15/03	4505	3929	3543	3504	3222	2898	2716	2231	2571	2643	2614	3048	2964	-	-	-	-	-
PC Gasoline Medium	ECE 15/04	6058	5284	4765	4712	4333	3897	3653	3001	3457	3554	3516	4100	3986	3988	4194	4794	4957	4758
PC Gasoline Medium	Euro 1	7497	6539	5897	5831	5362	4823	4521	3714	4278	4398	4351	5073	4933	4935	5190	5932	6135	5888
PC Gasoline Medium	Euro 2	8454	7374	6650	6576	6047	5439	5098	4188	4825	4960	4907	5721	5562	5565	5852	6689	6918	6640
PC Gasoline Medium	Euro 3	9755	8509	7674	7588	6977	6276	5882	4832	5567	5723	5662	6602	6419	6422	6753	7719	7983	7662
PC Gasoline Medium	Euro 4	10286	8972	8092	8001	7357	6618	6203	5096	5870	6035	5970	6961	6768	6772	7121	8139	8417	8079
PC Gasoline Medium	Euro 5	-	-	-	-	8057	7247	6793	5580	6429	6609	6538	7623	7412	7416	7798	8914	9218	8848
PC Gasoline Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	7183	7106	8286	8056	8060	8475	9688	10019	9616
PC Gasoline Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	8699	8704	9153	10462	10819	10384
PC Gasoline Large	PRE ECE	3290	2870	2588	2559	2353	2117	1984	1630	1878	1931	1910	2227	2165	2166	2278	2604	2693	2584
PC Gasoline Large	ECE 15/00-01	3936	3433	3096	3062	2815	-	-	-	-	-	-	-	-	-	-	-	-	-
PC Gasoline Large	ECE 15/02	4005	3493	3150	3115	2864	2576	2415	1984	2286	-	-	-	-	-	-	-	-	-
PC Gasoline Large	ECE 15/03	4750	4143	3737	3695	3398	3056	2864	2353	2711	2787	2757	3215	3126	-	-	-	-	-
PC Gasoline Large	ECE 15/04	6302	5497	4957	4902	4508	4054	3800	3122	3597	3698	3658	4265	4147	4149	4363	4987	5157	4950
PC Gasoline Large	Euro 1	7680	6699	6042	5974	5493	4941	4631	3805	4383	4506	4458	5198	5054	5056	5317	6077	6285	6032
PC Gasoline Large	Euro 2	9023	7870	7098	7018	6454	5805	5441	4470	5149	5294	5237	6106	5937	5940	6246	7140	7384	7087
PC Gasoline Large	Euro 3	10046	8762	7902	7814	7185	6463	6058	4976	5733	5894	5830	6798	6610	6613	6954	7949	8220	7890
PC Gasoline Large	Euro 4	11293	9850	8884	8784	8077	7265	6810	5594	6445	6626	6554	7643	7431	7434	7818	8936	9241	8870
PC Gasoline Large	Euro 5	-	-	-	-	8567	7706	7223	5934	6836	7028	6952	8106	7881	7886	8292	9478	9802	9408
PC Gasoline Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	7647	7564	8820	8576	8580	9022	10313	10665	10237
PC Gasoline Large	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	9270	9275	9753	11148	11529	11065

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PC Gasoline Hybrid Medium	Euro 4	-	-	-	9172	8434	7586	7111	5842	6729	6918	6844	7980	7759	7763	8163	9331	9649	9262
PC Gasoline Hybrid Medium	Euro 5	-	-	-	-	8587	7723	7239	5947	6851	7044	6968	8125	7899	7903	8311	9499	9824	9429
PC Gasoline Hybrid Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	8209	8121	9469	9207	9211	9686	11072	11450	10990
PC Gasoline Hybrid Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	9736	9741	10243	11709	12109	11622
PC Diesel Small	Conventional	22907	16823	15266	13240	12061	11706	12046	9693	10148	10544	10039	10585	10805	10945	10014	10817	10269	10000
PC Diesel Small	Euro 1	25806	18953	17198	14916	13587	13188	13570	10919	11432	11878	11309	11925	12172	12330	11282	12186	11568	11266
PC Diesel Small	Euro 2	30396	22323	20257	17568	16004	15534	15984	12861	13465	13991	13321	14045	14337	14523	13288	14353	13626	13270
PC Diesel Small	Euro 3	34490	25330	22986	19935	18159	17626	18136	14594	15279	15875	15115	15937	16268	16479	15078	16287	15461	15057
PC Diesel Small	Euro 4	34794	25554	23188	20110	18319	17781	18296	14722	15414	16015	15248	16078	16412	16624	15211	16430	15597	15190
PC Diesel Small	Euro 5	-	-	-	-	20753	20143	20727	16678	17461	18143	17274	18213	18592	18833	17232	18613	17669	17208
PC Diesel Small	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	19637	18696	19713	20123	20383	18651	20146	19124	18625
PC Diesel Small	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	21654	21934	20070	21678	20579	20042
PC Diesel Medium	Conventional	22907	16823	15266	13240	12061	11706	12046	9693	10148	10544	10039	10585	10805	10945	10014	10817	10269	10000
PC Diesel Medium	Euro 1	25806	18953	17198	14916	13587	13188	13570	10919	11432	11878	11309	11925	12172	12330	11282	12186	11568	11266
PC Diesel Medium	Euro 2	30396	22323	20257	17568	16004	15534	15984	12861	13465	13991	13321	14045	14337	14523	13288	14353	13626	13270
PC Diesel Medium	Euro 3	34490	25330	22986	19935	18159	17626	18136	14594	15279	15875	15115	15937	16268	16479	15078	16287	15461	15057
PC Diesel Medium	Euro 4	34794	25554	23188	20110	18319	17781	18296	14722	15414	16015	15248	16078	16412	16624	15211	16430	15597	15190
PC Diesel Medium	Euro 5	-	-	-	-	20753	20143	20727	16678	17461	18143	17274	18213	18592	18833	17232	18613	17669	17208
PC Diesel Medium	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	19637	18696	19713	20123	20383	18651	20146	19124	18625
PC Diesel Medium	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	21654	21934	20070	21678	20579	20042
PC Diesel Large	Conventional	25296	18578	16859	14621	13319	12928	13302	10704	11206	11644	11086	11689	11932	12086	11059	11945	11340	11044
PC Diesel Large	Euro 1	28659	21048	19100	16565	15090	14646	15071	12127	12696	13192	12560	13243	13518	13693	12529	13534	12848	12512
PC Diesel Large	Euro 2	32219	23663	21472	18622	16964	16465	16942	13633	14273	14830	14120	14888	15197	15394	14085	15215	14443	14066
PC Diesel Large	Euro 3	37664	27662	25101	21770	19831	19248	19806	15937	16685	17337	16506	17404	17766	17996	16466	17786	16884	16443
PC Diesel Large	Euro 4	38971	28621	25972	22525	20519	19916	20493	16490	17264	17938	17079	18008	18382	18620	17037	18403	17470	17013
PC Diesel Large	Euro 5	-	-	-	-	22886	22214	22858	18393	19256	20008	19050	20086	20503	20769	19003	20527	19486	18977
PC Diesel Large	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	21681	20643	21766	22218	22506	20592	22243	21116	20564
PC Diesel Large	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	23933	24243	22182	23960	22745	22151
PC LPG	Conventional	84468	73392	63752	62233	55323	49958	45807	43290	37282	35359	36341	37814	33940	30615	17174	15516	15743	15366
PC LPG	Euro 1	95876	83305	72362	70639	62795	56706	51994	49137	42317	40135	41249	42921	38524	34750	19494	17612	17869	17441
PC LPG	Euro 2	101793	88446	76828	74998	66671	60206	55203	52169	44929	42612	43795	45570	40901	36895	20697	18699	18972	18518
PC LPG	Euro 3	106704	92713	80534	78616	69887	63110	57866	54686	47096	44667	45908	47768	42874	38674	21695	19601	19887	19411
PC LPG	Euro 4	104311	90633	78728	76853	68320	61695	56569	53460	46040	43665	44878	46697	41913	37807	21209	19161	19441	18976
PC LPG	Euro 5	-	-	-	-	74525	67298	61706	58315	50222	47631	48954	50938	45719	41241	23135	20901	21207	20699
PC LPG	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	49746	51128	53200	47749	43072	24162	21829	22148	21618
PC LPG	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	49779	44902	25189	22757	23089	22537
PC CNG	Euro 4	36443	40166	30395	35482	40726	38193	39738	42362	43463	39161	37276	37942	35444	35783	31544	32811	24076	21414
PC CNG	Euro 5	-	-	-	-	44425	41662	43347	46209	47410	42717	40662	41388	38663	39032	34409	35791	26263	23359
PC CNG	Euro 6 a/b/c	-	-	-	-	-	-	-	-	-	44614	42467	43225	40380	40765	35937	37380	27429	24396
PC CNG	Euro 6 d	-	-	-	-	-	-	-	-	-	-	-	-	42096	42498	37464	38969	28595	25433
LCV Gasoline	Conventional	8010	6986	6301	6230	5729	5153	4830	3968	4571	4699	4649	5421	5270	5273	5545	6338	6554	6291
LCV Gasoline	Euro 1	9219	8041	7252	7171	6594	5931	5559	4567	5261	5409	5351	6239	6066	6069	6382	7295	7544	7241
LCV Gasoline	Euro 2	10313	8995	8112	8021	7376	6634	6219	5109	5885	6050	5985	6979	6785	6789	7139	8160	8439	8100
LCV Gasoline	Euro 3	11699	10204	9203	9100	8367	7526	7055	5795	6676	6864	6790	7917	7698	7702	8099	9257	9573	9188
LCV Gasoline	Euro 4	13228	11538	10406	10289	9461	8510	7977	6553	7549	7761	7677	8952	8704	8708	9157	10467	10825	10390
LCV Gasoline	Euro 5	-	-	11303	11176	10277	9244	8664	7118	8200	8430	8339	9724	9454	9459	9947	11370	11758	11285
LCV Gasoline	Euro 6 a/b/c	-	-	-	-	-	-	-	-	8937	9188	9089	10598	10304	10309	10841	12392	12815	12300
LCV Diesel	Conventional	23591	17326	15722	13635	12421	12056	12405	9982	10451	10859	10339	10901	11127	11271	10313	11140	10575	10299
LCV Diesel	Euro 1	27368	20100	18239	15818	14409	13986	14391	11580	12124	12597	11994	12646	12909	13076	11964	12924	12268	11948
LCV Diesel	Euro 2	30106	22111	20064	17401	15851	15386	15831	12739	13337	13858	13194	13912	14201	14384	13162	14217	13496	13143
LCV Diesel	Euro 3	32848	24124	21891	18986	17295	16787	17273	13899	14551	15119	14395	15178	15494	15694	14360	15511	14725	14340
LCV Diesel	Euro 4	37874	27816	25241	21891	19941	19356	19916	16026	16778	17433	16598	17501	17865	18096	16558	17885	16978	16535

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
LCV Diesel	Euro 5	-	-	27039	23450	21361	20734	21335	17167	17973	18675	17780	18748	19137	19385	17737	19159	18188	17712
LCV Diesel	Euro 6 a/b/c	-	-	-	-	-	-	-	-	19481	20242	19272	20321	20743	21012	19225	20767	19714	19199
HDV Gasoline >3,5t	Conventional	10538	9191	8290	8197	7537	6779	6355	5220	6014	6183	6116	7132	6934	6937	7295	8338	8623	8277
HDV Diesel Rigid <=7,5t	Conventional	34152	25082	22760	19739	17981	17453	17959	14451	15129	15720	14967	15781	16109	16318	14930	16127	15310	14910
HDV Diesel Rigid <=7,5t	Euro I	40043	29409	26686	23144	21083	20464	21057	16943	17739	18431	17549	18503	18888	19132	17506	18909	17951	17482
HDV Diesel Rigid <=7,5t	Euro II	47177	34648	31441	27268	24839	24110	24808	19962	20899	21715	20675	21800	22253	22541	20625	22278	21149	20596
HDV Diesel Rigid <=7,5t	Euro III	55206	40545	36792	31908	29067	28213	29030	23359	24456	25411	24194	25510	26040	26377	24135	26069	24748	24101
HDV Diesel Rigid <=7,5t	Euro IV	59697	43843	39785	34504	31431	30508	31392	25260	26446	27478	26162	27585	28158	28523	26098	28190	26761	26062
HDV Diesel Rigid <=7,5t	Euro V	-	-	44739	38801	35345	34307	35301	28405	29739	30900	29420	31020	31665	32075	29348	31701	30094	29307
HDV Diesel Rigid <=7,5t	Euro VI	-	-	-	-	-	-	-	-	32674	33949	32323	34082	34790	35240	32244	34829	33064	32200
HDV Diesel Rigid 7,5-12t	Conventional	35133	25802	23414	20306	18498	17954	18475	14866	15564	16171	15397	16234	16572	16786	15359	16590	15749	15338
HDV Diesel Rigid 7,5-12t	Euro I	44119	32402	29403	25500	23229	22547	23200	18668	19545	20307	19335	20387	20810	21080	19288	20834	19778	19261
HDV Diesel Rigid 7,5-12t	Euro II	51816	38055	34533	29949	27282	26480	27248	21925	22954	23850	22708	23944	24441	24757	22653	24469	23228	22621
HDV Diesel Rigid 7,5-12t	Euro III	61279	45005	40839	35419	32264	31316	32224	25929	27146	28206	26855	28316	28904	29279	26790	28937	27470	26753
HDV Diesel Rigid 7,5-12t	Euro IV	66896	49130	44583	38665	35222	34187	35177	28306	29635	30792	29317	30912	31554	31962	29245	31590	29988	29205
HDV Diesel Rigid 7,5-12t	Euro V	-	-	50686	43959	40044	38867	39993	32181	33692	35007	33331	35144	35874	36338	33249	35915	34094	33203
HDV Diesel Rigid 7,5-12t	Euro VI	-	-	-	-	-	-	-	-	37266	38721	36867	38872	39680	40194	36777	39725	37711	36726
HDV Diesel Rigid 12-14t	Conventional	30638	22501	20418	17708	16131	15657	16111	12964	13572	14102	13427	14157	14451	14639	13394	14468	13734	13376
HDV Diesel Rigid 12-14t	Euro I	40017	29390	26669	23130	21070	20451	21043	16932	17728	18420	17537	18491	18876	19120	17495	18897	17939	17470
HDV Diesel Rigid 12-14t	Euro II	47839	35134	31882	27651	25188	24448	25156	20242	21193	22020	20965	22106	22565	22857	20914	22591	21446	20885
HDV Diesel Rigid 12-14t	Euro III	59686	43835	39777	34498	31425	30502	31386	25255	26441	27473	26157	27580	28153	28517	26093	28185	26756	26057
HDV Diesel Rigid 12-14t	Euro IV	61554	45207	41023	35578	32409	31457	32368	26045	27268	28333	26976	28443	29034	29410	26910	29067	27594	26873
HDV Diesel Rigid 12-14t	Euro V	-	-	48249	41845	38118	36998	38070	30633	32072	33324	31728	33454	34149	34591	31650	34188	32454	31607
HDV Diesel Rigid 12-14t	Euro VI	-	-	-	-	-	-	-	-	35682	37075	35300	37220	37993	38485	35213	38036	36108	35165
HDV Diesel Rigid 14-20t	Conventional	38559	28319	25698	22287	20302	19706	20277	16316	17082	17749	16899	17818	18188	18423	16857	18209	17286	16834
HDV Diesel Rigid 14-20t	Euro I	48351	35511	32224	27947	25458	24710	25426	20459	21420	22256	21190	22343	22807	23102	21138	22833	21675	21109
HDV Diesel Rigid 14-20t	Euro II	55720	40923	37135	32206	29338	28476	29301	23577	24684	25648	24419	25748	26283	26623	24360	26312	24979	24326
HDV Diesel Rigid 14-20t	Euro III	64603	47446	43054	37340	34014	33015	33972	27335	28619	29736	28312	29852	30472	30867	28243	30507	28960	28204
HDV Diesel Rigid 14-20t	Euro IV	66018	48486	43998	38158	34760	33738	34716	27934	29246	30388	28932	30506	31140	31543	28862	31175	29595	28822
HDV Diesel Rigid 14-20t	Euro V	-	-	50651	43928	40016	38840	39965	32158	33668	34983	33307	35119	35849	36313	33226	35889	34070	33180
HDV Diesel Rigid 14-20t	Euro VI	-	-	-	-	-	-	-	-	36821	38259	36426	38408	39206	39713	36337	39250	37261	36287
HDV Diesel Rigid 20-26t	Conventional	38617	28361	25736	22320	20332	19735	20307	16340	17107	17775	16924	17844	18215	18451	16882	18236	17311	16859
HDV Diesel Rigid 20-26t	Euro I	48995	35984	32653	28319	25797	25039	25764	20731	21705	22552	21472	22640	23110	23410	21420	23137	21964	21390
HDV Diesel Rigid 20-26t	Euro II	56184	41263	37443	32474	29581	28712	29544	23773	24889	25861	24622	25962	26501	26844	24562	26531	25186	24528
HDV Diesel Rigid 20-26t	Euro III	66727	49006	44470	38568	35133	34101	35089	28234	29560	30714	29243	30834	31474	31882	29172	31510	29913	29131
HDV Diesel Rigid 20-26t	Euro IV	60792	44648	40515	35137	32008	31068	31968	25723	26931	27982	26642	28091	28675	29046	26577	28707	27252	26540
HDV Diesel Rigid 20-26t	Euro V	-	-	48576	42128	38377	37249	38328	30841	32289	33550	31943	33681	34380	34825	31865	34419	32674	31821
HDV Diesel Rigid 20-26t	Euro VI	-	-	-	-	-	-	-	-	35039	36407	34664	36549	37309	37792	34579	37351	35458	34531
HDV Diesel Rigid 26-28t	Conventional	38463	28248	25633	22231	20251	19656	20226	16275	17039	17704	16856	17773	18142	18377	16815	18163	17242	16792
HDV Diesel Rigid 26-28t	Euro I	47342	34769	31551	27363	24926	24194	24895	20032	20972	21791	20747	21876	22330	22620	20697	22356	21223	20668
HDV Diesel Rigid 26-28t	Euro II	54424	39971	36271	31457	28655	27813	28619	23028	24110	25051	23851	25149	25671	26003	23793	25700	24397	23760
HDV Diesel Rigid 26-28t	Euro III	63952	46968	42621	36963	33672	32682	33629	27060	28330	29436	28027	29551	30165	30556	27958	30199	28669	27920
HDV Diesel Rigid 26-28t	Euro IV	65684	48240	43775	37965	34583	33567	34540	27793	29098	30234	28786	30352	30982	31383	28715	31017	29445	28676
HDV Diesel Rigid 26-28t	Euro V	-	-	50176	43516	39640	38476	39591	31857	33353	34655	32995	34790	35513	35972	32914	35553	33751	32869
HDV Diesel Rigid 26-28t	Euro VI	-	-	-	-	-	-	-	-	36500	37925	36109	38073	38864	39367	36021	38908	36936	35971
HDV Diesel Rigid 28-32t	Conventional	38550	28312	25692	22282	20297	19701	20272	16312	17078	17744	16895	17814	18184	18419	16853	18204	17281	16830
HDV Diesel Rigid 28-32t	Euro I	47961	35224	31963	27721	25252	24510	25220	20294	21246	22076	21019	22162	22622	22915	20967	22648	21500	20938
HDV Diesel Rigid 28-32t	Euro II	55184	40529	36777	31896	29055	28201	29019	23350	24446	25401	24184	25500	26029	26367	24125	26059	24738	24092
HDV Diesel Rigid 28-32t	Euro III	65526	48124	43669	37873	34500	33487	34457	27726	29028	30161	28716	30279	30908	31308	28646	30943	29374	28607
HDV Diesel Rigid 28-32t	Euro IV	61765	45362	41163	35700	32520	31565	32479	26135	27362	28430	27068	28541	29134	29511	27002	29167	27688	26965
HDV Diesel Rigid 28-32t	Euro V	-	-	48648	42191	38433	37304	38385	30887	32337	33599	31990	33730	34431	34877	31912	34470	32723	31868
HDV Diesel Rigid 28-32t	Euro VI	-	-	-	-	-	-	-	-	35172	36545	34795	36687	37450	37935	34710	37492	35592	34662

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
HDV Diesel Rigid >32t	Conventional	47497	34883	31654	27453	25008	24273	24976	20097	21041	21862	20815	21948	22404	22694	20764	22429	21292	20736
HDV Diesel Rigid >32t	Euro I	52408	38490	34927	30291	27594	26783	27559	22176	23217	24123	22968	24217	24720	25040	22912	24748	23494	22880
HDV Diesel Rigid >32t	Euro II	64308	47230	42858	37170	33859	32865	33817	27211	28488	29601	28183	29716	30333	30726	28114	30368	28828	28075
HDV Diesel Rigid >32t	Euro III	74069	54398	49363	42811	38998	37852	38949	31341	32812	34093	32460	34226	34937	35390	32381	34977	33204	32336
HDV Diesel Rigid >32t	Euro IV	67851	49832	45219	39217	35725	34675	35680	28710	30058	31231	29736	31353	32004	32419	29663	32041	30417	29622
HDV Diesel Rigid >32t	Euro V	-	-	53274	46203	42088	40852	42035	33824	35412	36794	35032	36938	37705	38194	34947	37748	35835	34898
HDV Diesel Rigid >32t	Euro VI	-	-	-	-	-	-	-	-	38175	39665	37766	39820	40647	41174	37673	40693	38631	37621
HDV Diesel Art. 14-20t	Conventional	50224	36886	33472	29029	26444	25667	26410	21251	22249	23118	22011	23208	23690	23997	21957	23717	22515	21926
HDV Diesel Art. 14-20t	Euro I	60692	44574	40448	35079	31955	31016	31915	25680	26886	27936	26598	28045	28627	28998	26533	28660	27207	26496
HDV Diesel Art. 14-20t	Euro II	72615	53330	48394	41971	38233	37110	38185	30725	32168	33424	31823	33554	34251	34695	31745	34290	32552	31702
HDV Diesel Art. 14-20t	Euro III	90537	66493	60339	52330	47669	46269	47609	38309	40108	41674	39678	41836	42705	43258	39581	42754	40586	39526
HDV Diesel Art. 14-20t	Euro IV	96105	70582	64049	55548	50601	49114	50537	40665	42574	44236	42118	44409	45331	45918	42015	45383	43082	41957
HDV Diesel Art. 14-20t	Euro V	-	-	73654	63878	58189	56479	58116	46763	48959	50870	48434	51068	52129	52804	48315	52188	49543	48249
HDV Diesel Art. 14-20t	Euro VI	-	-	-	-	-	-	-	-	54346	56467	53763	56688	57865	58615	53632	57931	54994	53558
HDV Diesel Art. 20-28t	Conventional	55688	40899	37113	32187	29321	28459	29284	23563	24670	25633	24405	25733	26267	26608	24346	26297	24964	24312
HDV Diesel Art. 20-28t	Euro I	66156	48587	44089	38237	34832	33809	34788	27992	29307	30451	28993	30570	31205	31609	28922	31240	29657	28882
HDV Diesel Art. 20-28t	Euro II	79216	58179	52794	45786	41709	40483	41656	33519	35093	36463	34716	36605	37365	37849	34631	37408	35511	34584
HDV Diesel Art. 20-28t	Euro III	96002	70506	63980	55488	50546	49061	50483	40621	42528	44189	42072	44361	45283	45869	41970	45334	43036	41912
HDV Diesel Art. 20-28t	Euro IV	96105	70582	64049	55548	50601	49114	50537	40665	42574	44236	42118	44409	45331	45918	42015	45383	43082	41957
HDV Diesel Art. 20-28t	Euro V	-	-	74534	64641	58884	57154	58810	47322	49543	51478	49012	51678	52752	53435	48892	52812	50135	48825
HDV Diesel Art. 20-28t	Euro VI	-	-	-	-	-	-	-	-	54447	56572	53863	56793	57973	58723	53731	58038	55096	53657
HDV Diesel Art. 28-34t	Conventional	59787	43909	39845	34556	31478	30554	31439	25297	26485	27519	26201	27627	28200	28566	26137	28233	26801	26101
HDV Diesel Art. 28-34t	Euro I	70155	51524	46755	40549	36937	35852	36891	29684	31078	32292	30745	32418	33091	33520	30670	33129	31449	30628
HDV Diesel Art. 28-34t	Euro II	83907	61624	55920	48497	44178	42880	44123	35503	37170	38622	36772	38772	39578	40090	36682	39623	37614	36631
HDV Diesel Art. 28-34t	Euro III	101194	74320	67440	58489	53280	51715	53213	42818	44829	46579	44348	46760	47732	48350	44240	47786	45364	44178
HDV Diesel Art. 28-34t	Euro IV	110175	80916	73426	63680	58009	56304	57936	46618	48807	50712	48284	50910	51968	52641	48166	52027	49390	48099
HDV Diesel Art. 28-34t	Euro V	-	-	83031	72011	65597	63670	65515	52717	55192	57347	54600	57570	58766	59527	54467	58833	55851	54392
HDV Diesel Art. 28-34t	Euro VI	-	-	-	-	-	-	-	-	61031	63414	60377	63661	64984	65825	60230	65058	61760	60146
HDV Diesel Art. 34-40t	Conventional	57013	41872	37996	32953	30018	29136	29981	24124	25257	26243	24986	26345	26892	27241	24925	26923	25558	24890
HDV Diesel Art. 34-40t	Euro I	73296	53831	48848	42364	38591	37458	38543	31014	32470	33737	32122	33869	34573	35020	32043	34612	32857	31999
HDV Diesel Art. 34-40t	Euro II	86935	63848	57938	50248	45773	44428	45715	36785	38512	40015	38099	40172	41006	41537	38006	41053	38972	37953
HDV Diesel Art. 34-40t	Euro III	104961	77086	69951	60666	55263	53640	55194	44412	46497	48313	45999	48501	49509	50150	45886	49565	47052	45823
HDV Diesel Art. 34-40t	Euro IV	111266	81717	74153	64310	58583	56862	58509	47080	49290	51215	48762	51414	52483	53162	48643	52542	49879	48576
HDV Diesel Art. 34-40t	Euro V	-	-	85802	74413	67786	65795	67701	54476	57034	59260	56422	59491	60727	61514	56284	60796	57714	56207
HDV Diesel Art. 34-40t	Euro VI	-	-	-	-	-	-	-	-	63243	65712	62565	65968	67339	68211	62412	67415	63998	62326
HDV Diesel Art. 40-50t	Conventional	65821	48341	43866	38044	34656	33638	34612	27851	29159	30297	28846	30415	31047	31449	28775	31082	29507	28736
HDV Diesel Art. 40-50t	Euro I	80739	59297	53808	46666	42510	41261	42457	34163	35767	37163	35384	37308	38084	38577	35297	38127	36194	35248
HDV Diesel Art. 40-50t	Euro II	99347	72963	66209	57421	52307	50771	52242	42036	44010	45728	43538	45907	46860	47467	43432	46914	44535	43372
HDV Diesel Art. 40-50t	Euro III	118640	87132	79067	68572	62466	60630	62387	50200	52557	54609	51993	54822	55961	56685	51866	56024	53184	51795
HDV Diesel Art. 40-50t	Euro IV	111266	81717	74153	64310	58583	56862	58509	47080	49290	51215	48762	51414	52483	53162	48643	52542	49879	48576
HDV Diesel Art. 40-50t	Euro V	-	-	89170	77335	70447	68378	70359	56614	59273	61587	58637	61827	63111	63929	58494	63183	59980	58413
HDV Diesel Art. 40-50t	Euro VI	-	-	-	-	-	-	-	-	64978	67515	64281	67778	69186	70082	64124	69265	65754	64036
HDV Diesel Art. 50-60t	Conventional	60531	44456	40341	34986	31871	30934	31831	25613	26815	27862	26528	27971	28552	28922	26463	28584	27135	26426
HDV Diesel Art. 50-60t	Euro I	71892	52800	47912	41553	37852	36740	37805	30420	31848	33091	31507	33220	33911	34350	31430	33949	32228	31386
HDV Diesel Art. 50-60t	Euro II	87047	63930	58012	50312	45832	44485	45774	36832	38562	40067	38148	40223	41059	41591	38055	41105	39022	38002
HDV Diesel Art. 50-60t	Euro III	106062	77895	70685	61303	55843	54203	55773	44878	46985	48820	46482	49010	50028	50676	46368	50085	47546	46304
HDV Diesel Art. 50-60t	Euro IV	111266	81717	74153	64310	58583	56862	58509	47080	49290	51215	48762	51414	52483	53162	48643	52542	49879	48576
HDV Diesel Art. 50-60t	Euro V	-	-	85340	74012	67421	65440	67336	54182	56726	58941	56118	59171	60400	61182	55981	60469	57403	55904
HDV Diesel Art. 50-60t	Euro VI	-	-	-	-	-	-	-	-	62735	65184	62063	65439	66798	67663	61911	66874	63484	61825
BUS Diesel Urban Midi <=15t	Conventional	61057	44842	40692	35291	32148	31203	32107	25835	27048	28104	26758	28214	28800	29173	26693	28833	27371	26656
BUS Diesel Urban Midi <=15t	Euro I	75175	55211	50100	43450	39581	38418	39531	31809	33302	34602	32945	34737	35459	35918	32865	35499	33700	32819
BUS Diesel Urban Midi <=15t	Euro II	80238	58929	53475	46377	42247	41005	42193	33951	35545	36933	35164	37077	37847	38337	35078	37890	35969	35030

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
BUS Diesel Urban Midi <=15t	Euro III	85591	62860	57042	49471	45065	43741	45008	36216	37917	39397	37510	39550	40372	40895	37418	40418	38369	37367
BUS Diesel Urban Midi <=15t	Euro IV	80857	59383	53887	46734	42572	41321	42519	34213	35819	37217	35435	37363	38139	38633	35348	38182	36247	35300
BUS Diesel Urban Midi <=15t	Euro V	-	-	61039	52937	48222	46806	48162	38753	40573	42157	40138	42321	43201	43760	40040	43250	41057	39985
BUS Diesel Urban Midi <=15t	Euro VI	-	-	-	-	-	-	-	-	42789	44459	42330	44633	45560	46150	42226	45612	43299	42168
BUS Diesel Urban Std. 15-18t	Conventional	64652	47482	43087	37368	34040	33040	33997	27356	28640	29759	28333	29875	30495	30890	28264	30530	28982	28225
BUS Diesel Urban Std. 15-18t	Euro I	78575	57708	52366	45416	41371	40156	41319	33247	34809	36167	34435	36309	37063	37543	34351	37105	35224	34304
BUS Diesel Urban Std. 15-18t	Euro II	87583	64323	58369	50622	46113	44759	46055	37059	38799	40313	38383	40471	41311	41846	38289	41358	39262	38236
BUS Diesel Urban Std. 15-18t	Euro III	93397	68593	62244	53982	49175	47730	49113	39519	41375	42990	40931	43157	44054	44625	40831	44104	41868	40775
BUS Diesel Urban Std. 15-18t	Euro IV	90428	66413	60266	52267	47612	46213	47552	38263	40059	41623	39630	41786	42654	43206	39533	42702	40537	39478
BUS Diesel Urban Std. 15-18t	Euro V	-	-	68537	59440	54146	52556	54078	43514	45558	47336	45069	47521	48508	49136	44959	48563	46101	44897
BUS Diesel Urban Std. 15-18t	Euro VI	-	-	-	-	-	-	-	-	48498	50391	47978	50588	51639	52307	47861	51697	49077	47795
BUS Diesel Urban Art. >18t	Conventional	61936	45487	41277	35798	32610	31652	32569	26207	27437	28508	27143	28620	29214	29592	27077	29247	27765	27039
BUS Diesel Urban Art. >18t	Euro I	79016	58031	52660	45670	41603	40381	41550	33434	35004	36370	34628	36512	37270	37753	34544	37313	35421	34496
BUS Diesel Urban Art. >18t	Euro II	89001	65365	59315	51442	46860	45484	46802	37659	39427	40966	39005	41126	41981	42524	38909	42028	39898	38855
BUS Diesel Urban Art. >18t	Euro III	94460	69374	62953	54597	49735	48273	49672	39969	41845	43479	41397	43649	44555	45132	41296	44606	42345	41239
BUS Diesel Urban Art. >18t	Euro IV	89682	65865	59769	51835	47219	45832	47160	37947	39729	41280	39303	41441	42302	42850	39207	42350	40203	39153
BUS Diesel Urban Art. >18t	Euro V	-	-	69378	60169	54810	53200	54741	44048	46116	47916	45622	48103	49103	49739	45510	49158	46666	45447
BUS Diesel Urban Art. >18t	Euro VI	-	-	-	-	-	-	-	-	49259	51182	48731	51381	52449	53128	48611	52508	49847	48544
BUS Diesel Coaches Std. <=18t	Conventional	62298	45754	41519	36008	32801	31837	32760	26360	27598	28675	27302	28787	29385	29766	27235	29419	27927	27198
BUS Diesel Coaches Std. <=18t	Euro I	72842	53497	48545	42102	38352	37225	38304	30821	32269	33528	31923	33659	34358	34803	31845	34397	32654	31801
BUS Diesel Coaches Std. <=18t	Euro II	80305	58978	53519	46415	42282	41040	42229	33979	35575	36964	35193	37108	37879	38369	35107	37922	35999	35059
BUS Diesel Coaches Std. <=18t	Euro III	86927	63842	57932	50243	45768	44424	45711	36781	38508	40012	38095	40168	41002	41533	38002	41049	38968	37950
BUS Diesel Coaches Std. <=18t	Euro IV	90934	66785	60603	52559	47878	46472	47818	38477	40284	41856	39852	42019	42892	43448	39754	42941	40764	39699
BUS Diesel Coaches Std. <=18t	Euro V	-	-	66690	57838	52687	51140	52621	42342	44330	46061	43855	46240	47201	47812	43748	47254	44859	43687
BUS Diesel Coaches Std. <=18t	Euro VI	-	-	-	-	-	-	-	-	47491	49345	46982	49538	50567	51222	46867	50624	48058	46802
BUS Diesel Coaches Art. >18t	Conventional	61655	45282	41090	35636	32462	31509	32422	26088	27313	28379	27020	28490	29082	29459	26954	29115	27639	26917
BUS Diesel Coaches Art. >18t	Euro I	74330	54590	49537	42962	39136	37986	39087	31451	32928	34213	32575	34347	35060	35514	32495	35100	33321	32450
BUS Diesel Coaches Art. >18t	Euro II	84905	62357	56585	49074	44704	43390	44648	35926	37613	39081	37209	39233	40049	40567	37118	40094	38062	37067
BUS Diesel Coaches Art. >18t	Euro III	89994	66094	59976	52016	47383	45991	47324	38079	39867	41423	39440	41585	42449	42999	39343	42497	40343	39289
BUS Diesel Coaches Art. >18t	Euro IV	89904	66028	59916	51963	47336	45945	47276	38041	39827	41382	39400	41543	42406	42956	39304	42455	40302	39250
BUS Diesel Coaches Art. >18t	Euro V	-	-	67848	58843	53602	52027	53535	43077	45100	46860	44616	47043	48020	48642	44507	48075	45638	44446
BUS Diesel Coaches Art. >18t	Euro VI	-	-	-	-	-	-	-	-	48296	50182	47779	50378	51424	52090	47662	51483	48873	47596
BUS CNG Urban	Euro I	62537	68926	52160	60889	69888	65541	68191	72694	74584	67201	63967	65110	60823	61404	54131	56306	41315	36747
BUS CNG Urban	Euro II	69706	76827	58139	67868	77899	73054	76008	81027	83133	74905	71300	72574	67796	68443	60336	62760	46051	40959
BUS CNG Urban	Euro III	74333	81927	61999	72374	83071	77904	81054	86406	88652	79877	76033	77392	72297	72987	64342	66927	49109	43679
BUS CNG Urban	EEV	87131	96032	72673	84835	97373	91316	95009	101283	103915	93630	89124	90716	84744	85553	75419	78449	57564	51199
MOP 2-stroke <50cm^3	Conventional	1111	969	874	864	795	715	670	550	634	652	645	752	731	731	769	879	909	873
MOP 2-stroke <50cm^3	Euro 1	1328	1158	1045	1033	950	854	801	658	758	779	771	899	874	874	919	1051	1087	1043
MOP 2-stroke <50cm^3	Euro 2	1698	1481	1336	1321	1215	1092	1024	841	969	996	986	1149	1117	1118	1176	1344	1390	1334
MOP 2-stroke <50cm^3	Euro 3	1790	1561	1408	1392	1280	1152	1079	887	1022	1050	1039	1211	1178	1178	1239	1416	1465	1406
MOP 2-stroke <50cm^3	Euro 4	-	-	-	-	-	-	-	-	-	-	-	1410	1371	1372	1442	1649	1705	1637
MOP 2-stroke <50cm^3	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1839	1902	1826
MOT 2-stroke >50cm^3	Conventional	2526	2203	1987	1964	1806	1625	1523	1251	1441	1482	1466	1709	1662	1663	1748	1998	2067	1984
MOT 2-stroke >50cm^3	Euro 1	2634	2297	2072	2049	1884	1695	1588	1305	1503	1545	1529	1783	1733	1734	1823	2084	2155	2069
MOT 2-stroke >50cm^3	Euro 2	2984	2603	2347	2321	2134	1920	1799	1478	1703	1751	1732	2019	1963	1964	2066	2361	2442	2344
MOT 2-stroke >50cm^3	Euro 3	3058	2667	2406	2379	2187	1967	1844	1515	1745	1794	1775	2070	2012	2013	2117	2420	2503	2402
MOT 2-stroke >50cm^3	Euro 4	-	-	-	-	-	-	-	-	-	-	-	2225	2163	2164	2276	2601	2690	2582
MOT 2-stroke >50cm^3	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2755	2849	2735
MOT 4-stroke <250cm^3	Conventional	3272	2854	2574	2545	2340	2105	1973	1621	1867	1919	1899	2214	2153	2154	2265	2589	2677	2570
MOT 4-stroke <250cm^3	Euro 1	3638	3174	2862	2830	2602	2341	2194	1802	2076	2135	2112	2462	2394	2395	2519	2879	2977	2858
MOT 4-stroke <250cm^3	Euro 2	3223	2811	2535	2507	2305	2073	1943	1596	1839	1891	1870	2181	2120	2121	2231	2550	2637	2531
MOT 4-stroke <250cm^3	Euro 3	3442	3002	2707	2677	2462	2214	2075	1705	1964	2019	1998	2329	2265	2266	2383	2723	2816	2703

Subsector	Technology	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
MOT 4-stroke <250cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	2313	2249	2250	2366	2704	2796	2684
MOT 4-stroke <250cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2712	2804	2692
MOT 4-stroke 250-750cm³	Conventional	3366	2936	2648	2618	2408	2166	2030	1668	1921	1975	1954	2278	2215	2216	2330	2664	2755	2644
MOT 4-stroke 250-750cm³	Euro 1	3787	3303	2979	2946	2709	2436	2284	1876	2161	2222	2198	2563	2492	2493	2622	2997	3099	2975
MOT 4-stroke 250-750cm³	Euro 2	3394	2960	2670	2640	2427	2183	2046	1681	1937	1991	1970	2297	2233	2234	2349	2685	2777	2665
MOT 4-stroke 250-750cm³	Euro 3	3442	3002	2707	2677	2462	2214	2075	1705	1964	2019	1998	2329	2265	2266	2383	2723	2816	2703
MOT 4-stroke 250-750cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	2339	2274	2275	2392	2734	2828	2714
MOT 4-stroke 250-750cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2721	2814	2701
MOT 4-stroke >750cm³	Conventional	3417	2981	2688	2658	2444	2198	2061	1693	1950	2005	1983	2313	2249	2250	2366	2704	2796	2684
MOT 4-stroke >750cm³	Euro 1	3895	3397	3064	3029	2786	2506	2349	1929	2223	2285	2260	2636	2563	2564	2696	3082	3187	3059
MOT 4-stroke >750cm³	Euro 2	3482	3037	2739	2709	2491	2240	2100	1725	1987	2043	2021	2357	2291	2292	2411	2755	2850	2735
MOT 4-stroke >750cm³	Euro 3	3442	3002	2707	2677	2462	2214	2075	1705	1964	2019	1998	2329	2265	2266	2383	2723	2816	2703
MOT 4-stroke >750cm³	Euro 4	-	-	-	-	-	-	-	-	-	-	-	2351	2286	2287	2405	2749	2843	2729
MOT 4-stroke >750cm³	Euro 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2722	2815	2702