REPUBLIC OF SERBIA

Ministry of Environmental Protection

Environmental Protection Agency

National Greenhouse Gas Inventory document of Serbia 2025

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Republic of Serbia

Ministry of Environmental Protection

Serbian Environmental Protection Agency

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SUMMARY

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EXECUTIVE SUMMARY

Background information

This national inventory report provides emission data and the associated estimation methodologies for the Republic of Serbia for the period 1990-2023, for all substances which contribute to enhancing the greenhouse effect, required under the United Nations Framework Convention on Climate Change (UNFCCC).

This 2025 inventory reporting represents the second reporting obligation under the Paris Agreement. The substances covered are the direct greenhouse gases (GHG): carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), the two species of halogenous substances, hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). Indirect GHG are also to be reported under the Paris Agreement, and comprise the following substances: sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), and carbon monoxide (CO).

Compared with the latest GHG inventory reported in the first Biennial Transparency Report (BTR) from December 2024, for the period 1990-2022, the estimates have been revised and corrected to consider updated statistics, improved knowledge, possible changes in methodology and specifications contained in the guidelines (FCCC/CP/2013/10), as defined by the UNFCCC.

Although continuous progress is realized in terms of coverage of emission sources and the quality of estimates, non-negligible uncertainties remain concerning emissions. This should be borne in mind when using the data in this report. A table presenting uncertainties for each subsector and substance has been included in the report.

Future reviews and updates of these data are probable, in order to take into account both changes in the methodologies, the activity data and the ongoing work at international level on improving knowledge and rules on compiling and reporting emissions.

Summary of trends related to national emissions and removals

The emissions of GHG, which contribute directly to the greenhouse effect, expressed in CO_2 equivalent, amount a total of 62.2 Mt CO_2e in the Republic of Serbia in 2023, excluding LULUCF (land use, land-use change and forestry) contribution, which corresponds to a decrease of 25.7% compared with the emission levels of 1990. Since 2009 and the global economic downturn, the national emissions of the Republic of Serbia, excluding LULUCF, have been rather stable, except for the years 2011 and 2014 where winter climate conditions were respectively really cold and warm. In addition, in 2014, large floods occurred, disrupting the mining activity over the territory. The national GHG emissions of the Republic of Serbia including the LULUCF contribution amount 57.2 Mt CO_2e in 2023, and decreased of 30.5% compared with 1990, and follow a similar trend to the emissions including the LULUCF contribution. This overall trend does not enable to observe the different trends depending on the GHG considered. Without considering LULUCF, the national CO_2 emissions decreased by 24.8% in 2023, compared with 1990, whereas CH_4 and N_2O decreased by 32% and 24%, respectively, over that same period.

In 2023, the contributions of the different GHG to the national emissions excluding LULUCF are rather similar to the ones observed in 1990, with CO_2 the most predominant substance with 82%, followed by CH_4 (13.5%) and N_2O (4.1%), whereas the other substances contribute more negligibly with 0.01% for SF_6 and 0.24% for HFCs. Nevertheless, it is important to notice the increasingly HFC emissions, related to the use of refrigerants, which were not occurring in 1990.

Overview of source and sink category emission estimates and trends

The energy sector is the predominant source of GHG emissions in 2023 (as well as over the whole period), in the Republic of Serbia, contributing to 79.3% of the national GHG emissions without considering LULUCF contribution. The industrial process and product use, agriculture and waste sectors respectively contribute to 7.5%, 7.9% and 5.3% of the national GHG emissions excluding LULUCF, for the year 2023. Since 1990, all contributions have been varying but are rather stable in 2023, compared with 1990. Meanwhile, in the recent years, the relative contribution of the energy sector (CRT 1) has slightly decreased compared with 1990 (2023 is slightly higher than the previous years), which was of 79.5% in 1990, the one of the industrial processes and product use (CRT 2) increased, as a consequence, from 6.5% in 1990 to an average of 8.1% for, the period 2017-2023.

Key trends between 1990 and 2023 include:

- a significant decrease in the fugitive GHG emissions of oil and natural gas systems (CRT 1B2, -62%), in particular due to the downfall of flaring in refineries,
- a considerable decrease of CO_2 and N_2O emissions of the chemical industry (CRT 2B, -82% in CO_2e), in particular following the shutdown of ammonia and nitric acid plants, compensated partly by the increase in CO_2 emissions from iron and steel production (CRT 2C1, +58%),
- the important increase in CO_2 emissions from the use of urea in agriculture (CRT 3H, +489%), although relatively marginal in the national totals, accompanied with the significant increase in direct N_2O emissions related to application of inorganic fertilisers (CRT 3.D.a.1, +519%), but which do not compensate in CO_2e the significant reduction in CH_4 emissions of the enteric fermentation (CRT 3A, -49%) for the global agriculture sector (-34% in CO_2e),
- the large increase of the negative emissions of CO_2 of the LULUCF sector, which more-than-tripled between 1990 and 2023 (+253%), mostly due to the growing forest (CRT 4A, +159%).

In 2023, the CO_2 balance for LULUCF is a net removal which represents more than 8% of the total GHG emissions without LULUCF contribution, expressed as CO_2 equivalent (i.e., 5.0 Mt CO_2e).

Other information - indirect GHGs

The indirect GHG emissions are estimated and reported within the GHG emission inventory due to their indirect impact on climate change, and hence presented briefly in the NID. The emission estimation methodologies applied are from the EMEP/EEA guidelines.

Between 1990 and 2023, different trends in mass emissions for the four gases which indirectly contribute to the greenhouse effect are observed: -42% for sulphur dioxide, -27% for carbon monoxide, -23% for nitrogen oxides sand -30% for non-methane volatile organic compounds.

The emissions of NOx have been reduced mostly in relation with the drop in the Public electricity and heat production (CRT 1A1a, -32% between 1990 and 2023), due to the drop in coal consumption and the implementation of regulations on thermal power plants, as well as the road transport emissions (CRT 1A3b, -28%), which have gone down although the traffic increased, thanks to the better performances of the vehicles. The SO_2 emissions have fallen mostly due to the decline in the solid fuel consumption for the public heat and electricity production (CRT 1A1a), as well as due to national regulations, which have reduced its emissions by 43% meanwhile it represented more than 90% of the national emissions in 1990. The NMVOC emissions, which are more evenly distributed among subsectors, have been reduced due to the drop in the evaporative exhaust from road vehicles, the decline in the coal mining, the fall in the livestock of cattle, and the decrease in the

Serbian population which has a direct impact on solvent consumption. Finally, the CO emissions have principally decreased due to the improvement of the exhaust emission levels from road vehicle, whereas an increase is observed in some industrial sectors due to increasing productions. The CO emissions from the residential combustion, which contribute to more than half the national total in 1990, are stable over 1990-2023.

Key category analysis

According to the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, key categories are those which represent 95% (Tier 1) or 90% (Tier 2) of the total annual emissions in the last reported year or belonging to the total trend, when ranked from contributing the largest to smallest share in annual total and in the trend.

In 2023, in terms of emission levels, the principal key categories in the Republic of Serbia, without considering LULUCF contribution, are the public electricity and heat production by solid fuels (CRT1A1a-CO_2: rank 1, 45.0% contribution), the liquid fuel combustion in road transport (CRT 1A3b-CO_2: rank 2, 12.6%), the solid waste disposal (CRT 5A1-CH_4: rank 3, 4.0%), the steel production (CRT 2C1a-CO_2: rank 4, 3.6%) and the public electricity and heat production with burning of gaseous fuels (CRT 1A1a-CO_2: rank 5, 3.6%). They represent almost 70% of the whole national GHG emission totals, excluding LULUCF. In overall, 44 emission sources constitute the key categories in emission levels in 2023 in the Republic of Serbia, excluding LULUCF.

While considering the LULUCF emissions, the main key categories are relatively the same, but the CO_2 emissions related to the forest land remaining forest land (CRT 4A1) comes in 3rd position with a contribution of 7.5%. Only three LULUCF subcategories come in the emission level key categories analysis while considering LULUCF contribution, and the total number of key categories increases up to 49 emission sources in 2023.

In terms of emission trend, in 2023, the similar emission sources are responsible for the major changes but in a different order, excluding LULUCF: CO_2 from road transport with liquid fuels (rank 1, 17.4%), due to its large increase, CO_2 from public electricity and heat production burning gaseous fuels (rank 2, 5.4%) and solid fuels (rank 3, 4.7%), CO_2 from flaring in oil production (rank 4, 4.2%), and finally CO_2 from steel production (rank 5, 4.1%). These five main key categories contribute only to about 36% of the total trend contribution. Hence, a total of 63 emission sources constitutes the key categories in trend in 2023, in the Republic of Serbia, excluding LULUCF.

Considering the LULUCF contribution, the five main key categories in terms of trend assessment are relatively the same, except with the forest land remaining forest land (4A1) which comes in 2nd position with a contribution of 9.9% in 2023, due to its large increase over the studied period. 8 emission sources from LULUCF represent key categories in trend assessment in 2023. In total, considering the LULUCF emissions, a total of 72 emission sources constitutes the key categories in trend assessment in 2023, in the Republic of Serbia.

Improvements introduced

Since the latest inventory submission (through the BTR2024), various improvements have been implemented in terms of GHG emission inventory transparency, exhaustivity, completeness, accuracy and coherence, as well as on the transparency in terms of reporting. Among them, remarkable improvements which could be mentioned:

- Inclusion of recalculation description compared with latest submission;
- Consideration of CO_2 emissions resulting from NMVOC emissions of solvent uses (reported prior in CRT 2D3) as indirect CO_2;
- Addition of the analysis of key categories in Tier 2;

- Correction when negative emissions for N_2O in 4B2 and 4C2 are estimated (set to null);
- Correction when negative consumptions result from the balance with NEU in Chemical (CRT 1A2c) industry, impacting 2007 and the years 2012-2014;
- And, in general, improvement of the coherence between the energy balances and the GHG inventory (i.e., of the reference and sectoral approach comparison);
- Correction of the activity data of the nitrogen amounts of animal manure applied to soils to estimate indirect N_2O emissions from CRT 3D2 the whole period.

Chapter 1: Introduction

1.1 Background information on GHG inventories and climate change

General framework

The United Nations Framework Convention on Climate Change (hereinafter: the Convention – UNFCCC) was adopted and signed at the Earth Summit in Rio de Janeiro, Brazil, in June 1992. The Convention entered into force in March 1994. The Kyoto Protocol (hereinafter: the Protocol) to the Convention, was adopted at the third session of the Conference of the Parties, held in December 1997 in Kyoto, Japan.

The Republic of Serbia has been part of the United Nations Framework Convention on Climate Change (UNFCCC) (Convention) since 2001 and the Kyoto Protocol (hereinafter: Protocol) since 2008 as a developing country (non-Annex I country). The Ministry of Environmental Protection (MEP) is the National Focal Point for the implementation of the Convention and the Protocol. The Republic of Serbia, as a non–Annex I state member of the Convention, in line with its capabilities and principles of sustainable development, endeavors to contribute to the fulfilment of the primary goals of the Convention.

The Republic of Serbia harmonized national legislation with the EU legislation framework in the field of climate change and is continuing with the process of further alignment. This process will also contribute to the improvement of fulfilling the obligations of the Republic of Serbia under the UNFCCC and Paris Agreement, aiming at increasing its capacity to be able to fulfil the Annex I Party reporting requirements. As a result of this process, institutional and legislative structure for monitoring, reporting and verification of GHG emissions from stationary installations – as a prerequisite for EU Emission Trading System, as well as information relevant to climate change was established. Within this structure Serbian Environmental Protection Agency took an important role of technical assessment of Monitoring Plans from stationary installations.
The Republic of Serbia has updated National Determined Contribution (NDC), in accordance with the Articles 3 and 4 of the Paris Agreement and paragraphs 22 and 24 of Decision 1 CP/21. This led to increasing its ambition to the GHG emission reduction by 13.2% compared to 2010 level (i.e. 33.3% compared to 1990) by 2030.

National GHG inventories

In the framework of the Convention, the annual greenhouse gases (hereinafter: GHG) inventory should be transparent, consistent, comparable, complete and accurate.

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

b) *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. 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* (hereinafter referred to as the 2006 IPCC Guidelines);

c) *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;

d) *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;

e) *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.

Under the Convention, the annual GHG emission inventory covers:

- The period 1990-2023. The year 1990 should be the base year for the estimation and reporting of inventories.
- Seven direct GHG: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated carbons (HFC, PFC), sulfur hexafluoride (SF_6), nitrogen fluoride (NF_3).
- Four indirect GHG: sulphur dioxide (SO_2), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), oxides of nitrogen (NO_x).
- Five main activity sectors: Energy, Industrial Processes and Product Use, Agriculture, Land Use, Land-Use Change and Forestry, and Waste.

The Republic of Serbia has examined whether there are activities which would result in emissions of trinitrogenfluoride (NF_3) and perfluorocarbons (PFCs), and our assessment is that there are no emissions of these two substances on the territory for the covered period.

Global warming potentials (GWP)

In order to assess the relative impact of each GHG on climate change, the global warming potential (GWP) has been defined. It corresponds to the radiative effect that one GHG can exert over a period of a hundred years, in comparison with CO_2 for which the GWP is determined as 1. The GWP applied are the values provided by the

UNFCCC, which currently correspond to the values from the 2019 IPCC 5th Assessment Report (AR5), which are as follows:

GWP CO_2	GWP CH_4	GWP N_20	GWP SF_6	GWP NF_3
1	28	265	23 500	16 100

GWP									
HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-365mfc	HFC-23	HFC-4310mee	HFC-32	HFC-245fa
3 170	1 300	4 800	138	3 350	804	12 400	1 650	677	858

GWP							
PFC-14	PFC-116	C_3F_8	c-C_4F_8	C_4F_{10}	C_5F_{12}	C_6F_{14}	$C_{10}F_{18}$*
6 630	11 100	8 900	9 540	9 200	8 550	7 910	7 190

* the GWP for $C_{10}F_{18}$ is taken as 7 190, but is indicated as "> 7 190" in the IPCC AR5)

The four other substances which have an indirect impact on greenhouse effect as primary substances acting on the formation of secondary pollutants such as ozone (O_3) or aerosols are:

- CO, which can get oxidized in the atmosphere into CO_2,
- NMVOC and NO_x (expressed in equivalent NO_2), which can interact in complex chemical reactions into the atmosphere to form ozone, which contributes to the greenhouse effect,
- SO_x (expressed in equivalent SO_2), which have an indirect cooling action on the climate through the contribution to aerosol formation with a relatively high albedo.

Changes in the national inventory arrangements since previous annual GHG

This national inventory report is the second one reported in the format of CRT Reporter and NID requirements as per the Enhanced Transparency Framework. No specific changes are to be reported between these two NID submissions.

1.2 A description of the national circumstances and institutional arrangements

1.2.1 National circumstances

The Republic of Serbia is a landlocked country covering the area of 88,361 km^2.

Serbia's climate is moderate continental, with gradual transition between seasons. Continental climate prevails in the mountainous regions of above 1,000 m altitude. The southwestern part of the country borders the Mediterranean, subtropical and continental climates.

Since 2006, the Republic of Serbia is an independent democratic state with a multiparty parliamentary system. In March 2012, Serbia was granted the status of a European Union (EU) candidate country.

According to the 2022 Census, Serbia has a population of 6,623,183 in 2023, with a gender distribution of 51.4% women and 48.6% men. In 2015, Serbia's population was estimated at 7,095,383, with women accounting for 51.3% and men for 48.7%.

According to the data of the Statistical Office of the Republic of Serbia (SORS), the unemployment rate of the working age population stood at 19.2% in 2014, at 17.7% in 2015, 15.3% in 2016, 13.5% in 2017, 12.7% in 2018, 10.4% in 2019, and 9.0% in 2020. There are significant gender disparities in employment, with men making up the majority of the active workforce. In 2014, the employment rate for working-age women was significantly lower than that of men (43.7% vs. 57.7%). The labor market situation improved after 2015, as Serbia recovered from the economic crisis and the floods, leading to increased employment rates for both women and men (52.0% and 65.6% respectively). However, the gender gap persisted.

Serbia's economy is a service-based upper middle-income free-market economy, with the tertiary sector accounting for two-thirds of the total gross domestic product (GDP). Energy, machinery, mining, and agriculture are the strongest sectors of Serbia's economy.

Due to heavy floods, the GDP dropped by 1.8% in real terms in 2014 compared with 2013. The GDP registered a real year-on-year growth of 0.8% in 2015 and of 2.8% in 2016. The GDP registered real year-on-year growth of 2.0% in 2017 and 4.4% real year-on-year-growth in 2018. It registered nominal growth of 6.8% and real growth of 4.2% in 2019 over 2018. The GDP dropped by 0.9% in 2020 over 2019. GDP breakdown by sector is as follows: services 67.9%, industry 26.1%, and agriculture 6%. Energy is one of the largest sectors of the Serbian economy, accounting for around 10% of the national GDP. This sector comprises of the oil and gas industry, coal mines, the electric power system, the decentralized district heating system and industrial energy.

The share of industry in the GDP stood at 25.8% in 2015; the following sectors accounted for the highest shares in the GDP: the manufacturing industry (15.6%), retail and wholesale trade (10.1%), real estate (8.6%) and the agriculture, forestry and fishery sector (6.5%). The following sectors had the largest shares in the GDP in 2020: manufacturing industry – 13.3%; wholesale and retail trade and repair of motor vehicles – 11.3%; real estate industry – 7%; agriculture, forestry and fishing – 6.3%; information and communication industry – 5.4%; and construction industry – 5.4%.

Transport in Serbia includes transport by road, rail, water and air. Increased activity was registered in all modes of transport in 2016 over 2015, except railway and public transport. Road transport has traditionally been the most developed mode of transport. The road network is well developed but its quality has diminished. Fleet age is the main problem when it comes to environmental protection and traffic safety. According to SEPA, of the 2,047 million passenger vehicles in 2015, 22.7% were between 15 and 25 years old, while 18% were over 25 years old. SORS data show an increase in the number of registered road vehicles in all categories (except buses and working vehicles) in 2020 over 2019. A total of 2,164,818 passenger vehicles was registered.

Agriculture's share in Serbia's GDP is traditionally high. In 2016, agriculture accounted for 11.9% of GDP, a 2.4% increase over 2015, mostly due to very favourable weather conditions and record crops. It is also the leading export sector in Serbia. In 2016, agriculture and food production accounted for 19.4% of all Serbian exports. The GDP fell in real terms by 1.6% in 2019. According to the 2012 Serbian Agriculture Census, there are approximately 630,000 registered agricultural holdings; around 99.6 percent of them are family farms and 0.4 percent are holdings owned by legal entities. Land in Serbia is rarely owned by women, i.e., 84% women do not own agricultural land. A new census is under way.

Identification of land use change was performed by use of CORINE land cover mapping. Serbia's forest cover is close to the global average and stands at 39.3%, but is much lower than the European average. The preliminary results of the Second National Forest Inventory show that Serbia's forest cover stands at 39.3%, that 57.5% of the forests are now private and 42.5% are state owned, whereas the First National Inventory showed that state-owned forests dominated over private ones (53% to 47%). According to the national Spatial Plan for the 2010-

2020 period, Serbia's forest cover should optimally be 41.4%. Gross wood volume was higher in 2016 than in 2014, standing at 3.1 million m^3; gross wood volume in 2020 was lower than in 2019 and stood at 3.18 million m^3. On the other hand, a total of 11,320 ha was afforested in the 2011-2016 period, while the total area afforested in 2020 stood at 1,481 hectares.

Waste management accounted for 1.2% of the national GDP in 2016. There are 123 controlled non-compliant municipal landfill sites and around 3,450 illegal dumpsites in Serbia. In 2016, 474,018 tonnes of waste were landfilled; around 3% of municipal waste were recycled, while the bulk of the generated waste ended up in landfills. A total of 11,658 tonnes of hazardous waste was deposited in 2020. Serbia processes only 5-10% of its wastewater and needs to build 320 wastewater treatment facilities. More than 50% of the industrial facilities in Serbia do not treat wastewater, because there are no treatment systems in place. The percentage of households connected to the sewage system ranges from around 85% in Belgrade and 45% in Vojvodina to around 37% in central Serbia.

1.2.2 National entity or national focal point

Legal framework

The current Serbian legal framework contains different laws and legal texts which can be useful for the preparation of the national GHG inventory (not exhaustive):

- Regulation on fluorinated greenhouse gases management, as well as on conditions for license issuance to import and export of such gases (OJ No 120/13),
- Ordinance on the methodology for the development of national and local register of pollution sources and on the methodology and deadlines for data collection (OJ No 91/10, 10/13)
- Law on climate change (OJ No 26/21)
- Rulebook on the contents of the national GHG inventory and national report on GHG inventory (OJ No 55/23)
- Regulation on types of data, bodies and organizations and other natural and legal persons submitting data for the creation of the national GHG inventory (OJ No 43/23)
- Rulebook on monitoring and reporting of GHG (OJ No 118/23)

Institutional and procedural arrangements

In terms of organizational arrangements, a centralized model has been applied in the Republic of Serbia. From an institutional point of view, the Ministry of Environmental Protection (MEP) is the National Focal Point for the UNFCCC Convention.

As the UNFCCC National Focal Point and responsible of the National GHG Inventory, the MEP / Sector for International Cooperation and Climate Change proceeds at the relevant frequency to:

- the official approval of the national emission inventory and the national inventory report prepared by the Inventory Agency;
- the official communications and reporting of the national inventory to the UNFCCC.

The inventory preparation is under the responsibility of Serbian Environment Protection Agency (SEPA). SEPA undertakes all activities as data collection and preparation of emission reporting, according to CRT nomenclature, and the national GHG inventory report. All data which are necessary for the preparation of these products are collected by SEPA.

1.2.3 Inventory preparation process

Process of inventory preparation involves several steps starting with activity data collection and followed by emission estimations and recalculations, compilation of inventory including the NID and the CRT and, in parallel, implementation of general and source-category specific quality control procedures.

Process of preparation of the GHG inventory represents significant works because it includes many of national institutions and experts, and it requires different databases and/or data sets.

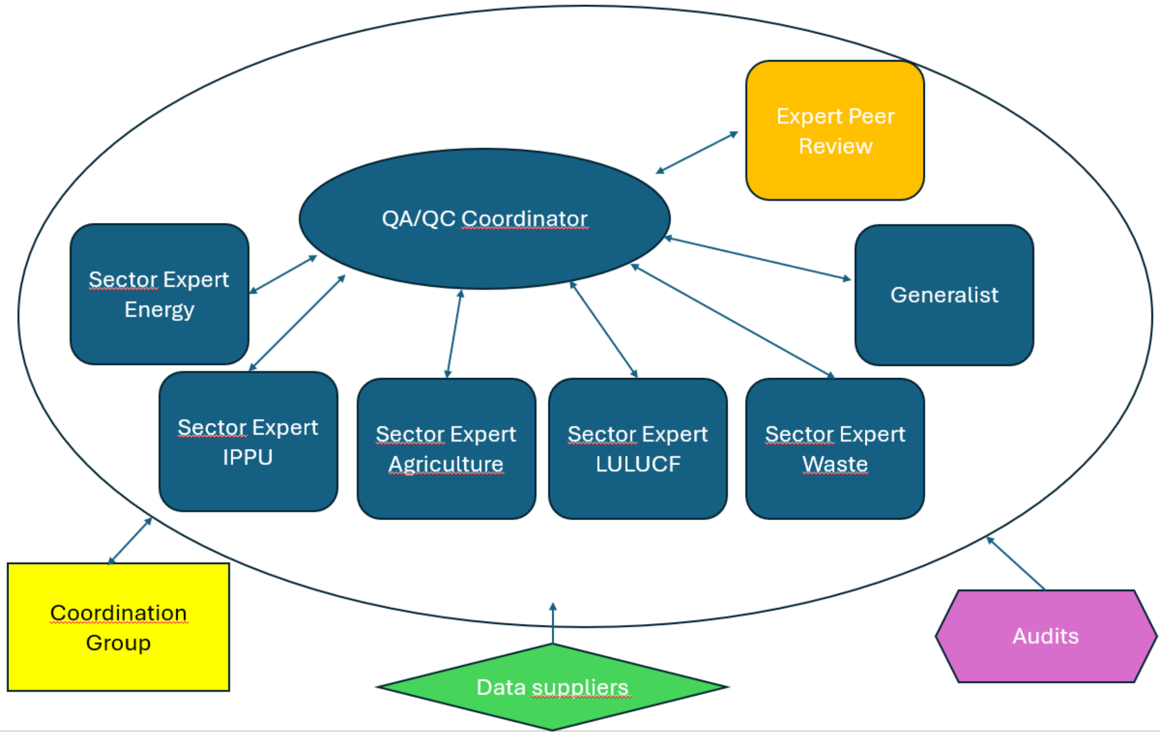
A synthetic description of the input elements, output elements for each activity of emission inventories is presented in the table below.

Table 1: Synthetic description of the input and output elements for each activity emission inventories

Input data	Activity emission inventories	Output data
- Decisions of the Coordination Group on the National Inventories CGNI proposal/approval for action plans - UNFCCC reviews	**Coordination & planning** - assure the coordination of the national inventory - organize the work to implement the action plan (methodological improvements)	- list of methodologies which have to be implemented or updated - updated state of play of the inventory works followed by the CGNI
- List of data to be collected (activity data, emission factor, individual data, statistics, etc)	**Data sources management** - update of reference documents or reference nomenclature - data collection (including data checks) - preliminary treatment	- updated reference documents or reference nomenclature - updated and prepared data (e.g.: activity data, emission factors, etc.)
- international requirements - guidelines IPCC 2006 for GHG - international guidelines as EMEP for pollutants - results of the review of United Nations	**Emission calculation** - define the content of the calculation files - define the calculation methodologies - implement the calculation - emission checks	- updated estimations of emissions and related activity data and emission factors by sectors
- international requirements - updated estimations of emissions, activity data and emission factors by sectors	**Data reporting** - EXCEL template or Database/XML file for data import into the CRF Reporter - use of the CRF Reporter - preparation of other MMR reporting templates	- CRF tables - Other MMR reporting templates
- international requirements - results of the review of United Nations - CRF tables	**National Inventory Report (NIR)** - Preparation of the national inventory report	- NIR report
- choice of indicators/proxy activity data - data sources	**Proxy X-1** - estimation of proxy emissions for the year X-1	- emissions estimated for the year X-1 in CRF format summary 2

Figure 1: General process diagram for the preparation of the national emission inventory, with QA/QC procedures

For details on QA/QC procedures, see annex 4.



With the aim of ensuring the sustainability of the process, the data bases produced during the process of preparation of the GHG inventory are located in the Environmental Protection Agency of the Republic of Serbia.

Activity data collection is under responsibility of SEPA, which represents a hub between governmental and public institutions responsible for providing activity data and Authorised Institution responsible for inventory preparation.

For this submission, some confidential data are used and cannot be reported. This concerns mostly industrial sectors where only one plant constitutes the whole subsector. CRT sectors where confidential data are used are the CRT categories 2B1 (ammonia), 2B2 (nitric acid), 2C1 (iron and steel) and 2C4 (magnesium).

The scope and due dates for delivering activity data to SEPA are defined within the national inventory system.

Planning

A detailed and operational inventory planning is prepared by the Inventory Manager for the internal coordination of the works within the SEPA. In the framework of the preparation of the national emission inventory, the inventory manager prepares an internal schedule for the inventory team to follow the UNFCCC reporting deadlines.

Management

The following schema presents the emission inventory management system in the Republic of Serbia.

Preparation

The elaboration of the national inventory is realized by sectoral experts in SEPA.

Their different functions are to prepare the emission inventories with regard to methods and their annual updates:

- to collect data sources;
- to process data;
- to store data;
- to manage checks.

The methods retained to estimate emissions have to lean from:

- the international UNFCCC reviews which produce recommendations to improve the inventory methodologies;
- the international guidelines;
- new data sources available.

1.2.4 Archiving of information

The reporting guidelines in decision 24/CP.19 identify what a Party should archive:

- Disaggregated emission factors and activity data,
- Documentation of data collection, assumption, and aggregation,
- Internal documentation on QA/QC procedures,
- External and internal reviews,
- Documentation on annual key sources,
- Planned inventory improvements.

In order to ensure transparency about the emission calculation and the archiving of data, the inventory team annually prepares and updates emission inventory Excel sheets, which contain several information about the process of emission estimation. In each file, divided by CRT category, all details can be found on the person and organization responsible, the major changes throughout different reporting, the references used for activity data and the applied emission factors, the methodologies of calculation applied, eventual data gaps, and other relevant bibliographic references. The information provided in these files is available for each source category and for the entire time-series. In addition, a detailed file records all suggestions for future improvement. All files and data related to these emission inventory sheets are archived by SEPA for each submission.

1.2.5 Processes for official consideration and approval of inventory

During the preparation of the inventory, several checks were performed by sector experts from SEPA to avoid miscalculations, and in order to ensure completeness, consistency and comparability of the emission inventory. In addition, methodological changes and recalculations, as well as uncertainties on activity data, emission factors and emission estimates are analysed during the NID preparation. All details on these issues are elaborated in the NID for each sector, subsector and corresponding CRT.

Before SEPA submits the NID to MEP, QA/QC manager carried out an audit which covers selected IPCC source categories, as outlined in the QA/QC plan, with purpose to check which quality control elements, both general (Tier 1) and specific (Tier 2), as defined in the IPCC Good Practice Guidance, are already implemented by sector experts and which improvements and corrective actions should be carried out in the future submissions.

In addition, the coordination group of national inventories is also part of the approval process, as mentioned in the chapter 1.5 on QA/QC. Thus, its members provide their opinion on certain parts of the Inventory within the frame of their speciality and approve the methodological changes implemented.

Finally, the Ministry of Environmental Protection, as the national entity, approves the inventory before official submission to the UNFCCC. As a basis for approving the inventory, the MEP will consider the completion of the inventory and the NID.

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

Methodology

The GHG inventory for the Republic of Serbia was prepared according to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, as well as the 2019 IPCC refinement for some emission sources, for emission estimations of greenhouse gases which result from anthropogenic activities: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3. For some subsectors, the IPCC 2019 refinements have been implemented but this is not the case for all subsectors concerned yet. The emission calculations are developed for each emission source according to the CRT nomenclature.

The emissions for one specific activity data are estimated through the generic formula and following mechanism:

$$E_{s,a,t} = A_{a,t} \times EF_{s,a} \qquad (1)$$

with E: emission related to the substance "s" and the activity "a" during the time period "t", A: activity data related to activity "a" during the time period "t",

EF: emission factor related to substance "s" to the activity "a".

The associated emissions from one subsector are equal to the sum of the different emissions for the activities included in the subsector.

The major part of the methodologies applied to estimate emissions is Tier 1 and relates to the multiplication of activity data (e.g. fuel consumption, manufactured product production, etc.) with default emission factors from the IPCC Guidelines. In some cases, a Tier 2 methodology is applied when already possible for this inventory according to IPCC 2006 (e.g. lignite combustion in thermal power plants, product use as ODS substitutes, manure management).

Under the framework of the Tier 1 Method, the internationally recommended values for emission factors for all fossil fuels (solid, liquid and gaseous) and biomass were used, except for open pit mined lignite used in thermal power plants where a national emission factor is applied. The lignite produced and used in the Republic of Serbia, due to its characteristics, has a significantly lower net calorific value and a higher emission factor value than the default IPCC values. In addition, the net calorific values used in the Serbian inventory are country-specific values taken from the national energy balances.

The methodologies applied into the GHG emission inventory are summarized in the following tables.

Table 2: Methodology employed by CRT for emission estimate and emission factors used

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		HFCs		PFCs		Unspecified mix of HFCs and PFCs		SF_6		NF_3	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1. Energy	T1,T2,NA,NO	D,NA,NO	T1,T2,NA,NO	D,NA,NO	T1,T2,NA,NO	D,NA,NO										
1.A. Fuel combustion	T1,T2,NA,NO	D,NA,NO	T1,T2,NA,NO	D,NA,NO	T1,T2,NA,NO	D,NA,NO										
1.A.1. Energy industries	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA										
1.A.2. Manufacturing industries and construction	T1,NA,NO	D,NA,NO	T1,NA,NO	D,NA,NO	T1,NA,NO	D,NA,NO										
1.A.3. Transport	T1,T2,NA	D,NA,NO	T1,T2,NA	D,NA,NO	T1,T2,NA	D,NA,NO										
1.A.4. Other sectors	T1,T2,NA	D,NA	T1,T2,NA	D,NA	T1,T2,NA	D,NA										
1.A.5. Other	NA	NA	NA	NA	NA	NA										
1.B. Fugitive emissions from fuels	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA										
1.B.1. Solid fuels	NA	NA	T1,NA	D,NA	NA	NA										
1.B.2. Oil and natural gas and other emissions from energy production	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA										
1.C. CO_2 transport and storage	NA	NA														
2. Industrial processes	T1,NA	D,NA	T1,T2,NA	D,NA	NA	NA	T1,T2,NA	D,OTH,NA	NA	NA	NA	NA	T1,NA	D,NA,NO	NA	NA
2.A. Mineral industry	T1,NA	D,NA	NA	NA	NA	NA										
2.B. Chemical industry	T1,NA	D,NA	T1,NA	D,NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA,NO	NA	NA
2.C. Metal industry	T1,NA	D,NA	T2,NA	D,NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D. Non-energy products from fuels and solvent use	T1,NA	D,NA	NA	NA	NA	NA										
2.E. Electronic Industry					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.F. Product uses as ODS substitutes							T1,T2,NA	D,OTH,NA	NA	NA	NA	NA	NA	NA	NA	NA
2.G. Other product manufacture and use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	T1,NA	D,NA	NA	NA
2.H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	T1,NA	D,NA	T1,T2,NA	D,NA	T1,NA	D,NA										
3.A. Enteric fermentation			T1,NA	D,NA												
3.B. Manure management			T2	D	T1,NA	D,NA										
3.C. Rice cultivation			NA	NA												
3.D. Agricultural soils			NA	NA	T1,NA	D,NA										
3.E. Prescribed burning of savannahs			NA	NA	NA	NA										
3.F. Field burning of agricultural residues			T1,NA	D,NA	T1,NA	D,NA										
3.G. Liming	NA	NA														
3.H. Urea application	T1	D														
3.I. Other carbon-containing fertilizers	NA	NA														
3.J. Other	NA	NA	NA	NA	NA	NA										
4. Land use, land-use change and forestry	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA										
4.A. Forest land	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA										
4.B. Cropland	T1,NA	D,NA	NA	NA	T1,NA	D,NA										
4.C. Grassland	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA										
4.D. Wetlands	T1,NA	D,NA	NA	NA	T1,NA	D,NA										
4.E. Settlements	T1,NA	D,NA	NA	NA	T1,NA	D,NA										
4.F. Other land	T1,NA	D,NA	NA	NA	T1,NA	D,NA										
4.G. Harvested wood products	T1,NA	D,NA														
4.H. Other																
5. Waste	NA	NA	T1,NA	D,NA	T1,NA	D,NA										
5.A. Solid waste disposal			T1,NA	D,NA												
5.B. Biological treatment of solid waste			NA	NA	NA	NA										
5.C. Incineration and open burning of waste	NA	NA	NA	NA	NA	NA										
5.D. Waste water treatment and discharge			T1,NA	D,NA	T1,NA	D,NA										
5.E. Other	NA	NA	NA	NA	NA	NA										
6. Other *(as specified in summary 1)*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Use the following notation keys to specify the method applied:
D (IPCC default) **T1** (IPCC tier 1) **T1a, T1b, T1c** (IPCC tier 1a, tier 1b and tier 1c, respectively) **T2** (IPCC tier 2) **T3** (IPCC tier 3)
CR (CORINAIR) **CS** (country-specific) **M** (model) **RA** (reference approach) **OTH** (other)

If using more than one method within one 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 category wh one method is indicated, should be provided in the documentation box. Also use the documentation box to explain the use of notation OTH.

Use the following notation keys to specify the emission factor used:
D (IPCC default) **CR** (CORINAIR) **CS** (country-specific)
M (model) **PS** (plant-specific) **OTH** (other)

Data sources

In the framework of the preparation of the emission inventory, a large amount of data must be collected. Data sources can be:

- Activity data and associated characteristic values (such as fuel consumption, raw material consumption, net calorific value, production, etc.)
  - Examples of sources: international statistics, national statistics, local statistics, governmental agencies, professional bodies, reporting data from individual plants, possible default parameters available in models.
- Emission factors and associated variables (such as emission factor, oxidation factor, conversion factor, carbon content, biomass content, sulphur content, etc.)

- Examples of sources: international guidebooks, international web databases, sectoral documents, scientific articles, expert judgments, data within calculations tools / models.

A data source has to be available for all reported years (as far as possible, else estimation/extrapolation procedures are needed cf. IPCC 2006), available at a reasonable cost, traceable, transparent, reliable, registered and archived. In addition, to apply higher Tier methods, activity data with higher degree of precision are necessary, which can be hard to collect.

The primary sources of the activity data for the GHG inventory were provided by the Statistical Office of the Republic of Serbia (e.g. statistical yearbook, energy balance). In addition, for CRT subcategories 2C1, 2C4 and 2G1, data about activity data and emissions are directly obtained from facilities (bottom-up approach).

Emission factors applied are mostly default values provided in 2006 IPCC Guidelines and their 2019 Refinement.

1.4 Brief description of key categories

According to IPCC recommendations, a key category analysis (KCA) is developed in this chapter, based on the contribution of GHG emissions (expressed in CO_2e) for each CRT category and direct GHG. In addition, for combustion activities (i.e., CRT 1A), the key categories are determined per type of fuel. Key categories are defined as the sources of emissions which have a significant influence on the inventory as a whole, in terms of absolute level of emissions, uncertainty or trend. In Approach 1, key categories are identified using a pre-determined cumulative emissions threshold.

The following tables summarize the key source categories, for the latest inventory year (2023), and the base year (1990), derived from the IPCC Approach 1 key category analyses (KCA). Results are presented for the analysis with and without LULUCF contribution.

Tier 1 Approach

According to the 2006 IPCC Guidelines for the Tier 1 approach, key categories are those contributing in the accumulative 95% of the total emissions in level or in trend analysis, when ranking from the largest to smallest contributions in level and in trend.
Tier 1 analyses were performed at a detailed level of IPCC source categories and each greenhouse gas from each source category was considered separately with respect to its total CO_2e emissions.

The results from the key category analyses of the CRT reporter are presented in **Annex 1**. The Republic of Serbia has carried out a key-category analysis on a more-detailed category level than the one recommended, which is presented in the following tables. Excluding LULUCF contribution, the Tier 1 analysis identified 43 key categories on level of emissions, for the year 2023, and 63 key categories on trend between 1990 and 2023.

A comparison of the key-category analysis carried out within the CRT Reporter and Serbia's key-category analysis has found that the two analyses differ because of different choices of definition of category levels for the KCA. Indeed, differences of approach are apparent; for example, Serbia divides agricultural or F-gases sectors into sub-categories (e.g. 3.D.1.2.a and 3.D.1.4 in Serbia‘s approach vs 3D1 within the CRT Reporter approach, or 2.F.1.f for stationary air conditioning in Serbia‘s approach vs 2F1 with CRT Reporter approach, etc.). The resulting numbers of key categories are consequently quite different between these two approaches.

In 2023, the first key category is the CO_2 emissions from the combustion of solid fuels in public electricity and heat production (CRT 1A1a) with almost half of the total emissions in the Republic of Serbia by itself (45.0%, excluding LULUCF). The emissions of CO_2 in the road transport sector (CRT 1A3b) are the second highest contribution to the national GHG totals with 12.6% of the total emissions. Then, the emissions of CH_4 from managed waste disposal (CRT 5A1) constitute the third key category with 4.0% of the total emissions. CO_2 emissions from iron and steel production (CRT 2C1a) are the fourth highest contribution over the territory in 2023 with 3.7%, followed by CO_2 emissions from gaseous fuel combustion in public electricity and heat production (CRT 1A1a) with 3.6% as well.
Among the 44 key categories (95% of total emissions), CO_2 represents 80.0% of total GHG emissions excluding LULUCF.

In terms of trend of emissions between 1990 and 2023, excluding LULUCF contribution, similar emission sources as in the level assessment analysis constitute the principal key categories. The CO_2 emissions from road transport (CRT 1A3b) is the first key category with 17.4%, due to the large increase in emissions and its significant level contribution. Then, the public electricity and heat production (CRT 1A1a) follows in second and third positions, with the CO_2 emissions related to the combustion of gaseous (5.4%) and solid (4.7%) fuels, respectively. Nevertheless, contrary to the key category in level in 2023, 9 key categories in trend assessment are necessary to represent more than 50% of the national contribution, meanwhile only 2 would contribute to 58% in level assessment.

Considering LULUCF emission sources and removals in absolute values, 49 key categories represent 95% of the national GHG emissions in level in 2023 whereas there are 72 key categories in trend assessment between 1990 and 2023. Three LULUCF sectors are among the key categories in levels while considering LULUCF contribution, and the most predominant is the forest land remaining forest land (CRT 4A1), which is a sink, and is the third key category in level assessment with LULUCF in 2023 with a contribution of 7.5%. The other two subsectors which are key categories are the harvested wood products (CRT 4G) and the forest land converted to settlements (CRT 4E21), but with less significant contributions, at the 44nd and 49th positions (0.2% each). In terms of trend assessment, 8 LULUCF subsectors are among the key categories. The CRT 4A1 is still the most predominant one and comes in 2nd position with 9.9% of contribution to the trend, due to its significant increase over the studied period. CO_2 emissions from grassland converted to forest lands (CRT 4A22) are the second highest LULUCF contributor to the trend with 0.8% (rank 26), whereas all other CRT 4 key categories contribute to less than 0.5% and ranked higher than 47.

Table 3: Key Category Analysis in Tier 1 for the year 2023 based on level of emissions (including LULUCF)

CRF code	CRF Category	Gas	Last year emissions 2023 kt CO2e	|Ex,t| (Gg CO2 E	Lx,t	Cumulative Total of Column	KCA rank T1 in lev
1.A.1.a	Public Electricity and Heat Production / Solid fuels	CO2	27986,27	27986,27	41,1%	41,1%	1
1.A.3.b	Road transport / Liquid fuels	CO2	7806,31	7806,31	11,5%	52,6%	2
4.A.1	Forest Land Remaining Forest Land - Carbon stock change / -	CO2	-5073,94	5073,94	7,5%	60,0%	3
5.A.1	[5. Waste][5.A Solid Waste Disposal][5.A.1 Managed Waste Disposal Sites] / -	CH4	2480,97	2480,97	3,6%	63,7%	4
2.C.1.a	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.1 Iron and Steel Production][2.C.1.a	CO2	2297,32	2297,32	3,4%	67,0%	5
1.A.1.a	Public Electricity and Heat Production / Gaseous fuels	CO2	2210,52	2210,52	3,2%	70,3%	6
2.A.1	Mineral industry / Cement / -	CO2	1317,29	1317,29	1,9%	72,2%	7
1.A.4.b	Residential / Solid fuels	CO2	953,26	953,26	1,4%	73,6%	8
1.B.1	Fugitive Emissions from Fuels / Solid Fuels / Solid fuels	CH4	911,91	911,91	1,3%	75,0%	9
3.A.1.a	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.1 Cattle][Option A][Dairy Cattle] / -	CH4	874,93	874,93	1,3%	76,2%	10
1.B.2.a.2	Fugitive Emissions from Fuels / Oil / Production and Upgrading / Liquid fuels	CH4	778,93	778,93	1,1%	77,4%	11
1.A.4.b	Residential / Gaseous fuels	CO2	682,76	682,76	1,0%	78,4%	12
1.A.2.f	Non-metallic Minerals / Solid fuels	CO2	642,83	642,83	0,9%	79,3%	13
3.A.1.b	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.1 Cattle][Option A][Non-Dairy Cattle] / -	CH4	632,41	632,41	0,9%	80,3%	14
5.D.1	[5. Waste][5.D Wastewater Treatment and Discharge][5.D.1 Domestic Wastewater] / -	CH4	623,64	623,64	0,9%	81,2%	15
1.A.2.f	Non-metallic Minerals / Liquid fuels	CO2	616,80	616,80	0,9%	82,1%	16
1.A.4.a	Commercial/ Institutional / Gaseous fuels	CO2	569,47	569,47	0,8%	82,9%	17
3.D.1.1	3.D.1.1 Inorganic N Fertilizers / -	N2O	561,65	561,65	0,8%	83,7%	18
1.A.4.b	Residential / Biomass	CH4	502,82	502,82	0,7%	84,5%	19
1.A.1.a	Public Electricity and Heat Production / Liquid fuels	CO2	469,39	469,39	0,7%	85,2%	20
3.A.2	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.2 Sheep][Other (please specify)] / -	CH4	432,64	432,64	0,6%	85,8%	21
1.A.2.m	Not elsewhere specified (Industry) / Gaseous fuels	CO2	366,82	366,82	0,5%	86,3%	22
3.D.1.4	3.D.1.4 Crop Residues / -	N2O	362,80	362,80	0,5%	86,9%	23
3.D.2.2	3.D.2.2 Nitrogen Leaching and Run-off / -	N2O	360,51	360,51	0,5%	87,4%	24
3.D.1.2.a	3.D.1.2.a Animal Manure Applied to Soils / -	N2O	357,71	357,71	0,5%	87,9%	25
1.A.2.m	Not elsewhere specified (Industry) / Solid fuels	CO2	294,52	294,52	0,4%	88,4%	26
1.A.4.a	Commercial/ Institutional / Solid fuels	CO2	288,03	288,03	0,4%	88,8%	27
1.A.2.a	Iron and Steel / Gaseous fuels	CO2	275,74	275,74	0,4%	89,2%	28
1.A.2.c	Chemicals / Solid fuels	CO2	271,11	271,11	0,4%	89,6%	29
1.A.1.b	Petroleum Refining / Liquid fuels	CO2	268,59	268,59	0,4%	90,0%	30
2.C.1.d	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.1 Iron and Steel Production][2.C.1.c	CO2	258,25	258,25	0,4%	90,4%	31
1.A.4.c.ii	Agriculture/ Forestry/ Fishing : Off-road vehicles and other machinery] / Liquid fuels	CO2	238,68	238,68	0,4%	90,7%	32
2.B.8.b	[2. Industrial Processes and Product Use][2.B Chemical Industry][2.B.8 Petrochemical and Carbon Bla	CO2	231,44	231,44	0,3%	91,1%	33
1.A.2.e	Food Processing, Beverages and Tobacco / Gaseous fuels	CO2	224,65	224,65	0,3%	91,4%	34
1.A.1.b	Petroleum Refining / Gaseous fuels	CO2	217,52	217,52	0,3%	91,7%	35
1.A.2.i	Mining (excluding fuels) and Quarrying / Liquid fuels	CO2	216,09	216,09	0,3%	92,0%	36
3.B.1.3	[3. Agriculture][3.1 Livestock][3.B Manure Management][3.B.1 CH4 Emissions][3.B.1.3 Swine][Other	CH4	215,42	215,42	0,3%	92,3%	37
1.A.2.c	Chemicals / Gaseous fuels	CO2	208,19	208,19	0,3%	92,6%	38
2.A.2	Mineral industry / Lime / -	CO2	203,57	203,57	0,3%	92,9%	39
3.H	3.H Urea Application / -	CO2	189,62	189,62	0,3%	93,2%	40
1.A.4.a	Commercial/ Institutional / Liquid fuels	CO2	164,60	164,60	0,2%	93,5%	41
3.D.2.1	3.D.2.1 Atmospheric Deposition / -	N2O	154,42	154,42	0,2%	93,7%	42
1.B.2.b.5	Fugitive Emissions from Fuels / Natural gas / Distribution / Gaseous fuels	CH4	149,81	149,81	0,2%	93,9%	43
4.G	Harvested Wood Products - Approach B - Approach B2 - Total HWP from Domestic Harvest - HWP Pr	CO2	-149,22	149,22	0,2%	94,1%	44
1.A.2.f	Non-metallic Minerals / Gaseous fuels	CO2	135,11	135,11	0,2%	94,3%	45
1.A.2.k	Construction / Liquid fuels	CO2	130,83	130,83	0,2%	94,5%	46
3.B.2.3	[3. Agriculture][3.1 Livestock][3.B Manure Management][3.B.2 N2O and NMVOC Emissions][3.B.2.3	N2O	123,90	123,90	0,2%	94,7%	47
1.A.2.a	Iron and Steel / Solid fuels	CO2	114,09	114,09	0,2%	94,9%	48
4.E.2.1	Forest Land Converted to Settlements / -	CO2	113,27	113,27	0,2%	95,0%	49

Table 4: Key Category Analysis in Tier 1 for the year 2023 based on level of emissions (excluding LULUCF)

CRF code	CRF Category	Gas	Last year emissions 2023 kt CO2e	|Ex,t| (Gg CO2 Eq	Lx,t	Cumulative Total of Column	KCA rank T1 in lev
1.A.1.a	Public Electricity and Heat Production / Solid fuels	CO2	27986,27	27986,27	45,0%	45,0%	1
1.A.3.b	Road transport / Liquid fuels	CO2	7806,31	7806,31	12,6%	57,6%	2
5.A.1	[5. Waste][5.A Solid Waste Disposal][5.A.1 Managed Waste Disposal Sites] / -	CH4	2480,97	2480,97	4,0%	61,6%	3
2.C.1.a	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.1 Iron and Steel Production][2.C.1	CO2	2297,32	2297,32	3,7%	65,3%	4
1.A.1.a	Public Electricity and Heat Production / Gaseous fuels	CO2	2210,52	2210,52	3,6%	68,8%	5
2.A.1	Mineral industry / Cement / -	CO2	1317,29	1317,29	2,1%	70,9%	6
1.A.4.b	Residential / Solid fuels	CO2	953,26	953,26	1,5%	72,5%	7
1.B.1	Fugitive Emissions from Fuels / Solid Fuels / Solid fuels	CH4	911,91	911,91	1,5%	73,9%	8
3.A.1.a	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.1 Cattle][Option A][Dairy Cattle] / -	CH4	874,93	874,93	1,4%	75,4%	9
1.B.2.a.2	Fugitive Emissions from Fuels / Oil / Production and Upgrading / Liquid fuels	CH4	778,93	778,93	1,3%	76,6%	10
1.A.4.b	Residential / Gaseous fuels	CO2	682,76	682,76	1,1%	77,7%	11
1.A.2.f	Non-metallic Minerals / Solid fuels	CO2	642,83	642,83	1,0%	78,7%	12
3.A.1.b	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.1 Cattle][Option A][Non-Dairy Cattle] /	CH4	632,41	632,41	1,0%	79,8%	13
5.D.1	[5. Waste][5.D Wastewater Treatment and Discharge][5.D.1 Domestic Wastewater] / -	CH4	623,64	623,64	1,0%	80,8%	14
1.A.2.f	Non-metallic Minerals / Liquid fuels	CO2	616,80	616,80	1,0%	81,8%	15
1.A.4.a	Commercial/ Institutional / Gaseous fuels	CO2	569,47	569,47	0,9%	82,7%	16
3.D.1.1	3.D.1.1 Inorganic N Fertilizers / -	N2O	561,65	561,65	0,9%	83,6%	17
1.A.4.b	Residential / Biomass	CH4	502,82	502,82	0,8%	84,4%	18
1.A.1.a	Public Electricity and Heat Production / Liquid fuels	CO2	469,39	469,39	0,8%	85,1%	19
3.A.2	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.2 Sheep][Other (please specify)] / -	CH4	432,64	432,64	0,7%	85,8%	20
1.A.2.m	Not elsewhere specified (Industry) / Gaseous fuels	CO2	366,82	366,82	0,6%	86,4%	21
3.D.1.4	3.D.1.4 Crop Residues / -	N2O	362,80	362,80	0,6%	87,0%	22
3.D.2.2	3.D.2.2 Nitrogen Leaching and Run-off / -	N2O	360,51	360,51	0,6%	87,6%	23
3.D.1.2.a	3.D.1.2.a Animal Manure Applied to Soils / -	N2O	357,71	357,71	0,6%	88,2%	24
1.A.2.m	Not elsewhere specified (Industry) / Solid fuels	CO2	294,52	294,52	0,5%	88,6%	25
1.A.4.a	Commercial/ Institutional / Solid fuels	CO2	288,03	288,03	0,5%	89,1%	26
1.A.2.a	Iron and Steel / Gaseous fuels	CO2	275,74	275,74	0,4%	89,5%	27
1.A.2.c	Chemicals / Solid fuels	CO2	271,11	271,11	0,4%	90,0%	28
1.A.1.b	Petroleum Refining / Liquid fuels	CO2	268,59	268,59	0,4%	90,4%	29
2.C.1.d	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.1 Iron and Steel Production][2.C.1	CO2	258,25	258,25	0,4%	90,8%	30
1.A.4.c.ii	Agriculture/ Forestry/ Fishing : Off-road vehicles and other machinery] / Liquid fuels	CO2	238,68	238,68	0,4%	91,2%	31
2.B.8.b	[2. Industrial Processes and Product Use][2.B Chemical Industry][2.B.8 Petrochemical and Carbon B	CO2	231,44	231,44	0,4%	91,6%	32
1.A.2.e	Food Processing, Beverages and Tobacco / Gaseous fuels	CO2	224,65	224,65	0,4%	91,9%	33
1.A.1.b	Petroleum Refining / Gaseous fuels	CO2	217,52	217,52	0,3%	92,3%	34
1.A.2.i	Mining (excluding fuels) and Quarrying / Liquid fuels	CO2	216,09	216,09	0,3%	92,6%	35
3.B.1.3	[3. Agriculture][3.1 Livestock][3.B Manure Management][3.B.1 CH4 Emissions][3.B.1.3 Swine][Oth	CH4	215,42	215,42	0,3%	93,0%	36
1.A.2.c	Chemicals / Gaseous fuels	CO2	208,19	208,19	0,3%	93,3%	37
2.A.2	Mineral industry / Lime / -	CO2	203,57	203,57	0,3%	93,7%	38
3.H	3.H Urea Application / -	CO2	189,62	189,62	0,3%	94,0%	39
1.A.4.a	Commercial/ Institutional / Liquid fuels	CO2	164,60	164,60	0,3%	94,2%	40
3.D.2.1	3.D.2.1 Atmospheric Deposition / -	N2O	154,42	154,42	0,2%	94,5%	41
1.B.2.b.5	Fugitive Emissions from Fuels / Natural gas / Distribution / Gaseous fuels	CH4	149,81	149,81	0,2%	94,7%	42
1.A.2.f	Non-metallic Minerals / Gaseous fuels	CO2	135,11	135,11	0,2%	94,9%	43
1.A.2.k	Construction / Liquid fuels	CO2	130,83	130,83	0,2%	95,1%	44

Table 5: Key Category Analysis in Tier 1 based on trend in emissions (from base year 1990 to 2023, including LULUCF)

CRF code	CRF Category	Gas	Base year emissions 1990 kt CO2	Last year emissions 2023 kt CO2e	Base year Abs(Emission) kt CO2e	Trend Assessment (Txt)	% Contribution to Tren	Cumulative Total of Column	KCA rank T1 in tre
1.A.3.b	Road transport / Liquid fuels	CO2	4469,75	7 806,31	4 469,75	0,05423	16,4%	16,4%	1
4.A.1	Forest Land Remaining Forest Land - Carbon stock change / -	CO2	-1719,37	(5 073,94)	1 719,37	0,03265	9,9%	26,2%	2
1.A.1.a	Public Electricity and Heat Production / Gaseous fuels	CO2	1084,27	2 210,52	1 084,27	0,01681	5,1%	31,3%	3
2.C.1.a	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.1 Iron and Steel Production][2.C.1.a Steel] /	CO2	1652,68	2 297,32	1 652,68	0,01326	4,0%	35,3%	4
1.B.2.c.2.i	Fugitive Emissions from Fuels / Oil / Flaring / Liquid fuels	CO2	1450,68	-	1 450,68	0,01163	3,5%	38,8%	5
1.A.2.m	Not elsewhere specified (Industry) / Liquid fuels	CO2	1477,74	67,55	1 477,74	0,01107	3,3%	42,2%	6
1.A.4.b	Residential / Gaseous fuels	CO2	2317,49	682,76	2 317,49	0,01070	3,2%	45,4%	7
1.A.4.a	Commercial/ Institutional / Liquid fuels	CO2	1424,23	164,60	1 424,23	0,00952	2,9%	48,3%	8
1.A.4.b	Residential / Solid fuels	CO2	2359,94	953,26	2 359,94	0,00792	2,4%	50,7%	9
1.A.1.a	Public Electricity and Heat Production / Solid fuels	CO2	39321,05	27 986,27	39 321,05	0,00767	2,3%	53,0%	10
1.A.2.f	Non-metallic Minerals / Solid fuels	CO2	36,46	642,83	36,46	0,00712	2,2%	55,1%	11
1.A.4.a	Commercial/ Institutional / Gaseous fuels	CO2	0,00	569,47	-	0,00657	2,0%	57,1%	12
3.A.1.a	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.1 Cattle][Option A][Dairy Cattle] / -	CH4	2068,15	874,93	2 068,15	0,00648	2,0%	59,1%	13
3.D.1.1	3.D.1.1 Inorganic N Fertilizers / -	N2O	90,71	561,65	90,71	0,00575	1,7%	60,8%	14
1.A.2.f	Non-metallic Minerals / Liquid fuels	CO2	194,50	616,80	194,50	0,00556	1,7%	62,5%	15
1.A.2.e	Food Processing, Beverages and Tobacco / Liquid fuels	CO2	795,22	85,90	795,22	0,00538	1,6%	64,1%	16
1.A.2.e	Food Processing, Beverages and Tobacco / Solid fuels	CO2	634,08	25,97	634,08	0,00478	1,4%	65,5%	17
2.B.2	Chemical industry / Nitric acid / -	N2O	563,44	-	563,44	0,00452	1,4%	66,9%	18
1.A.2.k	Construction / Gaseous fuels	CO2	561,15	-	561,15	0,00450	1,4%	68,3%	19
2.A.1	Mineral industry / Cement / -	CO2	1340,26	1 317,29	1 340,26	0,00445	1,3%	69,6%	20
5.A.1	[5. Waste][5.A Solid Waste Disposal][5.A.1 Managed Waste Disposal Sites] / -	CH4	3047,26	2 480,97	3 047,26	0,00420	1,3%	70,9%	21
1.A.1.a	Public Electricity and Heat Production / Liquid fuels	CO2	1161,92	469,39	1 161,92	0,00390	1,2%	72,1%	22
2.C.1.d	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.1 Iron and Steel Production][2.C.1.d Sinter]	CO2	0,00	258,25	-	0,00298	0,9%	73,0%	23
1.A.2.c	Chemicals / Solid fuels	CO2	19,23	271,11	19,23	0,00297	0,9%	73,9%	24
1.A.2.k	Construction / Liquid fuels	CO2	552,77	130,83	552,77	0,00292	0,9%	74,7%	25
4.A.2.2	Grassland Converted to Forest Land / -	CO2	-205,70	(26,97)	205,70	0,00279	0,8%	75,6%	26
1.A.4.c.ii	Agriculture/ Forestry/ Fishing : Off-road vehicles and other machinery] / Liquid fuels	CO2	0,00	238,68	-	0,00275	0,8%	76,4%	27
1.A.1.b	Petroleum Refining / Liquid fuels	CO2	729,24	268,59	729,24	0,00275	0,8%	77,2%	28
2.B.1	Chemical industry / Ammonia / -	CO2	334,87	-	334,87	0,00268	0,8%	78,1%	29
3.A.1.b	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.1 Cattle][Option A][Non-Dairy Cattle] / -	CH4	1243,63	632,41	1 243,63	0,00267	0,8%	78,9%	30
1.A.4.b	Residential / Biomass	CH4	411,13	502,82	411,13	0,00251	0,8%	79,6%	31
1.A.2.m	Not elsewhere specified (Industry) / Gaseous fuels	CO2	218,57	366,82	218,57	0,00248	0,7%	80,4%	32
1.A.2.c	Chemicals / Gaseous fuels	CO2	572,87	208,19	572,87	0,00219	0,7%	81,0%	33
3.D.1.4	3.D.1.4 Crop Residues / -	N2O	277,40	362,80	277,40	0,00196	0,6%	81,6%	34
3.H	3.H Urea Application / -	CO2	32,18	189,62	32,18	0,00193	0,6%	82,2%	35
3.D.1.2.a	3.D.1.2.a Animal Manure Applied to Soils / -	N2O	752,13	357,71	752,13	0,00190	0,6%	82,8%	36
1.A.2.a	Iron and Steel / Liquid fuels	CO2	226,26	0,68	226,26	0,00181	0,5%	83,3%	37
1.A.2.i	Mining (excluding fuels) and Quarrying / Liquid fuels	CO2	91,30	216,09	91,30	0,00176	0,5%	83,9%	38
1.B.1	Fugitive Emissions from Fuels / Solid Fuels / Solid fuels	CH4	1086,87	911,91	1 086,87	0,00181	0,5%	84,4%	39
1.A.2.e	Food Processing, Beverages and Tobacco / Gaseous fuels	CO2	105,83	224,65	105,83	0,00174	0,5%	84,9%	40
1.A.2.f	Non-metallic Minerals / Gaseous fuels	CO2	408,26	135,11	408,26	0,00171	0,5%	85,4%	41
2.A.2	Mineral industry / Lime / -	CO2	499,45	203,57	499,45	0,00166	0,5%	85,9%	42
1.A.1.b	Petroleum Refining / Gaseous fuels	CO2	109,68	217,52	109,68	0,00163	0,5%	86,4%	43
3.D.2.2	3.D.2.2 Nitrogen Leaching and Run-off / -	N2O	336,63	360,51	336,63	0,00146	0,4%	86,9%	44
1.A.2.b	Non-Ferrous Metals / Solid fuels	CO2	173,27	0,05	173,27	0,00139	0,4%	87,3%	45
2.F.1.f	[2. Industrial Processes and Product Use][2.F Product Uses as Substitutes for ODS][2.F.1 Refrigeration and Ai	HFC	0,00	109,65	-	0,00127	0,4%	87,7%	46
4.C.2.1	Forest Land Converted to Grassland / -	CO2	159,21	2,36	159,21	0,00125	0,4%	88,1%	47
4.A.2.1	Land Converted to Forest Land - Carbon stock change - 4.A.2.1 Cropland Converted to Forest Land / -	CO2	-120,54	(49,97)	120,54	0,00124	0,4%	88,4%	48
1.A.2.b	Non-Ferrous Metals / Liquid fuels	CO2	158,85	7,04	158,85	0,00119	0,4%	88,8%	49
3.B.1.3	[3. Agriculture][3.1 Livestock][3.B Manure Management][3.B.1 CH4 Emissions][3.B.1.3 Swine][Other (please	CH4	454,37	215,42	454,37	0,00116	0,3%	89,1%	50
1.A.2.l	Textiles and leather / Liquid fuels	CO2	151,99	6,15	151,99	0,00115	0,3%	89,5%	51
1.A.2.k	Construction / Solid fuels	CO2	144,14	3,19	144,14	0,00112	0,3%	89,8%	52
2.D.1	[2. Industrial Processes and Product Use][2.D Non-energy Products from Fuels and Solvent Use][2.D.1 Lubrica	CO2	194,04	38,03	194,04	0,00112	0,3%	90,2%	53
2.C.4	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.4 Magnesium Production] / -	SF6	136,02	-	136,02	0,00109	0,3%	90,5%	54
4.E.2.1	Forest Land Converted to Settlements / -	CO2	31,41	113,27	31,41	0,00106	0,3%	90,8%	55
3.A.2	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.2 Sheep][Other (please specify)] / -	CH4	491,22	432,64	491,22	0,00105	0,3%	91,1%	56
4.F.2.1	Forest Land Converted to Other Land / -	CO2	22,83	102,72	22,83	0,00100	0,3%	91,4%	57
3.B.2.3	[3. Agriculture][3.1 Livestock][3.B Manure Management][3.B.2 N2O and NMVOC Emissions][3.B.2.3 Swine][(	N2O	299,79	123,90	299,79	0,00097	0,3%	91,7%	58
4.G	Harvested Wood Products - Approach B - Approach B2 - Total HWP from Domestic Harvest - HWP Produced a	CO2	-50,21	(149,22)	50,21	0,00097	0,3%	92,0%	59
1.A.2.d	Pulp, Paper and Print / Solid fuels	CO2	1,59	83,68	1,59	0,00095	0,3%	92,3%	60
1.A.2.m	Not elsewhere specified (Industry) / Solid fuels	CO2	310,22	294,52	310,22	0,00091	0,3%	92,6%	61
1.A.2.d	Pulp, Paper and Print / Gaseous fuels	CO2	0,00	73,88	-	0,00085	0,3%	92,8%	62
1.A.4.a	Commercial/ Institutional / Solid fuels	CO2	515,58	288,03	515,58	0,00081	0,2%	93,1%	63
4.C.1	Grassland Remaining Grassland - Biomass Burning - Wildfires / -	CO2	143,89	30,08	143,89	0,00081	0,2%	93,3%	64
5.D.2	[5. Waste][5.D Wastewater Treatment and Discharge][5.D.2 Industrial Wastewater] / -	CH4	209,89	80,24	209,89	0,00076	0,2%	93,5%	65
1.A.2.c	Chemicals / Liquid fuels	CO2	187,26	65,38	187,26	0,00075	0,2%	93,8%	66
1.A.3.b	Road transport / Liquid fuels	N2O	58,97	103,58	58,97	0,00072	0,2%	94,0%	67
1.A.2.b	Non-Ferrous Metals / Gaseous fuels	CO2	0,00	61,11	-	0,00071	0,2%	94,2%	68
3.B.2.1.a	[3. Agriculture][3.1 Livestock][3.B Manure Management][3.B.2 N2O and NMVOC Emissions][3.B.2.1 Cattle][(	N2O	213,33	90,25	213,33	0,00067	0,2%	94,4%	69
3.A.3	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.3 Swine][Other (please specify)] / -	CH4	217,14	93,28	217,14	0,00066	0,2%	94,6%	70
1.B.2.a.2	Fugitive Emissions from Fuels / Oil / Production and Upgrading / Liquid fuels	CH4	1038,43	778,93	1 038,43	0,00066	0,2%	94,8%	71
2.C.1.e	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.1 Iron and Steel Production][2.C.1.e Pellet] /	CO2	0,00	56,63	-	0,00065	0,2%	95,0%	72

Table 6: Key Category Analysis based in Tier 1 on trend in emissions (from base year 1990 to 2023, excluding LULUCF)

CRF code	CRF Category	Gas	Base year emissions 1990 kt CO2e	Last year emissions 2023 kt CO2e	Base year Abs(Emission) kt CO2e	Trend Assessment (Txt)	% Contribution to Trend	Cumulative Total of Column	KCA rank T1 in trend
1.A.3.b	Road transport / Liquid fuels	CO2	4469,75	7806,31	4469,75	0,053611	17,4%	17,4%	1
1.A.1.a	Public Electricity and Heat Production / Gaseous fuels	CO2	1084,27	2210,52	1084,27	0,016791	5,4%	22,8%	2
1.A.1.a	Public Electricity and Heat Production / Solid fuels	CO2	39321,05	27986,27	39321,05	0,014550	4,7%	27,6%	3
1.B.2.c.2.i	Fugitive Emissions from Fuels / Oil / Flaring / Liquid fuels	CO2	1450,68	0,00	1450,68	0,012874	4,2%	31,7%	4
2.C.1.a	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.1 Iron and Steel Production][2.C.1.a Ste	CO2	1652,68	2297,32	1652,68	0,012784	4,1%	35,9%	5
1.A.4.b	Residential / Gaseous fuels	CO2	2317,49	682,76	2317,49	0,012409	4,0%	39,9%	6
1.A.2.m	Not elsewhere specified (Industry) / Liquid fuels	CO2	1477,74	67,55	1477,74	0,012307	4,0%	43,9%	7
1.A.4.a	Commercial/ Institutional / Liquid fuels	CO2	1424,23	164,60	1424,23	0,010673	3,5%	47,3%	8
1.A.4.b	Residential / Solid fuels	CO2	2359,94	953,26	2359,94	0,009553	3,1%	50,4%	9
3.A.1.a	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.1 Cattle][Option A][Dairy Cattle] / -	CH4	2068,15	874,93	2068,15	0,007899	2,6%	53,0%	10
1.A.2.f	Non-metallic Minerals / Solid fuels	CO2	36,46	642,83	36,46	0,007358	2,4%	55,4%	11
1.A.4.a	Commercial/ Institutional / Gaseous fuels	CO2	0,00	569,47	0,00	0,006805	2,2%	57,6%	12
1.A.2.e	Food Processing, Beverages and Tobacco / Liquid fuels	CO2	795,22	85,90	795,22	0,006031	2,0%	59,6%	13
3.D.1.1	3.D.1.1 Inorganic N Fertilizers / -	N2O	90,71	561,65	90,71	0,005906	1,9%	61,5%	14
1.A.2.f	Non-metallic Minerals / Liquid fuels	CO2	194,50	616,80	194,50	0,005644	1,8%	63,3%	15
1.A.2.e	Food Processing, Beverages and Tobacco / Solid fuels	CO2	634,08	25,97	634,08	0,005317	1,7%	65,0%	16
2.B.2	Chemical industry / Nitric acid / -	N2O	563,44	0,00	563,44	0,005000	1,6%	66,6%	17
1.A.2.k	Construction / Gaseous fuels	CO2	561,15	0,00	561,15	0,004980	1,6%	68,3%	18
1.A.1.a	Public Electricity and Heat Production / Liquid fuels	CO2	1161,92	469,39	1161,92	0,004703	1,5%	69,8%	19
2.A.1	Mineral industry / Cement / -	CO2	1340,26	1317,29	1340,26	0,003846	1,2%	71,0%	20
3.A.1.b	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.1 Cattle][Option A][Non-Dairy Cattle] / -	CH4	1243,63	632,41	1243,63	0,003480	1,1%	72,2%	21
1.A.2.k	Construction / Liquid fuels	CO2	552,77	130,83	552,77	0,003342	1,1%	73,2%	22
1.A.1.b	Petroleum Refining / Liquid fuels	CO2	729,24	268,59	729,24	0,003262	1,1%	74,3%	23
2.C.1.d	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.1 Iron and Steel Production][2.C.1.d Sin	CO2	0,00	258,25	0,00	0,003086	1,0%	75,3%	24
1.A.2.c	Chemicals / Solid fuels	CO2	19,23	271,11	19,23	0,003069	1,0%	76,3%	25
2.B.1	Chemical industry / Ammonia / -	CO2	334,87	0,00	334,87	0,002972	1,0%	77,3%	26
1.A.4.c.ii	Agriculture/ Forestry/ Fishing : Off-road vehicles and other machinery] / Liquid fuels	CO2	0,00	238,68	0,00	0,002852	0,9%	78,2%	27
5.A.1	[5. Waste][5.A Solid Waste Disposal][5.A.1 Managed Waste Disposal Sites] / -	CH4	3047,26	2480,97	3047,26	0,002602	0,8%	79,0%	28
1.A.2.c	Chemicals / Gaseous fuels	CO2	572,87	208,19	572,87	0,002596	0,8%	79,9%	29
1.A.2.m	Not elsewhere specified (Industry) / Gaseous fuels	CO2	218,57	366,82	218,57	0,002443	0,8%	80,7%	30
3.D.1.2.a	3.D.1.2.a Animal Manure Applied to Soils / -	N2O	752,13	357,71	752,13	0,002401	0,8%	81,4%	31
1.A.4.b	Residential / Biomass	CH4	411,13	502,82	411,13	0,002360	0,8%	82,2%	32
1.A.2.f	Non-metallic Minerals / Gaseous fuels	CO2	408,26	135,11	408,26	0,002009	0,7%	82,9%	33
1.A.2.a	Iron and Steel / Liquid fuels	CO2	226,26	0,68	226,26	0,002000	0,6%	83,5%	34
2.A.2	Mineral industry / Lime / -	CO2	499,45	203,57	499,45	0,002000	0,6%	84,2%	35
3.H	3.H Urea Application / -	CO2	32,18	189,62	32,18	0,001980	0,6%	84,8%	36
3.D.1.4	3.D.1.4 Crop Residues / -	N2O	277,40	362,80	277,40	0,001873	0,6%	85,4%	37
1.A.2.i	Mining (excluding fuels) and Quarrying / Liquid fuels	CO2	91,30	216,09	91,30	0,001772	0,6%	86,0%	38
1.A.2.e	Food Processing, Beverages and Tobacco / Gaseous fuels	CO2	105,83	224,65	105,83	0,001745	0,6%	86,6%	39
1.A.1.b	Petroleum Refining / Gaseous fuels	CO2	109,68	217,52	109,68	0,001626	0,5%	87,1%	40
1.A.2.b	Non-Ferrous Metals / Solid fuels	CO2	173,27	0,05	173,27	0,001537	0,5%	87,6%	41
3.B.1.3	[3. Agriculture][3.1 Livestock][3.B Manure Management][3.B.1 CH4 Emissions][3.B.1.3 Swine][Other (ple	CH4	454,37	215,42	454,37	0,001458	0,5%	88,1%	42
1.A.2.b	Non-Ferrous Metals / Liquid fuels	CO2	158,85	7,04	158,85	0,001326	0,4%	88,5%	43
3.D.2.2	3.D.2.2 Nitrogen Leaching and Run-off / -	N2O	336,63	360,51	336,63	0,001320	0,4%	88,9%	44
2.F.1.f	[2. Industrial Processes and Product Use][2.F Product Uses as Substitutes for ODS][2.F.1 Refrigeration ar	HFC	0,00	109,65	0,00	0,001310	0,4%	89,3%	45
1.A.2.l	Textiles and leather / Liquid fuels	CO2	151,99	6,15	151,99	0,001275	0,4%	89,7%	46
2.D.1	[2. Industrial Processes and Product Use][2.D Non-energy Products from Fuels and Solvent Use][2.D.1 Lu	CO2	194,04	38,03	194,04	0,001268	0,4%	90,2%	47
1.A.2.k	Construction / Solid fuels	CO2	144,14	3,19	144,14	0,001241	0,4%	90,6%	48
2.C.4	[2. Industrial Processes and Product Use][2.C Metal Industry][2.C.4 Magnesium Production] / -	SF6	136,02	0,00	136,02	0,001207	0,4%	91,0%	49
1.B.1	Fugitive Emissions from Fuels / Solid Fuels / Solid fuels	CH4	1086,87	911,91	1086,87	0,001251	0,4%	91,4%	50
3.B.2.3	[3. Agriculture][3.1 Livestock][3.B Manure Management][3.B.2 N2O and NMVOC Emissions][3.B.2.3 Swi	N2O	299,79	123,90	299,79	0,001180	0,4%	91,7%	51
1.A.4.a	Commercial/ Institutional / Solid fuels	CO2	515,58	288,03	515,58	0,001134	0,4%	92,1%	52
1.A.2.d	Pulp, Paper and Print / Solid fuels	CO2	1,59	83,68	1,59	0,000986	0,3%	92,4%	53
5.D.2	[5. Waste][5.D Wastewater Treatment and Discharge][5.D.2 Industrial Wastewater] / -	CH4	209,89	80,24	209,89	0,000904	0,3%	92,7%	54
1.A.2.d	Pulp, Paper and Print / Gaseous fuels	CO2	0,00	73,88	0,00	0,000883	0,3%	93,0%	55
1.A.2.c	Chemicals / Liquid fuels	CO2	187,26	65,38	187,26	0,000881	0,3%	93,3%	56
3.B.2.1.a	[3. Agriculture][3.1 Livestock][3.B Manure Management][3.B.2 N2O and NMVOC Emissions][3.B.2.1 Catt	N2O	213,33	90,25	213,33	0,000815	0,3%	93,6%	57
3.A.3	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.3 Swine][Other (please specify)] / -	CH4	217,14	93,28	217,14	0,000812	0,3%	93,8%	58
3.A.2	[3. Agriculture][3.1 Livestock][3.A Enteric Fermentation][3.A.2 Sheep][Other (please specify)] / -	CH4	491,22	432,64	491,22	0,000810	0,3%	94,1%	59
1.A.2.m	Not elsewhere specified (Industry) / Solid fuels	CO2	310,22	294,52	310,22	0,000766	0,2%	94,3%	60
1.A.2.b	Non-Ferrous Metals / Gaseous fuels	CO2	0,00	61,11	0,00	0,000730	0,2%	94,6%	61
5.D.1	[5. Waste][5.D Wastewater Treatment and Discharge][5.D.1 Domestic Wastewater] / -	CH4	921,23	623,64	921,23	0,000724	0,2%	94,8%	62
1.A.3.b	Road transport / Liquid fuels	N2O	58,97	103,58	58,97	0,000714	0,2%	95,0%	63

Tier 2 Approach

A specific analysis has been developed to evaluate the key categories in a Tier 2 approach, considering the uncertainties of each category. The assessment of uncertainties (see chapter 1.6) is made at the third level of the CRT for Energy (i.e., 1A1, 1A2, etc.) and the CRT 3D, and at the second level for other sectors (i.e., 2A, 3B, 5A etc.). Hence, the key category analysis in tier 2 is developed at the same level of CRT categories, and therefore less categories represent the sectors compared with the Tier 1 approach.

For the year 2023, 19 sectors constitute the key categories in level, i.e. contributing to more than 90% to the emission level uncertainty. The main contributing sectors, which are quite different than in Tier 1, are the CH_4 emissions from solid waste disposal (CRT 5A, with 31%; rank 1), followed by CO_2 emissions from the forest lands (CRT 4A, with 8%; rank 2) and the CH_4 from enteric fermentation (CRT 3A, with 7%; rank 3). In general, the large uncertainties on the emission levels of some categories seem to account for more than the emission level, this is why CO_2 emissions only contribute to 26% in the Tier 2 approach whereas CH_4 contributes to 55%. In 2023, the CO_2 emissions from the combustion of solid fuels in the Energy industries (CRT 1A1) are ranked 4th in the Tier 2 KCA with a contribution to the emission level uncertainty of 6.2%

In terms of trend of emissions, between 1990 and 2023, 25 key categories contribute to 90%, including LULUCF. The sectors are rather the same, with the CRT 5A and 4A in the two first positions, but with a lower combined contribution (respectively 14% and 13%), followed by the CO_2 emissions from metal industry (CRT 2C, 8%), due to its considerable increase over the timeseries. The CO_2 emissions from the transport sector, which also underwent an important increase between 1990 and 2023, represent the 5th highest contributor with 7%, despite a rather small uncertainty on emissions compared to the other highest key categories.

Table 7: Key Category Analysis in Tier 2 for the year 2023, based on level of emissions (including LULUCF)

	CRT category / fuel	GHG	Emissions 2023 kt CO2e	|Emissions| 2023 kt CO2e	Tier 1 level assessment (%)	Uncertainty on emission levels (%)	Emission level uncertainty (%)	Cumulative total (%)	Tier2 Key Category (up to 90%)
5A	Solid Waste Disposal / -	CH4	2 481,0	2 481,0	3,7	177,6	30,9	30,9	1
4A	Forest Land / -	CO2	-5 219,3	5 219,3	7,7	22,4	8,2	39,0	2
3A	Enteric Fermentation / -	CH4	2 077,6	2 077,6	3,1	44,7	6,5	45,6	3
1A1	Energy industries / Solid fuels	CO2	27 986,3	27 986,3	41,2	3,2	6,2	51,8	4
1B2	Oil and Natural Gas / Liquid fuels	CH4	801,8	801,8	1,2	100,5	5,6	57,4	5
2C	Metal industry / -	CO2	2 612,2	2 612,2	3,8	26,9	4,9	62,3	6
1A3	Transport / Liquid fuels	CO2	7 850,3	7 850,3	11,6	7,1	3,9	66,2	7
1A4	Commercial, resid., agriculture… / biomass	CH4	510,7	510,7	0,8	100,5	3,6	69,8	8
5D	Wastewater treatment and discharge / -	CH4	703,9	703,9	1,0	70,7	3,5	73,3	9
3D2	Indirect N2O Emissions from managed soils / -	N2O	514,9	514,9	0,8	100,9	3,6	77,0	10
1B2	Oil and Natural Gas / Gaseous fuels	CH4	322,6	322,6	0,5	100,5	2,3	79,2	11
3D1	Direct N2O emissions from managed soils / -	N2O	1 313,1	1 313,1	1,9	28,0	2,6	81,8	12
1A3	Transport / Liquid fuels	N2O	106,7	106,7	0,2	200,1	1,5	83,3	13
1B1	Solid fuels / Solid fuels	CH4	911,9	911,9	1,3	20,6	1,3	84,6	14
3B	Manure Management / -	N2O	293,5	293,5	0,4	53,9	1,1	85,7	15
1A4	Commercial, resid., agriculture… / Gaseous fuels	CO2	1 292,9	1 292,9	1,9	12,2	1,1	86,8	16
3B	Manure Management / -	CH4	433,6	433,6	0,6	36,1	1,1	87,9	17
1A4	Commercial, resid., agriculture… / Solid fuels	CO2	1 241,6	1 241,6	1,8	12,2	1,1	89,0	18
4G	Harvested Wood Products / -	CO2	-149,2	149,2	0,2	100,5	1,1	90,0	19

Table 8: Key Category Analysis in Tier 2 based on trend in emissions (from base year 1990 to 2023, including LULUCF)

	CRT category / fuel	GHG	Emissions 1990 kt CO2e	Emissions 2023 kt CO2e	Trend assessment	Uncertainty on emissions (%)	Trend assessment with uncertainty	% contribution to trend with uncertainty	Cumulative total (%)	Tier 2 key category (up to 90%)
5A	Solid Waste Disposal / -	CH4	3 047,3	2 481,0	0,004	177,6	0,75	13,86	13,86	1
4A	Forest Land / -	CO2	-2 023,1	-5 219,3	0,030	22,4	0,67	12,38	26,24	2
2C	Metal industry / -	CO2	1 726,8	2 612,2	0,016	26,9	0,44	8,16	34,40	3
3A	Enteric Fermentation / -	CH4	4 090,4	2 077,6	0,009	44,7	0,40	7,34	41,74	4
1A3	Transport / Liquid fuels	CO2	4 469,8	7 850,3	0,055	7,1	0,39	7,20	48,94	5
1A4	Commercial, resid., agriculture… / biomass	CH4	411,1	510,7	0,003	100,5	0,26	4,85	53,79	6
3D2	Indirect N2O Emissions from managed soils / -	N2O	537,1	514,9	0,002	100,9	0,17	3,07	56,86	7
3D1	Direct N2O emissions from managed soils / -	N2O	1 179,1	1 313,1	0,006	28,0	0,16	2,97	59,83	8
2B	Chemical industry / -	N2O	563,4	-	0,005	40,0	0,18	3,37	63,19	9
1A3	Transport / Liquid fuels	N2O	59,0	106,7	0,001	200,1	0,15	2,82	66,01	10
4C	Grassland / -	CO2	339,3	0,6	0,003	51,0	0,14	2,57	68,59	11
1A2	Manufacturing industries / Liquid fuels	CO2	4 001,7	1 225,5	0,018	7,3	0,13	2,43	71,02	12
1B2	Oil and Natural Gas / Liquid fuels	CO2	1 453,2	2,0	0,012	10,2	0,12	2,21	73,22	13
1A4	Commercial, resid., agriculture… / Solid fuels	CO2	2 883,2	1 241,6	0,009	12,2	0,11	2,00	75,22	14
3B	Manure Management / -	N2O	650,5	293,5	0,002	53,9	0,10	1,83	77,05	15
4G	Harvested Wood Products / -	CO2	-50,2	-149,2	0,001	100,5	0,10	1,81	78,86	16
3H	Urea application / -	CO2	32,2	189,6	0,002	50,2	0,10	1,80	80,66	17
4F	Other Land / -	CO2	24,0	102,7	0,001	80,6	0,08	1,49	82,15	18
1A4	Commercial, resid., agriculture… / Liquid fuels	CO2	1 618,0	506,1	0,007	12,2	0,09	1,62	83,77	19
5D	Wastewater treatment and discharge / -	CH4	1 131,1	703,9	0,001	70,7	0,07	1,25	85,01	20
1B2	Oil and Natural Gas / Liquid fuels	CH4	1 064,0	801,8	0,001	100,5	0,07	1,35	86,36	21
3B	Manure Management / -	CH4	822,4	433,6	0,002	36,1	0,06	1,07	87,43	22
2D	Non-energy products from fuels and solvent use / -	CO2	194,0	38,5	0,001	52,2	0,06	1,08	88,51	23
2F	Product uses as substitutes for ODS / -	HFC	-	148,7	0,002	28,3	0,05	0,90	89,41	24
1A4	Commercial, resid., agriculture… / Gaseous fuels	CO2	2 328,7	1 292,9	0,004	12,2	0,05	0,85	90,26	25

1.5 Brief general description of QA/QC plan and implementation

The development of an emission inventory is a complex task in the light of:

- The large number of data to manipulate,
- The great diversity of quantitative and qualitative sources of information,
- Methodologies to be implemented to best quantify each activity,
- The need to provide information as relevant and accurate as possible while respecting the constraints of resources and deadlines,
- Ensuring respect of the fundamental qualities of inventories (TACCC principle: Transparency, Accuracy, Consistency, Comparability, Completeness).

A quality control and quality assurance system is essential to achieve these tasks.

QA/QC procedures have been defined by listing a set of tasks to be carried out depending on the function of the inventory actor (see annex 5) and the type of QA/QC activities. Nevertheless, it has to be mentioned that the Serbian Inventory system is under construction to fully answer EU and UNFCCC Annex I requirements in that field. Thus, all tasks listed for the QA/QC activities are not yet carried out. They can be applied, partially applied or not applied.

In Annex 4, QA/QC procedures are positioned along with the inventory process. The QA/QC activities concerned different steps of the inventory and different actors:

QA/QC Activities	Actors / Function
Q1: coordination and planning	(1) sectoral expert
Q2: data sources	(2) inventory manager
Q3: emissions calculations	(3) coordination group of national inventories
Q4/Q5: data reporting	(4) ETS expert
Q6/Q7: National Inventory Report	(5) Inventory manager or sectoral experts
Q8/Q9/Q10: Proxy GHG inventories (X-1)	(6) CRT reporter expert
	(7) Ministry in charge of Environment
	(8) NID expert
	(9) Proxy expert

1.6 General uncertainty evaluation

The 2006 IPCC Guidelines characterize determination of uncertainties as a key element of any complete inventory. As a result of the need to continually improve the inventories, the uncertainty analysis plays an important role. The uncertainty analysis is used primarily to define priorities for improving the precision of emission inventories, as well as for selecting methods and carrying out recalculations for inventories.

Uncertainties are quantified for emission factors and activity data, then combined uncertainties for emission estimations are estimated according to IPCC guidelines.

In general, two methods for determining uncertainties are distinguished. The Tier 1 method combines, in a simple way, the uncertainties in activity data and emission factors, for each category and greenhouse gas, and then aggregates these uncertainties, for all categories and greenhouse gases, to obtain the total uncertainty for the GHG emission inventory. The Tier 2 method for uncertainties determination and aggregation is based on Monte Carlo simulation processes considering the distribution functions for the different parameters and variables of emissions calculations.

In the present NID, Serbia reports uncertainties that have been calculated pursuant to the Tier 1 method. The uncertainties for the activity data and emission factors used were taken from expert judgments and literature.

The results from the uncertainties are summarized in **Annex 2**.

The total national emissions of GHG, including LULUCF, in 2023 are estimated with an uncertainty of 8.8%. In 2023, the sector contributing the most to the overall inventory uncertainty including LULUCF is the CH_4 emissions of the solid waste disposal (CRT 5A) with a combined uncertainty of 7.7% of the national total. The major emission source of the inventory, the CO_2 emissions from the solid fuel combustion of public electricity and heat production (CRT 1A1a), has a combined uncertainty of 1.5% in the national GHG total. Another significant contributor to the overall emission inventory uncertainty in 2023 is the methane emissions of the enteric fermentation (CRT 3A) with an uncertainty of 1.6%. The uncertainty associated with the GHG emissions in the Republic of Serbia excluding the LULUCF contribution is of 7.8% in 2023, implying the national total is of 62.2 +/- 4.9 Mt CO_2e.
For the reference year (1990), the total uncertainty level was 7.5% including LULUCF and 8.8% excluding LULUCF contribution. As for the latest inventory year, the biggest contributor to the overall uncertainty, including LULUCF contribution, is the solid waste disposal (CH_4, CRT 5A) with 6.6%, followed by the enteric fermentation (CH_4, CRT 3A) with 2.2% and by the solid fuel combustion in public electricity and heat production (CO_2, CRT 1A1a) with 1.5%, including LULUCF.

In terms of trend of emissions between 1990 and 2023, the uncertainty for the national GHG emissions is 1.8% including LULUCF contribution, and 1.3% without it. Excluding LULUCF contribution, the CO_2 from the burning of liquid fuels in transport (1A3, 0.7%) and from the combustion of solid fuels in energy industries (1A1, 0.5%), with the methane emissions from enteric fermentation (3A, 0.5%) are the main contributors, due to their significant change in emissions over the timeseries.

When considering the LULUCF sectors, the most predominant one in 2023 in terms of uncertainty level is the Forest lands (4A), both in terms of emission levels (2.0% in 2023) than in emission trend (1.0%). The other significant category among LULUCF is the harvested wood products (4G) with uncertainty contributions of 0.3% in emission level and 0.14% in emission trend, due to its important growth over the timeseries.

1.7 General assessment of completeness (MPGs para 30)

1.7.1 Information on completeness (MPGs para. 30)

Temporal coverage

The emission inventories reported in the UNFCCC framework in the present document cover the period 1990-2023, with a timestep of one year. The reference year for all substances is 1990.

Geographical scope

Administratively and territorially, the Republic of Serbia is divided into provinces, regions and administrative districts. It consists of two autonomous provinces: the Autonomous Province of Vojvodina (21,614 km²), in the north, and the Autonomous Province of Kosovo and Metohija (10,910 km²), in the south. According to the international standard NUTS (Nomenclature of Territorial Units for Statistics), Serbia is divided into two parts – the North (Vojvodina and Belgrade) and the South (the rest of the country). The country is further divided into five statistical regions: Vojvodina, Belgrade, Šumadija and Western Serbia, Southern and Eastern Serbia, and Kosovo and Metohija. The territory of the Republic of Serbia includes 30 administrative districts, 24 cities, 28 city municipalities and 150 municipalities. The city of Belgrade, as the capital, has a special status as regulated by law and the statute of the capital city of Belgrade. The Republic of Serbia has 6,158 settlements, of which 193 are urban settlements.

Categories included elsewhere (IE)

Several emission sources are included within the emission estimations of other categories by lack of detail to separate the activity data between

- CRT 1A3a – Domestic aviation (included in international aviation 1D1a)
- CRT 1A4aii – Mobile combustion in commercial/institutional activities (included in 1A4ai)
- CRT 1A4bii – Mobile combustion in residential activities (included in 1A4bi)
- CRT 1A4cii – Off-road vehicles and other machinery (from 1990 to 2006, included in 1A4ci)
- CRT 1A4ciii – Fishing (included in 1A4ci and 1A4cii)
- CRT 4D2.2 – Lands converted to Wetlands

1.7.2 Description of insignificant categories (MPGs para. 32)

The revised UNFCCC Reporting Guidelines on Annual Inventories as adopted by the COP by its Decision 24/CP.19 specifies that 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. In such cases, the notation key “NE” should be used. The Party should in the NID provide 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% of the national total GHG emissions (specified in a footnote to total GHG emissions without LULUCF for the latest reported inventory year) and does not exceed 500 kt CO_2 equivalents. The total national aggregate of estimated emissions for all gases and categories considered insignificant shall remain below 0.1% of the national total GHG emissions.

In the scope of this submission, several activities remained not estimated (NE) for the Republic of Serbia:

- CRT 2F2 – Foam blowing agents: lack of data. Questionnaires were sent to companies and will hopefully be available for next submission.
- CRT 2F3 – Fire protection: lack of data. Questionnaires were sent to companies and will hopefully be available for next submission.
- CRT 3G – Liming: Statistical data on liming activities are not available.
- CRT 4B1 – Cropland remaining cropland: no emission estimation methodology applicable,
- CRT 4D1 – Wetlands remaining wetlands: no emission estimation methodology applicable,
- CRT 4E1 – Settlements remaining settlements: no emission estimation methodology applicable,
- CRT 5C2 – Open burning of waste: no activity data available.

For all these subsectors, effort is currently ongoing in order to estimate the associated emissions

1.7.3 Total aggregate emissions considered insignificant (MPGs para. 32)

The total aggregate emissions considered insignificant are not estimated for the Republic of Serbia.

1.8 Metrics (MPGs para. 37)

In accordance with decisions 6/CP.27, the emissions and removals of all GHG are expressed in CO_2 equivalent. Since the GHG have different irradiation properties, hence different contribution to the greenhouse effect, it is necessary to multiply the emission of every gas with proper Global Warming Potential (GWP), excluding the value for fossil methane, over a 100-year time horizon as listed in table 8.A.1 of the contribution of Working Group I to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC).

1.9 Summary of any flexibility applied (MPGs paras. 4-6)

In accordance with the MPGs paragraphs 4-6, some flexibilities are used by the Republic of Serbia in terms of GHG emission inventory estimation and reporting:

- Mostly Tier 1 methodologies are used for emission calculations in the absence of the necessary data. Future improvements include moving to higher tiers, in particular for key categories.
- For completeness assessment (see section 1.7.2) to estimate emissions for all sources.

Chapter 2: Trends in greenhouse gas emissions

2.1 Description of emission and removal trends for aggregated GHG emissions and removals

The observed trend for the aggregated GHG emissions in the Republic of Serbia is a reduction of 25.7%, excluding the LULUCF contribution, between 1990 and 2023. Considering the contribution of the LULUCF sector, the total national GHG emissions, expressed in CO_2e, decreased by 30.5% over the same period. This overall decrease is the result of the respective reductions in the emissions of all substances compared with 1990, excepted for HFC emissions which were not occurring by the time. The observed trend of emissions is also the result of the changes in the climate severity depending on the years, as well as the economic and conjunctural situations. Between 1992 and 1994, the Federal Republic of Yugoslavia, of which the Republic of Serbia was part of, experienced a long period of hyperinflation, resulting in a drastic deterioration of the economy, and consequently of the GHG emissions. Moreover, another event which led to a change in the GHG emission trend is the bombing in 1999. The year 2009 was marked by a global economic downturn, meanwhile some important floodings occurred in 2014, leading to a least exploitation of mines, explaining the drop in emissions observed for these two years. During the year 2020, the global pandemic related to Covid virus is observed to have a relatively moderate impact on the Serbian GHG emissions.

The following table and graph present the evolution of the national GHG emissions for the Republic of Serbia, per CRT sector, between 1990 and 2023.

Table 9: Total GHG emissions in the Republic of Serbia for the period 1990-2023 (in kt CO_2e)

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2023
	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	vs.1990
TOTAL with LULUCF, without indirect CO_2	**82 213**	**58 528**	**57 135**	**63 497**	**58 261**	**57 559**	**59 387**	**59 944**	**58 517**	**57 557**	**58 848**	**56 952**	**58 209**	**57 121**	**-31%**
TOTAL without LULUCF, without indirect CO_2	**83 625**	**63 285**	**61 185**	**69 725**	**64 320**	**62 826**	**64 328**	**65 003**	**63 336**	**62 654**	**63 795**	**61 934**	**62 657**	**62 110**	**-26%**
TOTAL with LULUCF, with indirect CO_2	**82 277**	**58 582**	**57 189**	**63 551**	**58 313**	**57 610**	**59 439**	**59 993**	**58 566**	**57 606**	**58 896**	**57 000**	**58 256**	**57 168**	**-31%**
TOTAL without LULUCF, with indirect CO_2	**83 688**	**63 339**	**61 239**	**69 779**	**64 372**	**62 877**	**64 380**	**65 053**	**63 386**	**62 703**	**63 843**	**61 982**	**62 704**	**62 156**	**-26%**
1	66 454	50 409	48 357	54 557	50 228	49 680	50 513	50 700	48 796	48 703	49 948	48 399	48 999	49 280	-26%
1.A	62 333	47 220	45 418	51 373	47 574	46 875	47 819	47 891	46 092	46 346	47 659	46 239	46 853	47 219	-24%
1.B	4 121	3 189	2 939	3 185	2 654	2 805	2 693	2 809	2 704	2 358	2 288	2 161	2 146	2 060	-50%
1.C	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
2	5 452	2 250	3 009	4 920	4 920	4 028	4 340	5 235	5 920	5 187	4 578	5 108	5 084	4 638	-15%
3	7 419	6 944	6 438	7 137	6 139	6 106	6 455	6 147	5 626	5 694	6 139	5 235	5 350	4 924	-34%
4	-1 412	-4 757	-4 050	-6 228	-6 059	-5 267	-4 940	-5 059	-4 819	-5 097	-4 947	-4 982	-4 448	-4 988	253%
5	4 300	3 683	3 381	3 112	3 034	3 012	3 020	2 921	2 994	3 070	3 131	3 192	3 224	3 267	-24%
indirect CO2	64	54	54	53	52	51	52	50	50	49	48	48	46	46	-28%
MEMO	434	108	90	149	132	194	360	401	422	430	239	341	455	598	38%
1.D.1	434	108	90	149	132	194	360	401	422	430	239	341	455	598	38%

Note: Unless stated otherwise, all results discussed below and in the sectorial chapters consider national totals excluding indirect CO_2 emissions.

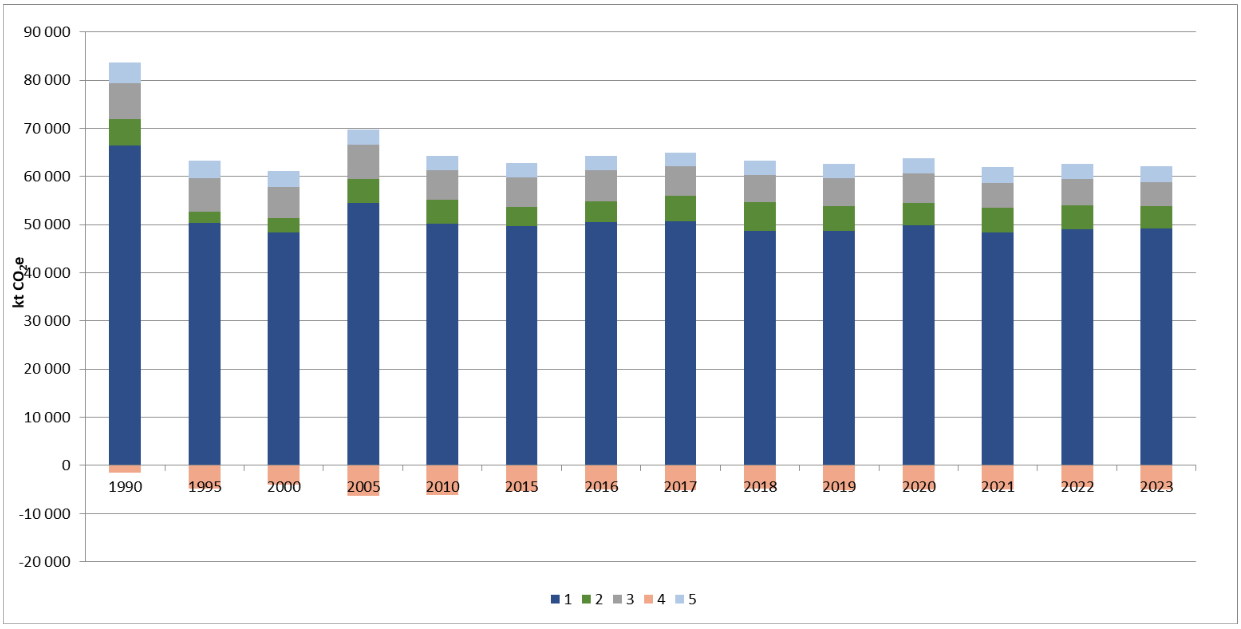
In terms of population, the total GHG emissions without LULUCF per inhabitant have increased by 10% for the period 1990-2023, from 8.6 to 9.4 kg CO_2e/inhabitant, due to the fact that the population decreased faster (-32%) than the GHG emissions without LULUCF (-26%). Considering the LULUCF contribution, this rate is more stable between 1990 and 2023, as the sink related to LULUCF has increased in the meantime. In terms of economy, the GHG emissions per gross domestic product (GDP) have decreased significantly over the whole timeseries, by 53% without considering LULUCF, due to the fact that the GDP increased by 56% meanwhile the GHG emissions decreased.

Table 10: Total GHG emissions per GDP (kg CO_2e/$) and per capita (t CO_2e/inhabitant), in the Republic of Serbia, for the period 1990-2023, without considering indirect CO_2

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2023/1990
GDP ($ million)	40 444	16 750	6 540	26 252	39 460	37 160	38 300	41 430	50 597	51 409	52 960	63 070	63 563	63 564	57%
GHG per GDP (kg CO2e/$) - without LULUCF and without indirect CO2	2,07	3,78	9,36	2,66	1,63	1,69	1,68	1,57	1,25	1,22	1,20	0,98	0,99	0,98	-53%
GHG per GDP (kt CO2e/$ million) - with LULUCF but without indirect CO2	2,03	3,49	8,74	2,42	1,48	1,55	1,55	1,45	1,16	1,12	1,11	0,90	0,92	0,90	-56%

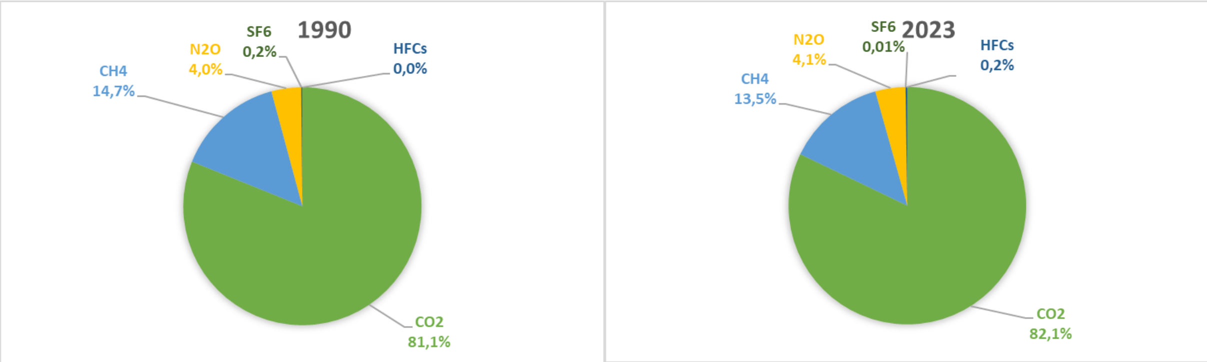
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2023/1990
Population (million)	9,72	7,85	7,78	7,46	7,32	7,13	7,09	7,05	7,02	6,98	6,93	6,87	6,80	6,62	-32%
GHG per capita (t CO2e/inhabitant) - without LULUCF and without indirect CO2	8,60	8,06	7,86	9,34	8,79	8,81	9,07	9,21	9,02	8,98	9,21	9,02	9,22	9,38	9%
GHG per capita (t CO2e/inhabitant) - with LULUCF but without indirect CO2	8,46	7,46	7,34	8,51	7,96	8,07	8,38	8,50	8,34	8,25	8,49	8,29	8,56	8,62	2%

Figure 2: Total GHG emissions, including LULUCF but without indirect CO_2, in the Republic of Serbia (in kt CO_2e), with CRT main sector contributions, over the period 1990-2023



The relative contribution of each GHG to the national aggregated GHG emissions (excluding LULUCF) between 1990 and 2023, have evolved as follows:

Figure 3: Contributions of each gas on the Republic of Serbia aggregated GHG emissions, excluding LULUCF, in 1990 and 2023



Despite some inter-annual variations, for the years 1990 and 2023, the relative contribution of the CO_2 to the total GHG emissions excluding LULUCF is quite stable at 81-82%. However, over the whole period, the CO_2 contribution has been observed to vary between 76% and 82%, with a mean value of 80%. The CH_4 and N_2O emission contributions are also rather stable between 1990 and 2023, with a slightly decreasing contribution for CH_4 (from 15% to 13.5%) whereas N_2O increases slightly in consequence (from 4.0% to 4.1%). Meanwhile SF_6 emissions are less prominent in the national GHG emissions, without LULUCF contribution, and now almost marginal, going from 0.2% in 1990 to 0.01% in 2023, HFC emissions, which were not occurring in 1990, increased their contribution in 2023 at 0.24%.

2.2 Description of emission and removal trends by sector and by gas

Table 11 presents the national GHG emission and removal trends for each gas, in the Republic of Serbia, for the period 1990-2023.

Table 11: GHG emissions in the Republic of Serbia, per substance and per main CRT category, between 1990 and 2023

				1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2023
TOTAL with LULUCF, without indirect CO2		**GHG**	**kt CO2e**	**82 213**	**58 528**	**57 135**	**63 497**	**58 261**	**57 559**	**59 387**	**59 944**	**58 517**	**57 557**	**58 848**	**56 952**	**58 209**	**57 121**	**-30,5%**
Total with LULUCF		CO2	kt	**66 373**	**44 236**	**44 160**	**50 270**	**45 616**	**44 617**	**46 519**	**47 482**	**46 528**	**45 652**	**46 421**	**45 385**	**46 601**	**46 000**	**-30,7%**
		CH4	kt	**440**	**397**	**366**	**324**	**318**	**323**	**315**	**310**	**310**	**314**	**319**	**315**	**311**	**300**	**-31,7%**
		N2O	kt	**13**	**12**	**10**	**15**	**13**	**13**	**14**	**13**	**11**	**11**	**12**	**10**	**10**	**10**	**-24,6%**
		SF6	t	**6**	**3**	**0**	**1**	**1**	**4**	**4**	**4**	**4**	**3**	**1**	**2**	**2**	**0**	**-95,9%**
		HFC	t	**-**	**-**	**2**	**19**	**100**	**185**	**160**	**139**	**131**	**106**	**97**	**79**	**78**	**79**	**-**
			kt CO2e	**-**	**-**	**2**	**43**	**231**	**406**	**348**	**300**	**272**	**224**	**199**	**165**	**154**	**149**	**-**
TOTAL without LULUCF, without indirect CO2		**GHG**	**kt CO2e**	**83 625**	**63 285**	**61 185**	**69 725**	**64 320**	**62 826**	**64 328**	**65 003**	**63 336**	**62 654**	**63 795**	**61 934**	**62 657**	**62 110**	**-25,7%**
Total without LULUCF		CO2	kt	**67 823**	**49 012**	**48 311**	**56 514**	**51 693**	**49 921**	**51 485**	**52 563**	**51 369**	**50 770**	**51 390**	**50 389**	**51 070**	**51 010**	**-24,8%**
		CH4	kt	**439**	**397**	**364**	**324**	**318**	**322**	**314**	**310**	**309**	**314**	**319**	**315**	**311**	**300**	**-31,7%**
		N2O	kt	**13**	**12**	**10**	**15**	**13**	**13**	**14**	**13**	**11**	**11**	**12**	**9**	**10**	**10**	**-24,5%**
		SF6	t	**6**	**3**	**0**	**1**	**1**	**4**	**4**	**4**	**4**	**3**	**1**	**2**	**2**	**0**	**-95,9%**
		HFC	t	**-**	**-**	**2**	**19**	**100**	**185**	**160**	**139**	**131**	**106**	**97**	**79**	**78**	**79**	**-**
			kt CO2e	**-**	**-**	**2**	**43**	**231**	**406**	**348**	**300**	**272**	**224**	**199**	**165**	**154**	**149**	**-**
1	**ENERGY**	**GHG**	**kt CO2e**	**66 454**	**50 409**	**48 357**	**54 557**	**50 228**	**49 680**	**50 513**	**50 700**	**48 796**	**48 703**	**49 948**	**48 399**	**48 999**	**49 280**	**-25,8%**
1	ENERGY	CO2	kt	63 058	47 164	45 458	51 946	47 252	46 505	47 418	47 621	45 840	45 711	46 833	45 383	45 984	46 346	-26,5%
		CH4	kt	111	108	96	84	97	103	100	99	95	96	100	97	96	93	-15,7%
		N2O	kt	1,12	0,83	0,81	1,02	1,03	1,06	1,12	1,14	1,10	1,10	1,18	1,18	1,21	1,21	8,2%
1.A	Fuel Combustion	GHG	kt CO2e	62 333	47 220	45 418	51 373	47 574	46 875	47 819	47 891	46 092	46 346	47 659	46 239	46 853	47 219	-24,2%
1.A	Fuel Combustion Activities	CO2	kt	61 560	46 699	44 876	50 751	46 884	46 215	47 141	47 228	45 438	45 678	46 803	45 356	45 959	46 322	-24,8%
		CH4	kt	17	11	12	13	15	14	14	13	13	13	19	20	21	21	19,5%
		N2O	kt	1,10	0,83	0,80	1,00	1,02	1,06	1,12	1,13	1,09	1,10	1,18	1,17	1,21	1,21	10,4%
1.B	Fugitive emissions	GHG	kt CO2e	4 121	3 189	2 939	3 185	2 654	2 805	2 693	2 809	2 704	2 358	2 288	2 161	2 146	2 060	-50,0%
1.B	Fugitive emissions from fuels	CO2	kt	1 498	465	581	1 194	368	290	277	393	402	33	30	27	25	24	-98,4%
		CH4	kt	93	97	84	71	82	90	86	86	82	83	81	76	76	73	-22,2%
		N2O	kt	0,02	0,01	0,01	0,02	0,01	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	-98,2%
2	**IPPU**	**GHG**	**kt CO2e**	**5 452**	**2 250**	**3 009**	**4 920**	**4 920**	**4 028**	**4 340**	**5 235**	**5 920**	**5 187**	**4 578**	**5 108**	**5 084**	**4 638**	**-14,9%**
2	Industrial Processes and Product Use	CO2	kt	4 733	1 835	2 818	4 435	4 343	3 283	3 815	4 728	5 455	4 888	4 331	4 873	4 870	4 474	-5,5%
		CH4	kt	1	-	0	1	1	0	1	0	0	0	0	1	0	0	-47,9%
		N2O	kt	2	1	1	2	1	1	0	0	0	0	-	-	-	-	-100,0%
		SF6	t	6	3	0	1	1	4	4	4	4	3	1	2	2	0	-95,9%
		HFC	t	-	-	2	19	100	185	160	139	131	106	97	79	78	79	-
3	**Agriculture**	**GHG**	**kt CO2e**	**7 419**	**6 944**	**6 438**	**7 137**	**6 139**	**6 106**	**6 455**	**6 147**	**5 626**	**5 694**	**6 139**	**5 235**	**5 350**	**4 924**	**-33,6%**
3	Agriculture	CO2	kt	32	13	35	133	97	133	252	214	74	172	226	132	217	190	489,2%
		CH4	kt	179	161	151	132	115	114	109	109	110	111	109	107	102	93	-48,1%
		N2O	kt	9	9	8	12	11	10	12	11	9	9	11	8	9	8	-10,3%
4	**LULUCF**	**GHG**	**kt CO2e**	**-1 412**	**-4 757**	**-4 050**	**-6 228**	**-6 059**	**-5 267**	**-4 940**	**-5 059**	**-4 819**	**-5 097**	**-4 947**	**-4 982**	**-4 448**	**-4 988**	**253,3%**
4	LULUCF	CO2	kt	- 1 451	- 4 776	- 4 150	- 6 244	- 6 077	- 5 304	- 4 966	- 5 081	- 4 841	- 5 119	- 4 969	- 5 003	- 4 469	- 5 009	245,3%
		CH4	kt	0,47	0,05	1,74	0,01	0,20	0,54	0,28	0,20	0,20	0,20	0,20	0,20	0,20	0,20	-56,9%
		N2O	kt	0,10	0,07	0,19	0,06	0,05	0,08	0,07	0,06	0,06	0,06	0,06	0,06	0,06	0,06	-40,0%
5	**WASTE**	**GHG**	**kt CO2e**	**4 300**	**3 683**	**3 381**	**3 112**	**3 034**	**3 012**	**3 020**	**2 921**	**2 994**	**3 070**	**3 131**	**3 192**	**3 224**	**3 267**	**-24,0%**
5	WASTE	CO2	kt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CH4	kt	149	128	117	108	105	104	105	101	104	107	109	111	112	114	-23,8%
		N2O	kt	0,46	0,37	0,37	0,35	0,34	0,33	0,33	0,33	0,33	0,33	0,32	0,32	0,31	0,31	-32,3%

Note: Unless stated otherwise, all results discussed below and in the sectorial chapters consider national totals, excluding indirect CO_2 emissions.

CO_2

The national CO_2 emissions from the Republic of Serbia, excluding LULUCF contribution, decreased by 24.8% over the period 1990-2023. This reduction goes up to 30.7% when LULUCF contribution is included. CO_2 emissions are mainly related to fossil fuel combustion activities (CRT 1A) and, in 2023, around 91% of the national CO_2 emissions without LULUCF are originated from fuel combustion. In 2023, the energy industries (CRT 1A1) contribute to 61% of the national CO_2 emissions excluding LULUCF, meanwhile the transport (CRT 1A3) contribution is of 15.5%, the one of the manufacturing industries (combustion only, CRT 1A2) is of 8% and the residential-tertiary-agriculture subsector contributes to 6%. The sector of industry processes (CRT 2) is the other main contributor about 9% in 2023, and the metal industry (CRT 2C) is the predominant emission source of this sector with 5% of the national emissions without considering LULUCF in 2023, followed by the mineral industry (CRT 2A) with 3%.

Most of the biggest CO_2 emission sources follow a downward trend between 1990 and 2023, except for the transport (+77%) and the metal industry (+51%). The CO_2 emission reductions observed between 1990 and 2023 contributing the most to the overall reduction are for the sectors of the energy industries (CRT 1A1, -27%), the manufacturing industries (CRT 1A2, -46%), the other sector (CRT 1A4, -55%), the fugitive emissions of the oil and natural gas (CRT 1B2, - 98%) and the mineral industry (CRT 2A, -22%). Since the year 2009, the national CO_2 emissions are rather stable, except for some years where the emission levels were either particularly high, such as in 2011, or very low, such as in 2014. The national emissions between 1990 and 2002 underwent several significant interannual variations due to the war context around the Balkan and ex-Yugoslavia regions.

The CO_2 emissions of the residential-tertiary sector (CRT 1A4) and the production of heat and electricity (CRT 1A1a) rely much on the climate severity. In particular, in the most recent years, it can be observed that winter was quite cold in 2011, whereas it was pretty warm in 2014. On the opposite side, when summers are really warm and heat waves can strike the territory, the CO_2 emissions related to the production of electricity can be intensified by an increased consumption of air conditioning. The overall CO_2 emissions can also be impacted significantly by the import and export of electricity, although the balance remains rather stable in the Republic of Serbia.

Other structural parameters can also influence the interannual CO_2 emission variations: the economic context such as the global economic downturn in 2009, energy crisis in 2021 on natural gas supply following the Ukrainian and Russian conflict, or other conditions such as the sanitary crisis related to the Covid virus or the impact of policies and measures implemented by governments and administrations.

The national CO_2 emissions including the LULUCF contribution decreased by almost 31% between 1990 and 2023, which is higher than the observed reduction without LULUCF. In the Republic of Serbia, the net balance of the LULUCF sector is a net removal, which means that the CO_2 absorptions (tree growth, reforestation) overcompensate the CO_2 emissions (e.g., tree mortality, deforestation, artificialisation) and, in addition, an increasing net removal from this sector is observed. Indeed, for the period 1990-2023 the net CO_2 removals increased by 245%, mostly due to the forest lands (CRT 4A) which contribute to 91% of the emissions and removals of the sector in 2023, and increased by 158% over the same period. This is partly due to the fact that heavy commercial logging and industrial technical wood use for the pulp and paper industry were very present in the country in 1990. Although there has been a huge increase of the net removal of this subcategory over the whole period, the sink decreased significantly since 2007 (-23%) due to the increased use of biomass as a fuel and natural disasters. Among the other categories, the grassland category (CRT 4C) reduced its CO_2 emissions by almost 100%, whereas the net removals from harvested wood products (CRT 4G) increased by 197%, but varies much during the recent years, between 1990 and 2023.

CH_4

The national CH_4 emissions from the Republic of Serbia, decreased by 32% for the period 1990-2023, with or without considering the LULUCF contribution. Different emission sources contribute significantly to the national CH_4 emissions. In 1990, the predominant source is the agriculture sector (CRT 3), which represented 41% of the Republic of Serbia methane emissions and, in 2023, had a contribution of 31%. The other major emission source is the waste sector (CRT 5), which contributed to 34% in 1990 and increased its share up to 38% in 2023. The CH_4 emissions of these two sectors decreased considerably for the period 1990-2023, with a faster rate for agriculture (-48%) than for the waste (-24%). In addition, the fugitive emissions (CRT 1B) are also a significant contributor to the national emissions excluding LULUCF with 24% in 2023, despite having reduced their emissions by 22% for the period 1990-2023. The fall in the fugitive CH_4 emissions of this sector is related to the drops in coal and oil productions, respectively of 26% and 25% between 1990 and 2023. The reduction in the emissions of the agriculture is mainly related to the fall in the livestock, which impact enteric fermentation (CRT 3A, - 49%), the main emission source, and manure management (CRT 3B, -47%). For the waste sector, the drop in the solid waste disposal (CRT 5A, -19%), due to smaller amounts being disposed, and the wastewater treatment (CRT 5D, -38%), due to a decreasing population, can explain the observed trends. For the waste sector, the solid waste disposal is the main source of methane emissions with a contribution of 78% to the sector total in 2023.

Contrarily to the CO_2 emissions, the fuel combustion activities (CRT 1A) represent a rather smaller share of the national totals for CH_4 with only 7% in 2023. However, the contribution of the sector was less significant in 1990 (4%), as the emissions of this sector can be observed to increase from 20% over the period 1990-2023. This is mainly due to the residential-tertiary sector (CRT 1A4, +20%), related to an increase in the residential wood consumptions.

N_2O

The national N_2O emissions have been reduced by 24.5% in the Republic of Serbia, for the period 1990-2023, with or without considering the LULUCF contribution. The agriculture sector is the most predominant N_2O emission sources on the territory, with more than 84% of the national emissions in 2023. Actually, the emissions of this sector are observed to have decreased over the period 1990-2023, by 10%, and its contribution was of 71% in 1990. The growing share of this sector is only due to the increase in the emissions of the agricultural soils (CRT 3D, +6.5%); in particular, the increase in inorganic N-fertiliser application (CRT 3D1a, +519% in emissions), partly compensated by the decline in the organic N-fertilisers and manure (3D1bi has decreased by 52%), and, to another extent, in the indirect N_2O from managed soils (CRT 3D2, -4%). This trend is also the consequence of a lack of consistency in the activity data, which are better managed by the SORS from 2013 onwards. In contrast, the N_2O emissions related to manure management, which contributed to 19% of the emissions of the agricultural sector in 1990 and 12% of the national emissions without LULUCF, have decreased by 55% due to the fall in the livestock.

In addition, the fuel combustion activities (CRT 1A) also contribute in a non-negligible way with 13% of the Republic of Serbia emissions in 2023. The N_2O emissions of this sector are rather stable over time and slightly increased by 10% between 1990 and 2023, mostly due to the growth in road transport and biomass consumption, compensated by the decline in coal consumption. In addition, its contribution to the national total has increased from 9% in 1990 to 13% in 2023, and the shares between the subsectors are rather equal among subsectors in 2023: the energy industries (CRT 1A1, 4.0%), the transport (CRT 1A3, 4.2%) and the other sectors (CRT 1A4, 3.7%). The chemical industry (CRT 2B) was also an important contributor to the national N_2O emissions in 1990 with 17% of the share, but has suppressed its emissions due to the stop in the acid nitric production in 2019, contributing significantly to the overall national emission reduction. Finally, the N_2O emissions of the wastewater treatment have been reduced by 32% over the period 1990-2023, and now contributes to only 3% to the national emissions.

SF_6

The national SF_6 emissions from the Republic of Serbia have been drastically reduced by 96% for the period 1990-2023. The industrial processes (CRT 2) are the only emitting sector of SF_6 over the territory. Among it, the metal industry with the production of magnesium was for long the only SF_6 emission source but, since 2000, emissions from the use of SF_6 in electrical equipment for insulation (CRT 2G1) have arisen. In 2022, the magnesium production represented 83% of the national SF_6 emissions but, in 2023, the production has stopped. Before then, this subsector has decreased its emissions by 69% between 1990 and 2022, explaining most of the observed downward trend, due to the drop in the production of magnesium. In 2023, the SF_6 emissions in Serbia are almost negligible.

HFCs

The national HFC emissions in the Republic of Serbia occurred from 1997, and now contribute to 0.24% of the national GHG emissions excluding LULUCF contribution. Several HFC can be emitted and the evolution of the mass emissions depending on the HFC are presented in Table 12. The observed trend of the national emissions, in CO_2 equivalent, is a growing trend up to 2014, where a maximum was reached, and since then the emissions are constantly decreasing over the years, with a mean interannual decrease rate of 12% between 2014 and 2023, due to the regulations implemented about the use of refrigerants such as the Regulation on the treatment of fluorinated gases with a greenhouse effect, as well as on the conditions for issuing permits for the import and export of these gases (OJ No 120/13).

Table 12: Mass emissions of the different fluorinated gases in the Republic of Serbia, for the period 1990-2023

		1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
HFC-125	t	-	-	-	3,5	20,1	31,0	26,4	22,4	19,1	16,2	13,8	11,7	9,9	8,5
HFC-134a	t	-	-	1,5	11,7	57,2	118,6	102,9	90,4	89,9	70,6	66,9	53,5	55,9	61,1
HFC-32	t	-	-	-	0,6	4,1	4,3	3,7	3,1	2,7	2,3	1,9	1,6	1,4	1,2
HFC-143a	t	-	-	-	3,4	18,8	31,3	26,6	22,6	19,2	16,3	13,9	11,8	10,0	8,5
HFC-227ea	t	-	-	-	0,0	0,1	0,3	0,3	0,3	0,3	0,3	0,3	0,2	0,2	0,2
Total	kt CO2e	-	-	2,0	42,9	231,4	406,4	348,3	299,9	272,1	223,8	199,3	165,1	154,0	148,7

Table 13 presents the evolution of the aggregated GHG emissions for each CRT category, with more details than before, in the Republic of Serbia, for the period 1990-2023.

Table 13: Aggregated GHG emissions (in kt CO_2e) in the Republic of Serbia, for each CRT category, between 1990 and 2023

		1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2023
		kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	kt CO2e	vs.1990
	TOTAL with LULUCF, without indirect CO2	**82 213**	**58 528**	**57 135**	**63 497**	**58 261**	**57 559**	**59 387**	**59 944**	**58 517**	**57 557**	**58 848**	**56 952**	**58 209**	**57 121**	**-30,5%**
	TOTAL without LULUCF, without indirect CO2	**83 625**	**63 285**	**61 185**	**69 725**	**64 320**	**62 826**	**64 328**	**65 003**	**63 336**	**62 654**	**63 795**	**61 934**	**62 657**	**62 110**	**-25,7%**
	TOTAL with LULUCF, with indirect CO2	**82 277**	**58 582**	**57 189**	**63 551**	**58 313**	**57 610**	**59 439**	**59 993**	**58 566**	**57 606**	**58 896**	**57 000**	**58 256**	**57 168**	**-30,5%**
	TOTAL without LULUCF, with indirect CO2	**83 688**	**63 339**	**61 239**	**69 779**	**64 372**	**62 877**	**64 380**	**65 053**	**63 386**	**62 703**	**63 843**	**61 982**	**62 704**	**62 156**	**-25,7%**
1	**ENERGY**	**66 454**	**50 409**	**48 357**	**54 557**	**50 228**	**49 680**	**50 513**	**50 700**	**48 796**	**48 703**	**49 948**	**48 399**	**48 999**	**49 280**	**-26%**
1.A	Fuel Combustion Activities	62 333	47 220	45 418	51 373	47 574	46 875	47 819	47 891	46 092	46 346	47 659	46 239	46 853	47 219	-24%
1.A.1	Energy Industries	42 611	38 805	34 122	33 774	31 835	33 896	33 631	34 058	32 083	32 345	33 975	31 850	31 752	31 264	-27%
1.A.2	Manufacturing Industries and Construction	7 833	3 217	5 407	7 778	5 504	4 241	4 795	4 214	4 503	3 997	3 564	3 564	3 594	4 256	-46%
1.A.3	Transport	4 560	2 787	2 374	6 694	6 728	5 999	6 162	6 415	6 508	7 034	6 701	7 650	8 167	8 045	76%
1.A.4	Other Sectors	7 329	2 212	3 256	3 127	3 506	2 738	3 232	3 204	2 998	2 970	3 419	3 174	3 340	3 654	-50%
1.A.5	Non-Specified	NO,IE	199	259	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	-
1.B	Fugitive emissions from fuels	4 121	3 189	2 939	3 185	2 654	2 805	2 693	2 809	2 704	2 358	2 288	2 161	2 146	2 060	-50%
1.B.1	Solid fuels	1 087	1 247	1 145	1 070	1 125	1 138	1 148	1 173	1 091	1 144	1 121	1 021	991	912	-16%
1.B.2	Oil and Natural Gas	3 034	1 941	1 795	2 114	1 529	1 667	1 546	1 636	1 613	1 214	1 167	1 140	1 154	1 148	-62%
1.C	Carbon dioxide Transport and Storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
2	**Industrial Processes and Product Use**	**5 452**	**2 250**	**3 009**	**4 920**	**4 920**	**4 028**	**4 340**	**5 235**	**5 920**	**5 187**	**4 578**	**5 108**	**5 084**	**4 638**	**-15%**
2.A	Mineral Industry	2 024	1 269	1 485	1 543	1 339	1 037	1 125	1 170	1 264	1 280	1 374	1 475	1 538	1 586	-22%
2.B	Chemical Industry	1 371	628	504	1 050	894	611	593	825	576	6	300	378	303	247	-82%
2.C	Metal Industry	1 863	352	1 009	2 253	2 413	1 925	2 205	2 888	3 764	3 628	2 660	3 041	3 038	2 612	40%
2.D	Non-Energy Products from Fuels and Solvent Use	194	NO	9	30	39	44	65	48	39	45	39	44	46	39	-80%
2.E	Electronics Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
2.F	Product Uses as Substitutes for Ozone Depleting Su	NO	NO	2	43	231	406	348	300	272	224	199	165	154	149	-
2.G	Other Product Manufacture and Use	NO	NO	0	1	3	4	4	4	4	4	5	5	5	6	-
2.H	Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
3	**Agriculture**	**7 419**	**6 944**	**6 438**	**7 137**	**6 139**	**6 106**	**6 455**	**6 147**	**5 626**	**5 694**	**6 139**	**5 235**	**5 350**	**4 924**	**-34%**
3.A	Enteric fermentation	4 090	3 671	3 391	2 991	2 593	2 565	2 481	2 496	2 456	2 467	2 466	2 405	2 272	2 078	-49%
3.B	Manure Management	1 473	1 381	1 352	1 128	985	964	884	872	926	925	901	869	857	727	-51%
3.C	Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
3.D	Agricultural Soils	1 716	1 783	1 579	2 779	2 354	2 348	2 742	2 470	2 080	2 037	2 451	1 732	1 904	1 828	7%
3.E	Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
3.F	Field Burning of Agricultural Residues	107	96	81	105	109	96	96	94	90	92	95	97	100	102	-5%
3.G	Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
3.H	Urea application	32	13	35	133	97	133	252	214	74	172	226	132	217	190	489%
3.I	Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
3.J	Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
4	**LULUCF**	**-1 412**	**-4 757**	**-4 050**	**-6 228**	**-6 059**	**-5 267**	**-4 940**	**-5 059**	**-4 819**	**-5 097**	**-4 947**	**-4 982**	**-4 448**	**-4 988**	**253%**
4.A	Forest Land	-2 012	-5 324	-5 444	-6 313	-6 116	-5 311	-5 018	-5 099	-4 854	-5 101	-5 043	-5 100	-4 579	-5 212	159%
4.B	Cropland	19	19	12	84	14	56	56	56	56	56	57	53	49	46	147%
4.C	Grassland	354	233	1 159	-135	12	35	7	-5	-2	2	5	5	4	3	-99%
4.D	Wetlands	179	179	164	148	91	93	89	85	82	78	75	73	71	69	-61%
4.E	Settlements	73	73	71	128	141	148	148	149	149	150	150	150	150	150	105%
4.F	Other Land	25	25	21	7	77	90	92	93	95	97	99	101	103	105	322%
4.G	Harvested Wood Products	-50	39	-33	-148	-279	-378	-314	-339	-347	-379	-290	-263	-246	-149	197%
4.H	Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
5	**WASTE**	**4 300**	**3 683**	**3 381**	**3 112**	**3 034**	**3 012**	**3 020**	**2 921**	**2 994**	**3 070**	**3 131**	**3 192**	**3 224**	**3 267**	**-24%**
5.A	Solid Waste Disposal	3 047	2 765	2 426	2 171	2 115	2 129	2 102	2 089	2 167	2 252	2 319	2 385	2 433	2 481	-19%
5.B	Biological Treatment of Solid Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
5.C	Incineration and OpenBurning of Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
5.D	Wastewater Treatment and Discharge	1 253	918	954	941	919	883	918	832	827	817	812	807	791	786	-37%
5.E	Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
	Indirect CO2	64	54	54	53	52	51	52	50	50	49	48	48	46	46	-28%
MEMO		**434**	**108**	**90**	**149**	**132**	**194**	**360**	**401**	**422**	**430**	**239**	**341**	**455**	**598**	**38%**
1.D.1	International transportation	434	108	90	149	132	194	360	401	422	430	239	341	455	598	38%

Note: Unless stated otherwise, all results discussed below and in the sectorial chapters consider national totals, <u>excluding indirect CO_2 emissions</u>.

Energy (CRT 1)

The energy sector represents 79.3% of the national GHG emissions, in CO_2 equivalent, excluding LULUCF contribution, in the Republic of Serbia, in 2023. Its contribution was rather similar in 1990 with 79.5% of the national totals, varies slightly over the timeseries but is rather stable and has a mean value over the period 1990-2023 of 79%. This is mainly due to the energy industries (CRT 1A1), which is the major emitting source contributing up to 50% of the national GHG emissions without LULUCF in 2023, in particular due to the production of heat and electricity (CRT 1A1a). The main substance emitted by this sector is the CO_2, which represents 94% of the sector GHG emissions. Only CO_2 emissions from fuel combustion activities (CRT 1A), excluding CO_2 from biomass combustion, represent around 91% of the national CO_2 emissions and 75% of the national GHG emissions, without LULUCF contribution.

The energy sector is also responsible for 31% of the CH_4 national emissions excluding LULUCF in 2023, mostly related to fugitive emissions from coal, oil and natural gas production, as the CRT 1B has a share of 24% of the national methane totals in 2023. The other main methane emission source in the energy industries is the wood combustion in residential appliances (CRT 1A4, 6% of the national total in 2023). Finally, about its contribution to other direct GHG, the energy sector represents 13% of the N_2O emissions in the Republic of Serbia in 2023, excluding LULUCF contribution, related to the fuel combustion.

The energy sector is also a large predominant emission source in terms of indirect GHG emissions (including LULUCF) with 99%, 95% and 97% of the national emissions of SO_2, NO_x and CO in 2023. He also contributes to NMVOC emissions over the territory but to a lesser extent with 70% in 2023.

In 2023, for CO_2 emissions, the main contributing source is the energy industries (CRT 1A1) with a share of 61% of the national CO_2 emissions excluding LULUCF, mainly due to electricity and heat production, followed by the transport sector (CRT 1A3) with 15%, mostly related to road transport, the manufacturing industries (CRT 1A2) with 8% and the other sectors (CRT 1A4) with 6%. The total sectoral CO_2 emissions decreased by 24% for the period 1990-2023, thanks to the contribution of all sectors except transport which has increased its emissions by 77% due to the traffic growth. The other sectors all contributed to the observed emission reduction, in particular the highest influence is from the energy industries with a 27% decrease, mostly thanks to the drop of 26% in the fuel consumption of the production of heat and electricity (CRT 1A1a) over the period 1990-2023, with the coal consumption which decreased by 32%, substituted partially by natural gas which more than doubled (+103%), but also by increasing renewable energies. The CO_2 emissions of the other subsectors all decrease significantly as well, with -46% for the manufacturing industries (CRT 1A2) and -55% for the other sectors (CRT 1A4), related to fossil fuel consumption reductions and the partial substitutions with the development of biomass. Finally, the fugitive CO_2 emissions, mainly related to flaring in oil refining, have also decreased by 98% over the period 1990-2023, whereas it had a share of 3% of the CO_2 emissions of the energy in 1990.

The emissions of the energy industries, in particular of the power plants for electricity production, and of the residential sector, can vary quite significantly depending on the climate severity (for winters, mostly, with heating, but also, to another extent, for summers with air conditioning) and the eventual imports and exports of electricity. Over the most recent years, the year 2011 and 2014 are good examples of extreme climate conditions either leading to a peak of CO_2 emissions such as in 2011, or to a significant drop in emissions as in 2014.

The methane emissions of the energy sector also decrease by 16% between 1990 and 2023, mostly due to the drop in coal and oil productions with -22% for the fugitive methane production (CRT 1B) over this period, meanwhile the emissions related to fuel combustion (CRT 1A) increased by 19.5%, related to the increase in the use of biomass, in particular in small residential appliances. The energy emissions of N_2O, mainly related to fuel combustion in 2023, increased by 8% during the period 1990-2023, which is mostly due to the road transport growth (CRT 1A3, +82% for N_2O), as well as the increase in emissions of the other sectors (CRT 1A4, +40%).

In terms of SO_2, the emissions are mostly the responsibility of the Public heat and electricity production (1A1a), which contributes to 89% to the CRT 1 emissions in 2023. The main reason for the SO_2 emissions is the combustion of solid fuels. This emission source is also the main contributor to the NOx emissions of the Energy sector (50% in 2023), alongside with the road transport (CRT 1A3b) which is responsible of 27% of the sector emissions. The emissions of NMVOC from the Energy sector are mainly due to the residential heating (1A4bi) in 2023, in particular due to biomass and solid fuel combustion, with 41%, as well as coal mining and handling (1B1a) with 26%. Residential combustion also contributes significantly to the CO emissions from the CRT 1, with a share of 77% in 2023, the rest being mostly related to road transport (10%) and to other stationary combustion.

Most of the emissions of indirect GHG from the Energy sector have been reduced significantly over the timeseries, with -42% for SO_2, -25% for NOx, -23% for NMVOC and -28% for CO. The emission reductions are mostly achieved through the implementation of regulations and the change in the energy mix.

Industrial Processes and Product Use (CRT 2)

The sector of industrial processes and product use represents 7.5% of the national GHG emissions, excluding LULUCF contribution, in the Republic of Serbia, in 2023. It has a slightly growing contribution since 1990 where its share was less than 6.5%, although its GHG emissions have been reduced by 15% in between. In 2023, the main contributing source is the metal industry (CRT 2C), with 4.2% of the national GHG emissions excluding LULUCF, followed by the mineral industry (CRT 2A) with 2.6%. The main substance emitting by this sector is the CO_2, which represents 96.5% of the total sectoral GHG emissions in 2023. The industrial processes are the second biggest emission source of CO_2 in the Republic of Serbia, preceding by the energy sector, with almost 9% of the national emissions in 2023, excluding LULUCF contribution.

The industrial processes and product use sector is the only emission source of SF_6 and HFCs in the Republic of Serbia. On the opposite, in 2023, its contribution to the national emissions of CH_4 is relatively marginal with 0.1%, and there is no N_2O emission related to this category. In 1990, the CRT category was a relatively high N_2O emitter due to the chemical industry (CRT 2B), and contributed to 17% of the national emissions without LULUCF, but since 2019, the acid nitric production (CRT 2B2), the only emission source, has ceased.

The industry sector is a marginal contributor to the emissions of NO_x and SO_2 with about 0.5% for each in 2023. Its contribution to the national emissions of CO is also rather small with 3% in 2023. However, it has a non-negligible share in the NMVOC emissions over the territory with 17% in 2023, due principally to the emissions from solvent use (CRT 2D3) and from food and beverage industry (CRT 2H2).

In 2023, the most predominant source of CO_2 emissions for the CRT 2 is the metal industry (CRT 2C), which contributes to 5% to the national CO_2 emissions excluding LULUCF, principally due to the iron and steel industry (CRT 2C1). The metal industry was less important in 1990 as its CO_2 emissions increased by 51% over the period 1990-2023. The former most important CO_2 emission source, which is now the second highest, was the mineral industry (CRT 2A), which now has a share of 3% of the national emissions in 2023 and underwent a reduction of 22% between 1990 and 2023. The cement industry (CRT 2A1) is the most predominant source with 83% of the emissions of this CRT category, followed by the lime industry (CRT 2A2, 13%) and the use of carbonates in other industries (CRT 2A4a, 4%). The emission reduction observed for the mineral industry for the period 1990-2023 is mainly due to the decrease observed in the lime industry (-59%) and, to another extent, to the drop in the use of carbonates in other industries. The other CO_2 emissions sources, the chemical industry (CRT 2B) and the non-energy products from fuels and solvent use (CRT 2D) have both reduced their contributions to the sectoral CO_2 emissions with reductions of 70% and 67%, respectively. In overall, the CO_2 emissions of the whole CRT 2 category have been reduced by 5.8% between 1990 and 2023.

As already mentioned before, the N_2O emissions of the industry processes, which represented 10.3% of the sectoral GHG emissions in 1990, have been suppressed following the stop of the acid nitric production in 2019. The SF_6 emissions, which originate from the magnesium production (CRT 2C4) and the use in electrical equipment (CRT 2G1), have been reduced by 96% over the period 1990-2023, notably in 2023 where the magnesium production stopped. This is mainly related to the drop in the magnesium production which was of 69% for the period 1990-2022. Finally, the HFC emissions, which were not occurring in 1990, appeared in 1997 with the use of refrigerants and now represent 0.24% of the national GHG emissions excluding LULUCF.

In terms of indirect GHG, the analysis focuses only on NMVOC, which are rather significant in the Industry sector (CRT 2), the other substances being rather negligible. For NMVOC, the emissions from the CRT 2 in 2023 are mostly the responsibility of the domestic solvent use (CRT 2D3a) with 33%, the food and beverage industry (CRT 2H2) with 26%, the use of solvent in printing (2D3h) with 18% and the other solvent use (2D3i) with 11%. The NMVOC emissions from the Industry sector have been reduced by 37% between 1990 and 2023, mostly due to the drop in the population, in the production of food and beverages, as well as due to national regulation on solvent contents.

Agriculture (CRT 3)

The agriculture sector is the major source of N_2O emissions in the Republic of Serbia in 2023, with a share of 84% of the national emissions excluding LULUCF. In addition, it also contributes significantly to the CH_4 emissions with 31% of the national emissions without LULUCF in 2023. However, the agriculture sector has relatively marginal CO_2 emissions in the national totals with a total share of 0.4% in 2023, and does not contribute to the emissions of other direct GHG. In overall, the contribution of the CRT 3 to the national GHG emissions excluding LULUCF is of 7.9% in 2023, making it the second most predominant sector. Its contribution is rather stable over time as it was of 8.9% in 1990 and has a mean contribution value of 10% over the whole period. In 2023, the main emitted substance of the agriculture sector is CH_4, which represents 53% of the sectoral GHG emissions, followed by N_2O with a share of 43% and CO_2 with a share of 4%.

Enteric fermentation (CRT 3A) is the main CH_4 emission source and contributes to 25% of the national emissions of this substance, without considering LULUCF. The methane emissions of this subsector have decreased by 49% between 1990 and 2023, mostly due to the downfall in the livestock, in particular cattle and sheep. Another important methane emission source from agriculture which has been impacted by the drop in the livestock is the manure management (CRT 3B), which decreased its emissions by 47% for the period 1990-2023, but still represent 5% of the national totals. The final emission source contributing to the agricultural methane emissions is field burning (CRT 3F), with a rather small but stable contribution.

The emissions of N_2O in the agriculture are mostly related to the agricultural soils (CRT 3D) which contribute up to 72% to the national N_2O emissions excluding LULUCF. This subsector has slightly increased its emissions, by 7% between 1990 and 2023, due to the growth of the application of inorganic N-fertilisers (CRT 3D1a, +519%), compensated by manure application (CRT 3D1bi, -52%). The indirect N_2O emissions of the agriculture soils (CRT 3D2) have been impacted by this change and resulted in decreasing by 4% over the period 1990-2023. The other significant emission source is the manure management (CRT 3B), which contributes to around 12% of the national N_2O emissions, without LULUCF, in 2023. This CRT category had a higher share of emissions in 1990 with 19%, but underwent a considerable emission reduction of 55% for the period 1990-2023, due to the decline in the populations of livestock, and in particular cattle, pigs and poultry. As a result of these different variations, the agricultural N_2O emissions have decreased by 10% between 1990 and 2023.

Finally, the CO_2 emissions of the agriculture sector are related only to the urea application (CRT 3H) as the emissions and removals from agricultural soils are considered in CRT 4. For the CRT 3H, its emissions increased by 489% for the period 1990-2023, but are still rather marginal compared with the national totals with a contribution of 0.4% to the national totals excluding LULUCF.

In overall, the GHG emissions of the agriculture sector (CRT 3) decreased by 34% for the period 1990-2023.

The agriculture sector is a negligible emission source for the indirect GHG emissions of SO_2 and CO, as it is only related to field burning of agricultural residues (CRT 3F). However, it has a rather important contribution to the national emissions of NMVOC with 12% in 2023, due mostly to the manure management (CRT 3B). Finally, its contribution to the NOx emissions, mostly due to the use of inorganic N-fertilisers (CRT 3D1a), which represents 94% of the emissions from this sector, is rather small with 4% in 2023. The emissions of NOx have drastically increased for the period 1990-2023, by 377%, in relation with the increasing use of inorganic N-fertilisers. The emissions of NMVOC of the sector are more evenly spread out, with the most emitting sources being the manure management for cattle livestock (3B1) with 54%, the cultivated crops (3D5) with 17%, the manure management from poultry (3B4g) with 16% and from swine (3B3) with 9%.The emissions of NMVOC from the agriculture have decreased by 48% between 1990 and 2023.

LULUCF (CRT 4)

The land use, land-use change and forestry sector is a sink of GHG in the Republic of Serbia, over the whole period 1990-2023, in particular thanks to the growth of the forest lands (CRT 4A), mainly, and the harvested wood products (CRT 4G). The CO_2 represents almost 100% of the sectoral GHG emissions of this sector, making CH_4 and N_2O contributions almost negligible.

Forest land (CRT 4) is the most predominant emission source with more than 91% of the CO_2 emissions and removals of this sector, and represents a net removal of 5.2 Mt CO_2 in 2023. The net removal of this subsector has increased by 158% within the period 1990-2023, and now enables to compensate about 10% of the national CO_2 emissions excluding LULUCF. This is in particular due to the CRT 4A, where a large commercial logging and industrial technical wood use for the pulp and paper industry were very present in 1990, and decreased significantly over time. However, since 2007, the increasing trend of the sink observed for the CRT 4A has changed, due to the increasing use of wood as a fuel and, to another extent, the more frequent natural disasters (e.g., woodfires, breakages due to strong winds, damages caused by insects and diseases, etc.).

The land-use changes correspond either to a storage of CO_2 (e.g., through conversion of cropland or grassland in forest land) or to an emission of CO_2 (e.g., through deforestation). The emissions or removals for the subsectors cropland (CRT 4B) and grassland (CRT 4C) vary significantly for the period 1990-2023. In overall, the land-use changes for CRT 4B to 4F decrease their CO_2 emissions over the timeseries by 42%, contributing to the observed increase of the sink for the whole sector. For the CRT 4C, the observed reduction in emissions is due to a significantly reduced grassland area, which was easily affected by fires, as well as to land use changes. Finally, the harvested wood product category (CRT 4G) has also participated in the growth of the net removal of CO_2 as it increased its by 197% due to the increase in the wood products such as industrial roundwood, sawnwood, wood panels and paperboards.

The emissions of CH_4 and N_2O for LULUCF also decline between 1990 and 2023, in the Republic of Serbia, with respective reductions of 57% and 40%.

Waste (CRT 5)

The waste sector is a significant emission source of CH_4 emissions in the Republic of Serbia, with a contribution of 38% to the national emissions excluding LULUCF, in 2023. Its share in the national emissions is rather stable and was of 34% in 1990, although an overall emission reduction of 24% is observed between 1990 and 2023. The emission sources contributing to the methane emissions are the solid waste disposal (CRT 5A), with a share of 30% of the national CH_4 emissions excluding LULUCF in 2023, and, to another extent, the wastewater treatment (CRT 5D) with 8% of the national totals. For the period 1990-2023, both subsectors decreased their methane emissions, by 19% for the CRT 5A, due to the drop in solid waste amounts being disposed, and for the CRT 5D by 38%, due to a downfall in the population.

The waste sector also contributes, to a lesser extent, to N_2O emissions with 3.2% of the national emissions, without LULUCF, in the Republic of Serbia in 2023. The emissions of this substance are only related to wastewater treatment (CRT 5D), and an emission reduction of 32% is observed over the timeseries, corresponding to a decline in the Serbian population. However, the waste sector does not contribute to the emissions of other direct GHG over the timeseries.

The methane emissions of the waste sector represent 93% of the total sectoral GHG emissions in 2023, explaining the fact that the overall trend of the sector (-24% in GHG emissions between 1990 and 2023) corresponds to the CH_4 emission reduction observed. In overall, the waste sector contributes to 5.3% of the national GHG emissions from the Republic of Serbia, in 2023, and has a rather stable contribution between 1990 and 2023 and an average share of 5%.

In terms of indirect GHG emissions, the waste sector is a negligible emission source and contributes to less than 0.01% of the different concerned substances, in 2023, in the Republic of Serbia.

Chapter 3: Energy (CRT sector 1)

Note: Unless stated otherwise, all results discussed in the sectorial chapters consider national totals, excluding indirect CO_2 emissions.

3.1 Overview of sector

The CRT 1 category covers the following sectors:

- Energy industries (1A1), including the thermal power plants, the district heating, the oil refineries and the production of solid and gaseous fuels such as coke ovens,
- Manufacturing industry (1A2),
- Transports (1A3),
- Other sectors (1A4), including residential heating, as well as the tertiary and agriculture/forestry/fishing subsectors,
- Non-Specified (1A5),
- Fugitive emissions from solid fuels (1B1),
- Fugitive emissions from oil and natural gas (1B2).

The CO_2 transport and storage (1C) does not occur in Serbia.

The main reference for the Energy sector is the energy balance, developed and updated each year by the Ministry of mining and energy in the format of the IEA questionnaires. The energy flows presented in it are not corrected upon the yearly climate. The same methodology is applied to the energy balance for the whole period from 1990 to 2023.

Energy consumption data from energy balance can be completed with other more-detailed data or bottom-up data when available, but then a balance on the overall consumptions from the energy balance is operated so that this is the main reference for the Energy sector.

In the following graph, the total fuel consumptions in the Republic of Serbia, for the whole timeseries, are displayed. This includes all fuel consumptions over the territory, for each year, considering the production, the imports and exports, and the stock variations. Hence, all energy and non-energy fuel consumptions are considered in this analysis. Overall, a reduction of 20% is observed over the period for the total fuel consumptions in the Republic of Serbia. All fossil fuels contributed to that reduction, meanwhile the biomass consumption increased by 40%, and represents 11% of the total fuel consumption in 2023, whereas it contributed to 6% in 1990. The solid fuel consumption, which was the biggest contributor to the total fuel consumption in 1990 with 53%, has overgone the highest decrease with 29%, and now represents 47% of the total share. The liquid fuel and natural gas consumptions have respectively been reduced by 122 and 13% between 1990 and 2023, and their respective share in the total fuel consumptions remained constant for the same period. Since 2006, the apparition of other solid fossil fuel consumption is to be noted but remains negligible overall.

Over the period 1990-2023, the total fuel consumption has undergone significant variations. Between, 1992 and 1994, the Federal Republic of Yugoslavia experienced a long, intense period of hyperinflation, which resulted in a drastic deterioration of the economy, explaining the observed downward trend in the fuel consumptions. Following that event, the fuel consumption progressively increased, without reaching the pre-crisis levels, before drastically plunging in 1999 following the NATO bombing. Afterwards, all fuel consumptions increased progressively until 2004, when the solid fuel consumption significantly decreased in 2005. For the period 2006-2023, an overall decreasing trend is observed, punctuated by some variations following events such as the economic crisis in 2009, the large floods in 2014 which hindered the extraction of solid fossil fuels, the sanitary crisis in 2020, but also the variations of the severity of winters which can influence significantly the fuel consumptions in residential heating and electricity production.

Figure 4: Total aggregated fuel consumptions in the Republic of Serbia, for the period 1990-2023, per fuel type (in PJ)

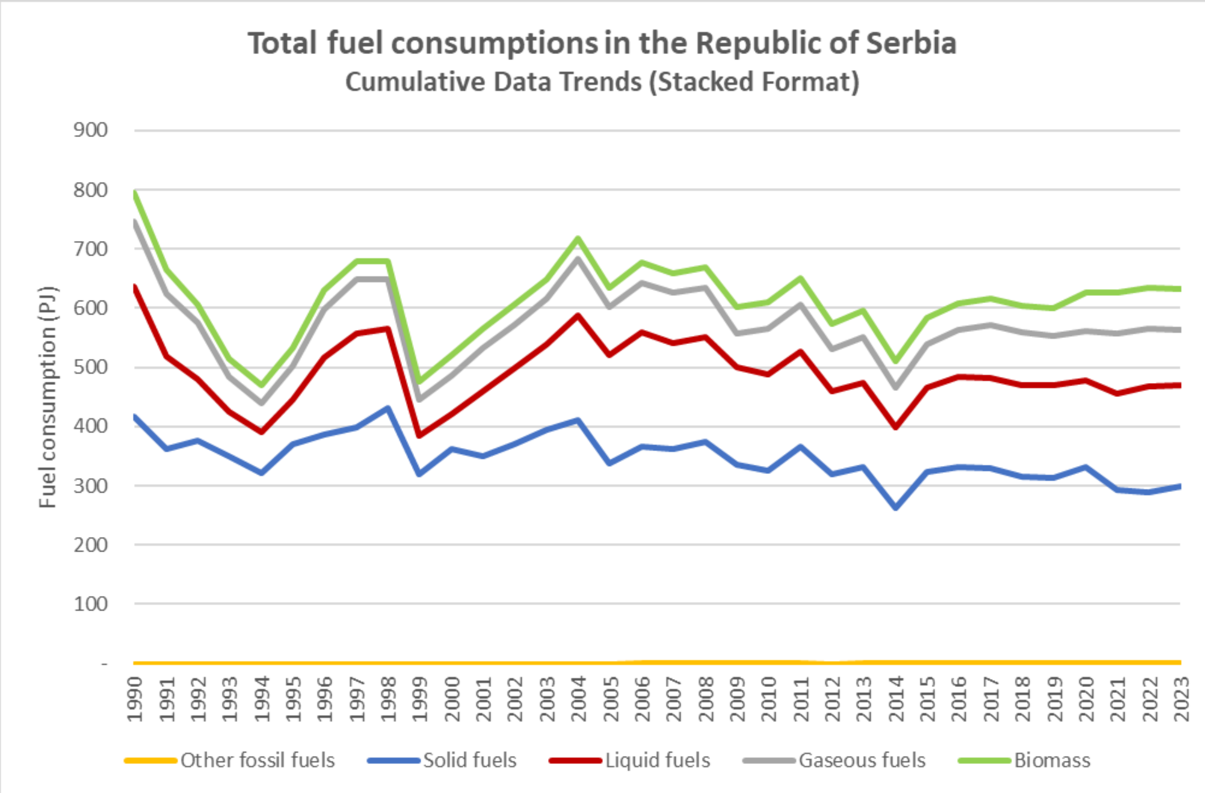
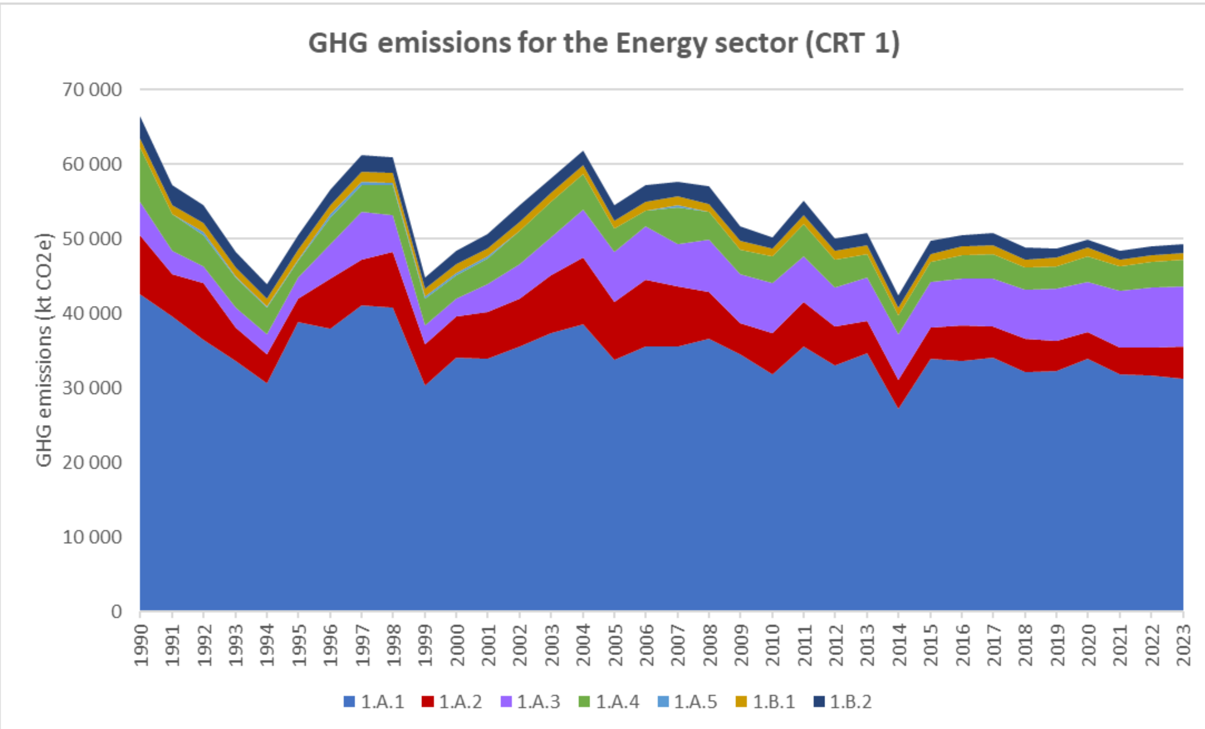


Figure 5: GHG emission trends for the Energy sector (CRT 1), per main subsector (in kt CO_2e)



The total annual emissions of GHGs from the Energy sector, expressed in CO_2e, for the period 1990–2023, are presented above.

In 2023, GHG emissions from CRT 1 are equal to 49.3Mt CO_2e, compared to 66.5 Mt CO_2e in 1990, which implies a reduction of 26%. The GHG emissions contribution of the sector to the Republic of Serbia total GHG emissions (without LULUCF) is rather stable and represented 79.5% of total emissions in 1990 and 79.3% in 2023. The GHG emissions vary significantly during the studied period, rather similarly to the total fuel consumption as described previously. All subsectors contributed to the overall observed GHG emission reduction, except the transport sector (CRT 1A3) which has known an emission increase of 76%. The Energy industries sector (CRT 1A1), which contributes to around 51% of total GHG emissions, have reduced its emissions by 27% over the 1990-2023 period.

3.2 Fuel combustion (CRT 1.A)

3.2.1 Comparison of the sectoral approach with the reference approach (RA vs. SA)

The reference approach is recommended by the IPCC. This consists of the comparison of the fuel consumptions of the Energy sector (CRT 1A) from the energy balances, based on the production, imports, exports and stock changes (reference approach), with the fuel consumptions used in the emission inventory (sectoral approach). The CO_2 emissions associated with these two approaches are also compared. The results from the comparison of both approaches are reported in the CRT tables, and a brief analysis of the main observations is presented hereafter.

Table 14: Overall comparison of the CO_2 emissions from the reference and sectoral approaches for the Republic of Serbia, for the period 1990-2023

	Reference approach (in kt CO_2) A	Sectoral approach (in kt CO_2) B	Difference % A/B-1
1990	62 428	61 560	1,4
1991	51 718	52 582	-1,6
1992	50 154	50 316	-0,3
1993	43 602	44 465	-1,9
1994	39 616	40 389	-1,9
1995	46 020	46 699	-1,5
1996	52 079	52 684	-1,1
1997	55 192	57 001	-3,2
1998	56 369	56 873	-0,9
1999	40 009	41 726	-4,1
2000	44 373	44 876	-1,1
2001	46 923	47 061	-0,3
2002	50 126	50 553	-0,8
2003	53 886	54 367	-0,9
2004	58 219	58 017	0,3
2005	49 502	50 751	-2,5
2006	52 981	53 174	-0,4
2007	50 891	53 920	-5,6
2008	51 758	52 907	-2,2
2009	47 724	47 831	-0,2
2010	47 092	46 884	0,4
2011	51 487	51 274	0,4
2012	46 301	46 509	-0,4
2013	46 094	47 252	-2,5
2014	37 839	39 156	-3,4
2015	45 273	46 215	-2,0
2016	46 454	47 141	-1,5
2017	46 225	47 228	-2,1
2018	44 629	45 438	-1,8
2019	44 978	45 678	-1,5
2020	46 846	46 803	0,1
2021	44 568	45 356	-1,7
2022	45 640	45 959	-0,7
2023	46 429	46 322	0,2
Mean	***48 336***	***48 970***	***-1,3***

In overall (all fuel considered), for the period 1990-2023, the differences between the two approaches are of -1.3% on average. It can be observed that the differences are always negative, meaning that the CO_2 emissions related to the fuel consumptions from the reference approach are smaller than the ones from the sectoral approach. Overall, the observed gaps are reasonable compared to the 5% IPCC recommendations. In the following paragraphs, additional details and explanations are given by fuel categories:

- Liquid fuels: the differences between energy consumptions and CO_2 emissions are rather proportional and, there are some years where they are not negligible. For the period 1990-2000 (in particular in 1999), most large differences can be explained by the statistical differences. For the period 2013-2015, the high discrepancies observed are related to the increases in non-energy uses of naphtha and refinery feedstocks, which are not compensated (e.g., by an increase of crude oil consumption), therefore making the reference approach consumptions way lower than the sectoral ones. It has to be noted that 'refinery feedstocks' reported as refinery intakes in the IEA questionnaires have been considered in the RA as non-energy products to be consistent with the SA.

- Solid fuels: a mean discrepancy of 1.6% is observed for the energy consumptions of the two approaches. Considering the CO_2 emissions, the mean difference for the whole period is 1.1%.
  In the sectoral approach, the emissions from the Iron&steel sector (CRT 2C1) are based on a Tier 1 methodology which does not enable the inventory team to estimate fuel quantities used for non-energy purposes. Even if such non-energy quantities are estimated in the IEA questionnaires and reported in the reference approach, a bias could remain due to the use of the Tier 1 methodology.

- Gaseous fuels: the average differences observed on the apparent consumption and the CO_2 emissions are rather small with 0.2% for both.
  In the reference approach, non-energy uses of natural gas are consistent with the sectoral approach. Non-energy uses have been only identified for ammonia (CRT 2B1) and methanol (CRT 2B8) productions. Except for 1990 and 1991, the remaining differences are almost only due to the natural gas consumptions considered for the distribution losses in the energy balances, without considering them the differences drop between -0.2% to 0.0%.

Table 15: Differences between sectoral and reference approaches (in %) in terms of fuel consumptions and CO_2 emissions, for all different fuel categories, for the Republic of Serbia, for the period 1990-2023

	LIQUIDS			SOLIDS			GASEOUS	
	Activity data	CO2 emissions		Activity data	CO2 emissions		Activity data	CO2 emissions
1990	-3,3%	-2,8%	1990	-0,9%	-1,6%	1990	2,5%	2,5%
1991	2,0%	3,1%	1991	1,3%	0,9%	1991	4,2%	4,2%
1992	-8,7%	-6,7%	1992	2,2%	1,6%	1992	0,0%	0,0%
1993	6,9%	6,8%	1993	2,1%	1,4%	1993	0,0%	0,0%
1994	4,9%	4,4%	1994	2,2%	1,5%	1994	2,5%	2,5%
1995	-3,9%	-2,9%	1995	2,5%	2,1%	1995	0,0%	0,0%
1996	1,0%	1,2%	1996	1,7%	1,3%	1996	0,0%	0,0%
1997	11,7%	11,6%	1997	1,7%	1,3%	1997	0,0%	0,0%
1998	2,9%	2,5%	1998	1,2%	0,7%	1998	0,0%	0,0%
1999	25,9%	26,9%	1999	1,4%	0,8%	1999	0,0%	0,0%
2000	4,7%	5,3%	2000	1,3%	0,8%	2000	0,0%	0,0%
2001	-2,4%	-2,1%	2001	1,3%	0,8%	2001	0,0%	0,0%
2002	1,3%	1,6%	2002	1,3%	0,8%	2002	0,0%	0,0%
2003	0,1%	0,8%	2003	1,5%	1,0%	2003	0,0%	0,0%
2004	-5,7%	-6,0%	2004	1,5%	1,0%	2004	0,0%	0,0%
2005	-2,6%	-2,4%	2005	4,8%	4,3%	2005	0,0%	0,0%
2006	0,0%	0,2%	2006	0,8%	0,4%	2006	0,0%	0,0%
2007	11,2%	12,0%	2007	5,0%	4,5%	2007	-0,6%	-0,6%
2008	-5,3%	-6,1%	2008	5,3%	4,8%	2008	-1,9%	-1,9%
2009	-3,4%	-3,7%	2009	2,0%	1,5%	2009	-0,5%	-0,5%
2010	-2,5%	-2,7%	2010	1,0%	0,3%	2010	-1,1%	-1,1%
2011	0,4%	0,4%	2011	0,1%	-0,6%	2011	-0,4%	-0,4%
2012	0,1%	0,0%	2012	1,3%	0,7%	2012	-0,7%	-0,7%
2013	10,5%	10,5%	2013	1,3%	0,9%	2013	-0,9%	-0,9%
2014	12,7%	12,8%	2014	1,4%	1,0%	2014	-1,1%	-1,1%
2015	10,1%	10,0%	2015	0,7%	0,3%	2015	-0,7%	-0,7%
2016	7,0%	6,9%	2016	0,8%	0,3%	2016	-1,1%	-1,1%
2017	4,8%	4,8%	2017	2,4%	1,9%	2017	-1,6%	-1,6%
2018	5,4%	5,5%	2018	1,6%	1,2%	2018	-1,5%	-1,5%
2019	4,5%	4,3%	2019	1,5%	1,1%	2019	-0,9%	-0,9%
2020	3,7%	3,8%	2020	-0,5%	-1,0%	2020	-0,7%	-0,7%
2021	4,0%	4,2%	2021	1,7%	1,4%	2021	-0,8%	-0,8%
2022	0,7%	0,8%	2022	1,2%	0,9%	2022	-0,6%	-0,6%
2023	-1,8%	-1,9%	2023	0,9%	0,4%	2023	-0,9%	-0,9%

3.2.2 International bunker fuels

In the GHG inventory, emissions reported on international bunkers concern emissions relating to international civil aviation and international maritime traffic based on fuel sales in Serbia.

International aviation bunkers

International aviation bunkers concern fuel consumptions of international flights refueling in Serbia.
There are few airports in Serbia and the two largest (Nikola Tesla in Belgrade and Konstantin Veliki in Nis) mainly concerns international flights. Thus, for this submission, all civil aviation is considered as international and is reported as a memo item.

International marine bunkers

Regarding international maritime traffic (between a Serbian port and a foreign port), this activity is considered as not occurring in Serbia since the country has no direct access to the sea and fluvial traffic is only considered domestic.
However, when looking at the IEA questionnaires/energy balance for the recent years, there are consumptions of gas/diesel oil for international bunkers. This needs to be investigated in order to understand if international fluvial traffic has to be excluded from the national total of the inventory.

3.2.3 Feedstocks and non-energy use of fuels

Fossil fuels can be consumed for different uses such as combustion for energy needs or as raw material, intermediate or reducing agent (non-energy uses).

As defined in Box 1.1 of the Introductory Volume for Industrial Processes in the 2006 IPCC Guidelines, Fuel Combustion is defined as the intentional oxidation of materials within an apparatus that is designed to provide heat or mechanical work to a process, or for use away from the apparatus.
During operations, emissions may occur both at the combustion stage and as an industrial process. However, it is not always possible, partly for practical reasons, to report these two types of emissions separately.

In the 2006 IPCC Guidelines, the following rule is formulated:

> Combustion emissions from fuels obtained directly or indirectly from the feedstock for an IPPU process will normally be allocated to the part of the source category in which the process occurs. These source categories are normally 2B and 2C. However, if the derived fuels are transferred for combustion in another source category, the emissions should be reported in the appropriate part of Energy Sector source categories (normally 1A1 or 1A2).

In the Serbian inventory, this rule of the guidelines is followed and for each fuel, the distinctions are as follows (see CRT tables "Table 1.A (d) Sectoral background data for energy - Feedstocks, reductants and other non-energy use of fuels for more details):

- Solid fuels: in iron & steel production, energy and non-energy use of solid fuels (coal, coking coal and derivate fuels) are considered CRT 2C1. Indeed, blast furnace gas is considered entirely combusted within the Iron and Steel industry and thus the associated emissions are reported in this IPPU subcategory.
- Liquid fuels:
    - Non-energy petroleum products are mainly consumed at petrochemical sites. This is the case of naphtha used for chemical production in steam crackers, some of which is self-consumed (oil and gas from raw materials) for energy purposes. The associated emissions are reported in CRT 2B8.

- Emissions related to the combustion of lubricants for 2-stroke are not considered yet in the energy category of the Serbian inventory. Thus, emissions related to the use of lubricants are all reported in CRT category 2D1.

- Gaseous fuels: The main non-energy use of natural gas in Serbia is for ammonia and methanol productions. The associated CO_2 emissions are accounted for in the CRT 2B1 and 2B8.

3.2.4 General characteristics for fuel combustion (CRT 1A)

A – Introduction

The term "fuel" is used in this report to define all type of product which is used in a combustion installation (fossil fuels, biomass, other products) in order to produce heat or electricity. In order to estimate GHG emissions related to fuel combustion, their different features such as chemical composition, calorific value, carbon content, etc. need to be known. The characteristics vary from one fuel to another, but also for similar fuel type depending on its origin and eventual regulations applying to it.

B – Calorific value

The calorific value is used to convert the amounts of fuel in mass or volume into energy unit. Among the most encountered energy units are:

Table 16: Conversions of different energy units into Joules

Unit	Symbole	Equivalence in Joules	Other multiples used
tonne oil equivalent	toe	41.868 GJ	ktoe, Mtoe
Watt hour NCV	Wh	3,600 J	kWh, MWh, GWh, TWh
Joule	J	1 J	MJ, GJ, TJ
Thermie	th	4,18 MJ	kth
Calorie	cal	4,18 J	kcal

k (kilo) = 10^3 M (Mega) = 10^6 G (Giga) = 10^9 T (Tera) = 10^{12}

In the emission inventory for the Republic of Serbia, for all fuels, the net calorific values given by the energy balances are used, can vary depending on the year, its origin (produced or imported) and the use, in the following ranges:

Table 17: Net calorific values (NCVs) ranges used in the Serbian inventory (source: national energy balances)

Fuel	NCV (GJ/t)
Anthracite	21.2-26.5
Other bituminous coal	22.0-28.7
Sub-bituminous coal	16.1-23.6
Lignite	7.1-17.0
Brown coal briquettes (BKB)	15.7-20.0
Coke/Oven Coke	24.1-30.1
Coal tar	37.8-41.3
Crude oil	42.7-44.2
Natural gas liquids	45.2-46.0
Gasoline	44.0-44.8
Jet kerosene	43.0-44.6
Other kerosene	42.5-43.8
Gas/Diesel oil	42.6-44.0

Fuel	NCV (GJ/t)
Residual fuel oil	40.0-41.6
Liquefied petroleum gas (LPG)	46.0-47.3
Naphtha	44.0-45.0
Bitumen	40.2
Lubricants	40.2-42.0
Petroleum coke	17.4-38.0
Refinery feedstocks	40.2-43.9
White spirit	40.2-43.6
Paraffin wax	40.0-40.4
Other oil products	40.0-40.4
Natural gas	33.3-33.9

C – Emission factors

In the Serbian emission inventory, all GHG emissions related to fuel combustion are estimated based on the application of emission factors to the sectoral consumptions given by the energy balances. Emission calculations based on mass balances or direct measurements are not considered. In addition, only top-down approaches are used for the fuel combustion emission estimations and no reported emission data are considered.

For CO_2 emission calculations, only the carbon content for lignite used in thermal power plants (TPP) is country-specific and varies over the timeseries 1990-2023. The carbon content of lignite is derived from measurements of its composition (mass fractions) in carbon, oxygen, sulphur and hydrogen, as well as its moisture. Otherwise, the default Tier 1 emission factors from IPCC 2006 guidelines are used. In overall, the CO_2 emission factors are as follows:

Table 18: Net calorific values (NCVs) ranges used in the Serbian inventory

Fuel	Carbon content (t C/TJ)	CO_2 EF (kg/GJ)
Anthracite	26.8	98.3
Other bituminous coal	25.8	94.6
Sub-bituminous coal	26.2	96.1
Lignite in TPP	29.0-30.4	106.4-111.3
Lignite for other uses	27.5	101.0
Brown coal briquettes (BKB)	26.6	97.5
Coke/Oven Coke	29.2	107.0
Coal tar	22.0	80.7
Crude oil	20.0	73.3
Natural gas liquids	17.5	64.2
Gasoline	18.9	69.3
Jet kerosene	19.5	71.5
Other kerosene	19.6	71.9
Gas/Diesel oil	20.2	74.1
Residual fuel oil	21.1	77.4
Liquefied petroleum gas (LPG)	17.2	63.1
Naphtha	20.0	73.3
Bitumen	22.0	80.7
Lubricants	20.0	73.3

Fuel	Carbon content (t C/TJ)	CO_2 EF (kg/GJ)
Petroleum coke	26.6	97.5
Refinery feedstocks	20.0	73.3
White spirit	20.0	73.3
Paraffin wax	20.0	73.3
Other oil products	20.0	73.3
Natural gas	15.3	56.1
Solid biomass	30.5	112.0
Industrial waste	39.0	143.0

For lignite used in thermal power plants, the CO_2 emission factor evolves as follows:

Table 19: Country-specific CO_2 emission factor used in the Serbian inventory for lignite burned in TPPs

	EF CO_2 (kg/GJ)
1990	106.95
1991	106.95
1992	106.95
1993	106.95
1994	106.95
1995	106.95
1996	106.95
1997	106.95
1998	106.95
1999	106.95
2000	106.95
2001	106.95
2002	106.95
2003	106.95
2004	106.95
2005	106.95
2006	106.95
2007	106.95
2008	106.95
2009	108.99
2010	109.81
2011	109.71
2012	109.53
2013	109.37
2014	108.93
2015	110.40
2016	110.40
2017	110.40
2018	110.40
2019	111.49
2020	111.49
2021	111.49
2022	111.49
2023	111.49

3.2.5 Energy industries (CRT 1A1)

In the Republic of Serbia, the energy industries sector covers:

- the production of public electricity and heat (CRT 1A1a),
- the petroleum refining (CRT 1A1b),
- the manufacture of solid fuels (CRT 1A1ci).

In 2023, the energy industries (CRT 1A1) contribute to 50% of the total GHG emissions without LULUCF, and it contributes to 63% of the Energy category (CRT 1) in Serbia.

3.2.5.1 Public electricity and heat production (CRT 1A1a)

3.2.5.1.1 Category description

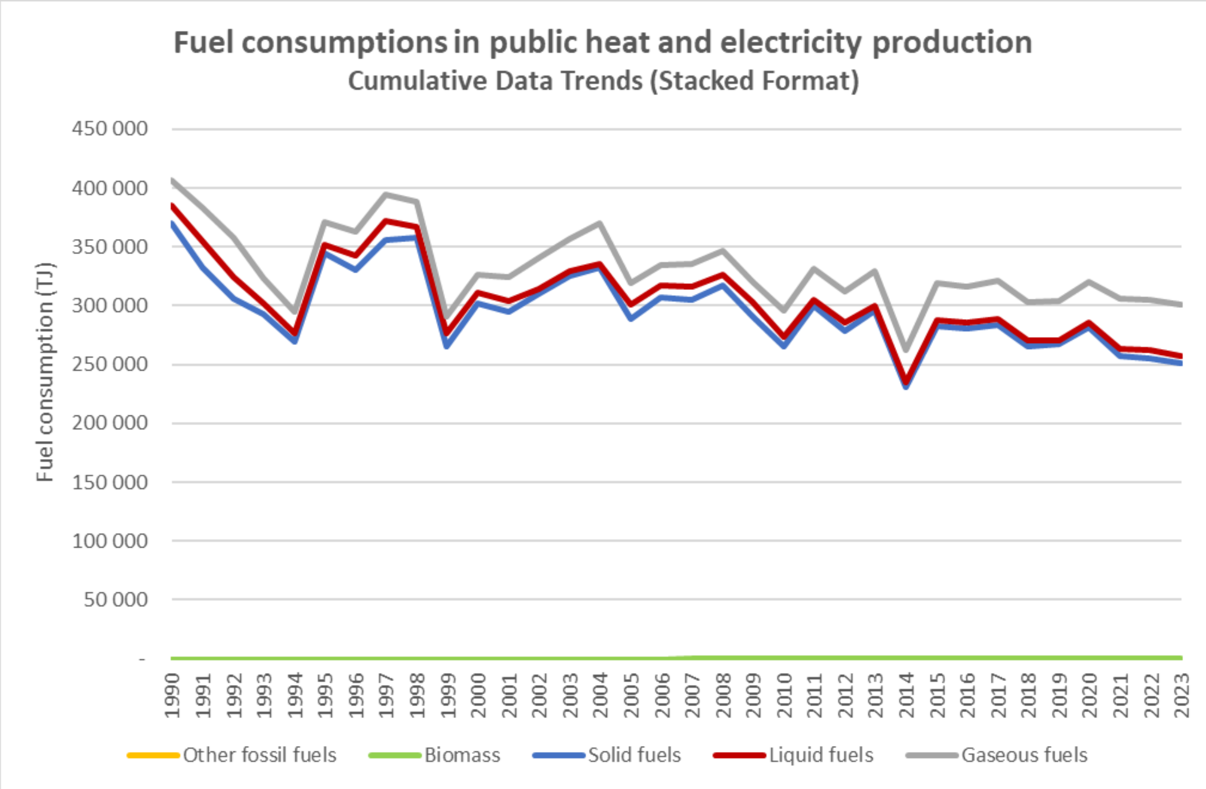
This sector consists of electric power system, and a decentralized municipal district for heating.

Electricity production is based on the combustion of low-quality domestic lignite in existing power plants and the use of hydropower potential in the existing impoundment and reservoir-pumped hydro power plants. In 1990, Serbia was equipped with modern and up–to–date electricity production system comprising eight lignite–burning thermal power plants (TPP) having 25 production units and three liquid fuel and gas burning combined heat and power (CHP) plants having 6 production units.

The total consumption of all distribution companies and consumers in the electricity market and the consumption of electricity production is high. High consumption is greatly affected by the use of electricity for household heating and the low-energy efficiency of buildings (mainly built in the 1970s and 1980s).

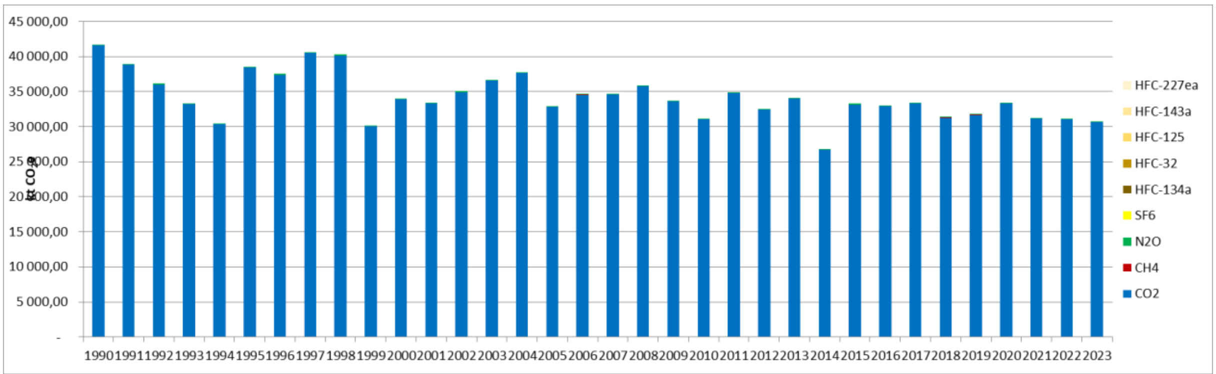
The evolution of fuel consumption in the public heat and electricity production sector are presented in the following graph. Overall fuel consumption decreased by 26% between 1990 and 2023. Solid fuels, and in particular lignite, is the fuel contributing to the highest share of the fuel consumption over the whole studied period, with 91% of the share in 1990 and 83% in 2023. Liquid fuel consumptions also significantly decreased between 1990 and 2023 and have been gradually substituted by natural gas, which more than doubled for the same period. Biomass began to develop in 2007 but remained marginal in the overall share (less than 0.5% in 2023).

Figure 6 : Fuel consumptions in the Public heat and electricity production (CRT 1A1a), for the period 1990-2023 (in TJ)



The GHG emissions, which are mainly related to CO_2, evolve as follows:

Figure 7: GHG emissions for the Public electricity and heat production (CRT 1A1a) for the period 1990-2023 (in kt CO_2e)



In general, GHG emissions from the public electricity and heat production evolved as the general trend described for the Energy sector in Chapter 3.1. First, the sector emissions declined from 1990 to 1994 due to the decrease in industrial activities, caused by the economic crisis related to the hyperinflation which occurred in the Republic of Serbia. Then, after increasing back to the pre-crisis level, they plunged in 1999 following the NATO bombing. Since 2004, emissions have fluctuated with climate conditions, the economic crisis and other external events such as the 2014 floods. However, a slight overall declining trend can be observed. Overall, a 27% emission reduction can be observed for the 1990-2023 period, mostly related to fuel consumption evolution, as the GHG implied emission factor has remained relatively stable to 104-105 kg/GJ.

In contrast to other industrial sectors in the Republic of Serbia, energy sector has not experienced a drastic decline in production compared to the production levels achieved in the 1990's. Reduced industrial production, lack of imported fuels and unrealistically low electricity price (imposed as a social peace–keeping factor), have led to a change in the electricity consumption structure. General electricity consumption in households and public and commercial sectors has increased significantly at the expense of industrial sector electricity consumption.

In 2023, the Public electricity and heat production category is a key category for CO_2 emissions in Serbia, without considering LULUCF, for the combustion of liquid, solid, and gaseous fuels:

Consumption of liquid fuels in the Public electricity and heat production
The CO_2 emissions related to the combustion of liquid fuels in the Public electricity and heat production contribute to 0.8% in terms of emissions level (rank 19) and 1.5% in terms of emissions trend (rank 19), without considering LULUCF.

Consumption of solid fuels in the Public electricity and heat production
The CO_2 emissions related to the combustion of solid fuels in the Public electricity and heat production contribute to 45.0% in terms of emissions level (rank 1) and 4.7% in terms of emissions trend (rank 3), without considering LULUCF.

Consumption of gaseous fuels in the Public electricity and heat production
The CO_2 emissions related to the combustion of gaseous fuels in the Public electricity and heat production contribute to 3.6% in terms of emissions level (rank 5) and 5.4% in terms of emissions trend (rank 2), without considering LULUCF.

3.2.5.1.2 Methodological issues

According to the CRT Tables nomenclature, GHG emissions related to the Public electricity and heat production are reported by fuels:

- Liquid fuels,
- Solid fuels,
- Gaseous fuels,
- Other fossil fuels,
- Peat,
- Biomass.

It should be noted that biomass consumption must be reported in the 1A1a sector, but the associated CO_2 emissions are excluded from the national total GHG emissions (they are reported under the "Memo items").

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate GHG emissions [E1], except for CO_2 related to lignite burning where a Tier 2 method is used.

Fuel consumptions for thermal power generation are provided in the energy balance of Serbia [E2].

Default Tier 1 emissions factors (CO_2, CH_4, N_2O) are used to calculate all GHG emissions, except for the CO_2 emissions related to the burning of lignite where country-specific carbon contents (i.e., Tier 2) derived from national measurements are used, as presented in the chapter 3.2.4. Default values come from the 2006 IPCC Guidelines [E3]. It should be noted that emissions related to heat and electricity auto-production in industrial plants are estimated in the sector CRT 1A2-Manufacturing industry sector, according to the IPCC 2006 guidelines.

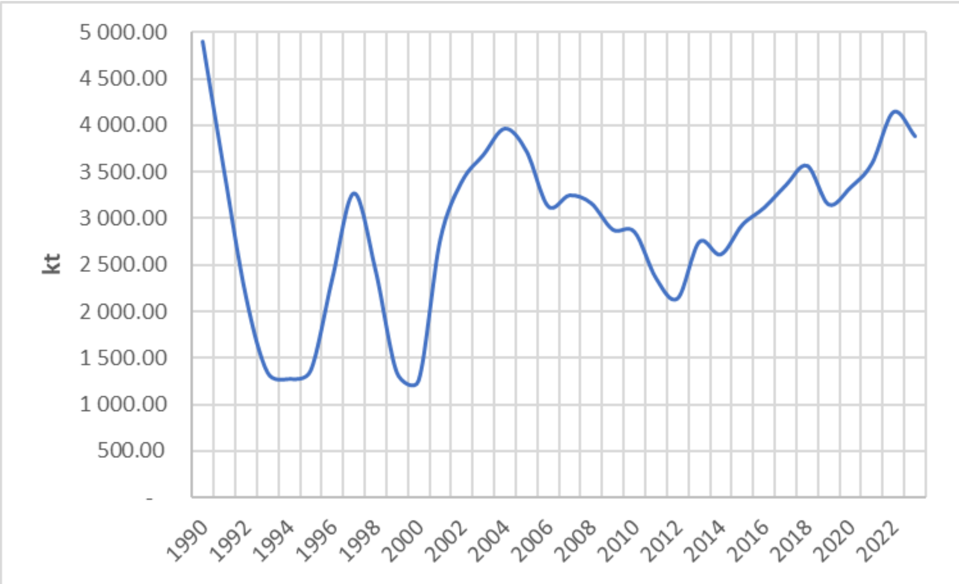
3.2.5.2 Petroleum refining (CRT 1A1b)

3.2.5.2.1 Category description

In the Republic of Serbia, there are two oil refineries, in Pančevo and in Novi Sad. The two refineries consume residual fuel oil, natural gas, LPG and refinery gas. Hence, emissions of CO_2, CH_4, N_2O are originated from the fuel combustion. Starting from 2019, the oil refinery in Novi Sad became a tank farm.

The evolution of crude oil treated in oil refineries for the period 1990-2023 is as follows:

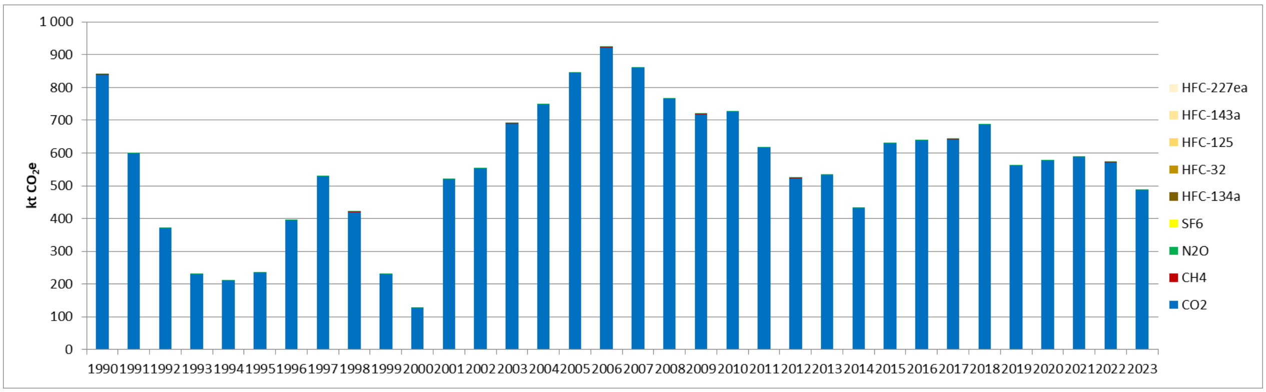
Figure 8: Evolution of the amounts of crude oil treated in petroleum refining for the period 1990-2023



For the period 1990-2023, the amounts of crude oil refined have varied significantly, rather similarly to the trend observed for the overall energy consumptions of the country for the period 1990-2014 (cf. chapter 3.1). Between 2014 and 2022, a large increase of 59% in the amount of crude oil treated has been observed, meanwhile the fuel consumptions have increased by 40% over the same period. In 2023, a decrease in the crude oil refined can be observed for the first time since 2019 (-6% compared with 2022).

The following graph presents the evolution of the GHG emissions for the petroleum refining sector:

Figure 9: GHG emissions for the petroleum refining (CRT 1A1b), for the period 1990-2023 (in kt CO_2e)



GHG emissions from Petroleum refining follows roughly the trend of the amount of crude oil treated over the whole timeseries. At the end of the period, GHG emissions underwent a smaller increase as the fuel consumptions did not increase as much as the amount of crude oil refined. This was also influenced by the gradual phase-out of heavy fuel oil, partly substituted by lower-carbon content fuels such as natural gas and LPG.

In 2023, the category Petroleum refining is a key category for CO_2 emissions in Serbia, for the consumption of liquid and gaseous fuels, both in level and trend of emissions:

Consumption of liquid fuels in the Petroleum refining
The CO_2 emissions related to the consumption of liquid fuels in the Petroleum refining contribute to 0.4% in terms of emissions level (rank 29) and 1.1% in terms of emissions trend (rank 23), without considering LULUCF.

Consumption of gaseous fuels in the Petroleum refining
The CO_2 emissions related to the consumption of gaseous fuels in the Petroleum refining contributes to 0.3% in terms of emissions level (rank 34) and 0.5% in terms of emissions trend (rank 40), without considering LULUCF.

3.2.5.2.2 Methodological issues

According to the CRT Tables nomenclature, GHG emissions related to the Petroleum refining are reported by fuels:

- Liquid fuels,
- Solid fuels,
- Gaseous fuels,
- Other fossil fuels,
- Peat,
- Biomass.

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate the GHG emissions [E1].

Fuel consumptions for refineries are taken directly from the refineries data from 2000 to 2022 [E4]. For the years 1990 to 1999, some extrapolations are developed based on the total amount of crude oil refined.

Default emissions factors (CO_2, CH_4, N_2O) are used to calculate emissions, and the applied CO_2 EF are presented in Chapter 3.2.4. Default values come from the 2006 IPCC Guidelines [E3].

3.2.5.3 Manufacture of solid fuels and other energy industries (CRT 1A1c)

3.2.5.3.1 Category description (e.g. characteristics of sources)

According to the CRT Tables nomenclature, GHG emissions related to the Manufacture of Solid fuels are reported by fuels:

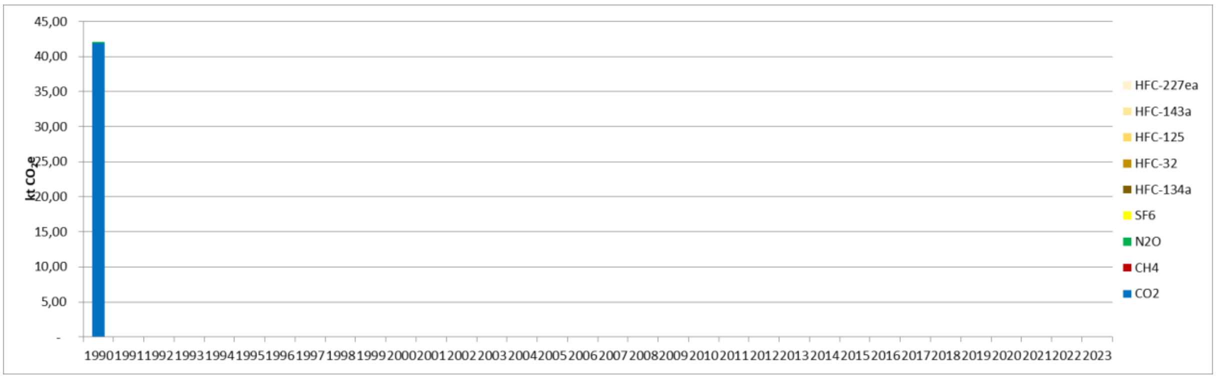
- Diesel oil,
- Fuel oil,
- Sub-bituminous coal,
- Biomass.

The consumption of other bituminous coal and lignite coke from Energy Balance, for coke manufacture, are not calculated in this category, since those amounts are already included in IPPU Tier Emission Factor for Steel Production. Also, emissions related to lignite production are included in fugitive emissions from coal handling (CRT 1B1b). In addition, the solid biomass consumption for charcoal production are all considered in CRT 1B1b.

Hence, only fuel consumptions for 1990 are given in the energy balance.

The GHG emissions for the manufacture of solid fuels and other energy industries evolve as follows:

Figure 10: GHG emissions for the Manufacture of solid fuels (CRT 1A1c), for the period 1990-2023 (in kt CO_2e)



The GHG emissions trend follows the fuel consumptions from the energy balance, with some fossil fuels used only in 1990

The manufacture of solid fuels and other energy industries (CRT 1A1c) is not a key category in 2023 in terms of level of emissions, nor in trend, without considering LULUCF.

3.2.5.3.2 Methodological issues

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate GHG emissions [E1].

The consumption of fuels comes from the Serbian energy balance for the whole timeseries [E2].

The emission factors come from the 2006 IPCC Guidelines [E3], and the applied CO_2 EF are presented in Chapter 3.2.4.

3.2.5.4 Uncertainties and time-series consistency

CO_2
In 2023, the uncertainty estimate associated with activity data for the 1A1-Energy industry category is 1%, based on 2006 IPCC Guidelines [E5].

Uncertainty estimate associated with CO_2 default emission factor for 1A1 category is 2% for liquid and gaseous fuels, 3% for solid fuels and 7% for other fossil fuels, accordingly to values reported in 1996 IPCC Guidelines [E6].

Combined uncertainty for CO_2 emissions is 1.5% in 2023, excluding LULUCF, in the total national terms of level of emissions.

CH_4
In 2023, the uncertainty estimate associated with activity data for the 1A1-Energy industry category is 1%, based on 2006 IPCC Guidelines [E5].

Uncertainty estimate associated with CH_4 default emission factor for 1A1 category is 100%, accordingly to values reported in 2006 IPCC Guidelines [E7].

Combined uncertainty for CH_4 emissions is 0.01% in 2023, excluding LULUCF, in the total national terms of level of emissions.

N_2O
In 2023, the uncertainty estimate associated with activity data for the 1A1-Energy industry category is 1%, based on 2006 IPCC Guidelines [E5].

Uncertainty estimate associated with N_2O default emission factor for 1A1 category is 100%, based on a conservative assumption.

Combined uncertainty for N_2O emissions is 0.2% in 2023, excluding LULUCF, in the total national terms of level of emissions.

3.2.5.5 Category-specific QA/QC and verification

During the preparation of the inventory submission, activities related to quality control were mainly focused on proper use of notation keys in the CRT tables according to QA/QC plan.

3.2.5.6 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission in November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	42 713	38 836	34 122	33 825	31 850	35 515	33 164	34 968	27 535	34 115	33 801	34 291	32 300	32 584	34 303	32 215	32 087	0
Nouveau	kt CO2e	42 611	38 805	34 122	33 774	31 835	35 497	33 076	34 658	27 263	33 896	33 631	34 058	32 083	32 345	33 975	31 850	31 752	31 264
Différence	kt CO2e	-101	-31	0	-52	-15	-18	-88	-310	-272	-219	-170	-233	-217	-240	-329	-365	-335	+31 264
	%	-0,2%	-0,1%	0%	-0,2%	-0,0%	-0,1%	-0,3%	-0,9%	-1,0%	-0,6%	-0,5%	-0,7%	-0,7%	-0,7%	-1,0%	-1,1%	-1,0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 1.A.1.a

1A1a – Public electricity and heat production

For the whole timeseries, natural gas consumptions from petroleum refining from energy balance are considered in the CRT 1A1a, but the natural gas consumptions from GHG inventory were not subtracted. This has been corrected and now, the natural gas consumptions for CRT 1A1a in the GHG inventory correspond to the balance between the whole Energy industry and the oil refineries.

CO_2 emissions from coal tar, which was consumed only in 2015, were added and accounted for in the 2015 data.

1A1b - Petroleum refining

Corrected NCV values for:

- Refinery gas for 2021 and 2022.
- Residual oil from 2015 to 2022.

1A1c – Manufacture of solid fuels

The solid biomass consumptions for 2011-2022 have been removed from CRT 1A1c because they are used as non-energy uses in charcoal production, and transferred in CRT 1B1b.

3.2.5.7 Category-specific planned improvements

For the manufacture of solid fuels, completeness of the activity data set should be improved.

In addition, for sectors where reporting data are available, the data used in the inventory will be compared with the reports from operators for QA/QC.

3.2.6 Manufacturing industry and construction (CRT 1A2)

3.2.6.1 Category description

Manufacturing Industries and Construction include emissions from fuel combustion in different industries, such as iron and steel industry, industries of non-ferrous metals, chemicals, pulp and paper, food processing, beverages and tobacco, non-mineral industry:

- Iron and steel (CRT 1A2a),
- Non-ferrous metals (CRT 1A2b),
- Chemicals (CRT 1A2c),
- Pulp, paper and print (CRT 1A2d),
- Food processing, beverages and tobacco (CRT 1A2e),
- Non-metallic minerals (CRT 1A2f)
- Transport equipment (CRT 1A2g)
- Machinery (CRT 1A2h)
- Mining (excluding fuels) and Quarrying (CRT 1A2i)
- Wood and wood products (CRT 1A2j)
- Construction (CRT 1A2k)
- Textile and Leather (CRT 1A2l)
- Non-specified Industry (CRT 1A2m).

In addition, the fuel consumptions related to the auto-production of heat and electricity in manufacturing industries are also estimated in this sector, according to the 2006 IPCC guidelines, and included in the CRT 1A2m.

According to the CRT Tables nomenclature, GHG emissions related to the Manufacturing industry are reported by consumption of the following fuel categories:

- Liquid fuels,
- Solid fuels,
- Gaseous fuels,
- Other fossil fuels,
- Peat,
- Biomass.

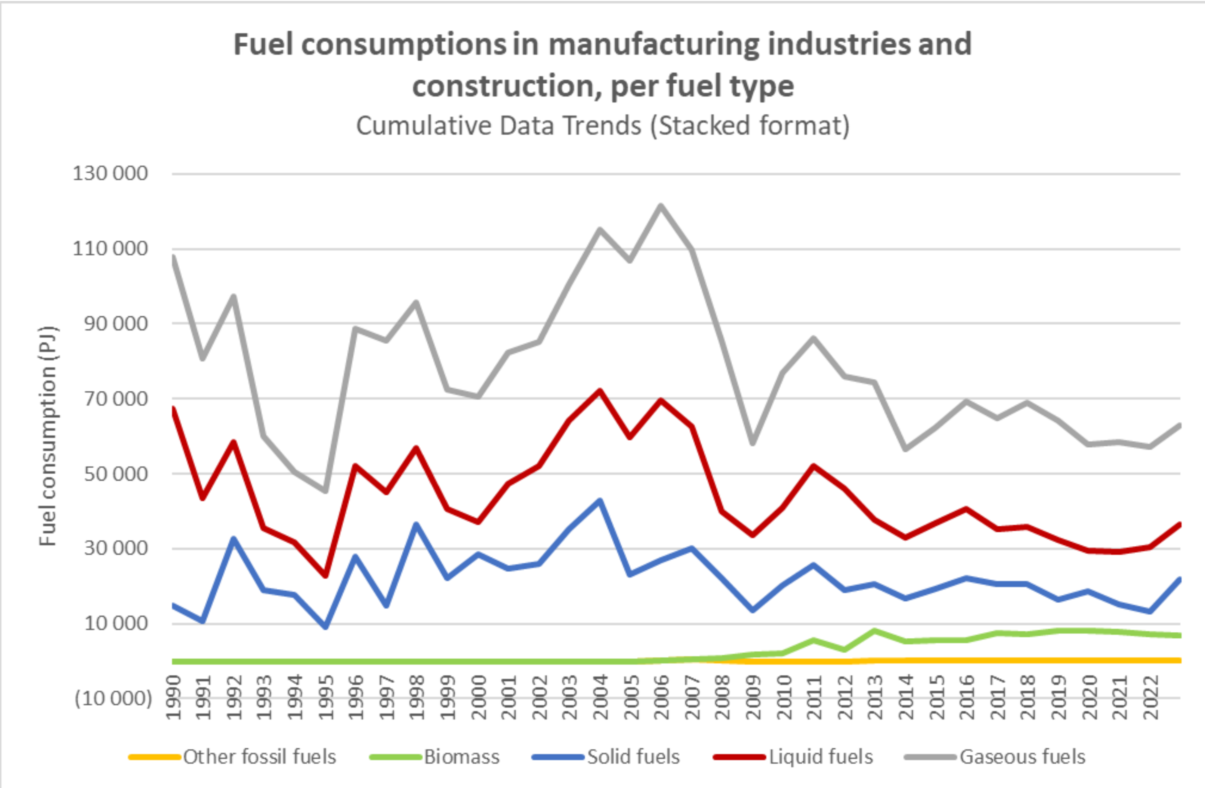
It should be noted that biomass consumption must be reported in the 1A2 sector, but the CO_2 related emissions are excluded from the national total GHG emissions (they are reported under the “Memo items”).

In 2023, the manufacturing industries (CRT 1A2) contributes to 7% of the total GHG emissions without considering LULUCF, and it contributes to 9% of the Energy category (CRT 1) in Serbia.

The evolution of the fuel consumptions in the manufacturing industries and construction sector, per fuel category and per subsector, are presented in the following graphs. It can be observed that some significant variations occur over the timeseries, according to generic comments which have been developed in the Chapter 3.1. To summarize, there have been some drastic changes following the hyperinflation period, which can be observed until 1995 for the industry, the NATO bombing in 1999, the 2000 global economic crisis, and the 2014 floods. Since 2016, a progressive declining trend can be observed, and there has been an overall reduction of the fuel consumptions of 9% in 2023 compared with 2016, although a 10% increase can be observed in 2023 compared with 2022. Overall, the industry fuel consumptions have decreased by 42% between 1990 and 2023, and all the different fuel have contributed to this reduction, except biomass and other fossil fuels which were not in the fuel mix in 1990.

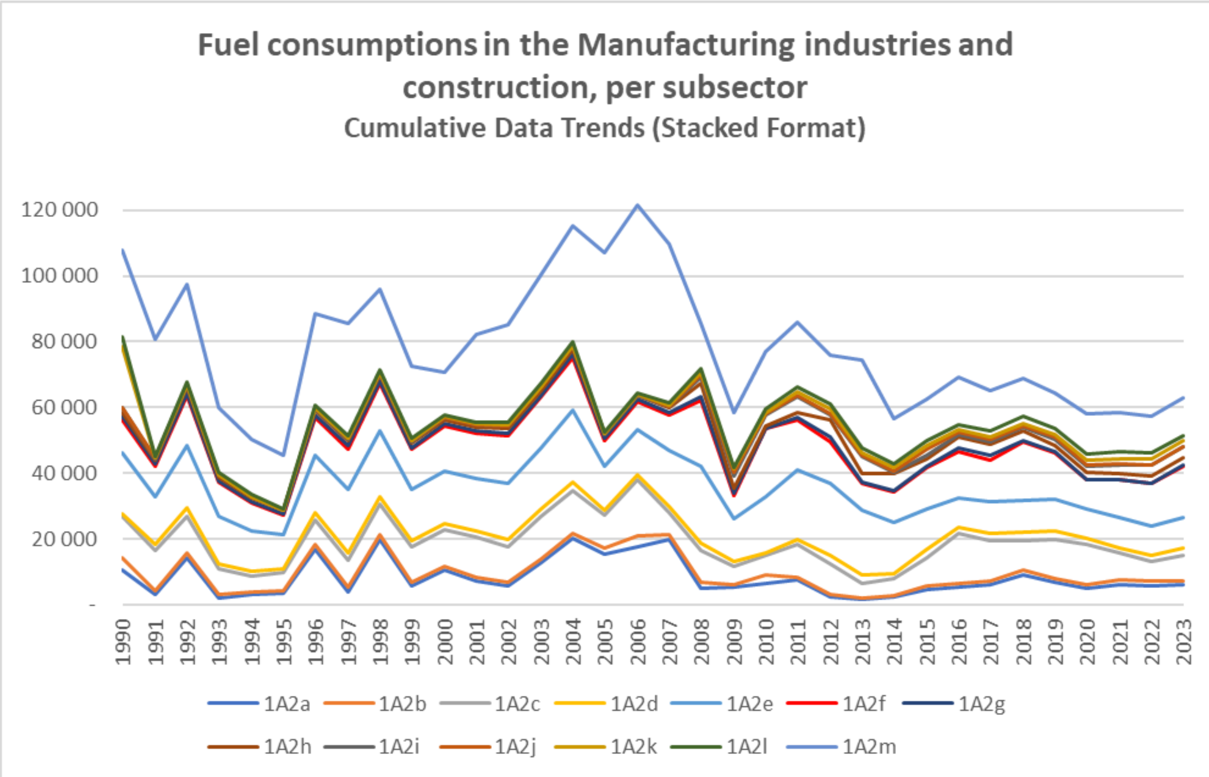
Comparing the different fuel types, for the period 1990-2023, the combustion of liquid fuels, which was predominant in 1990 and represented almost half the overall consumption, have decreased at a faster rate than the other fuels, and contribute to 24% of the total consumption in 2023. A similar observation, to a lesser extent and overall contribution, can be drawn for the solid fuels, although it experienced a sharp increase in 2023 (+145% compared with 2022). Liquid and solid fuels have been mainly substituted by the development of biomass – which was not occurring in 1990 and now contributes to 11% of total consumption – and by gaseous fuels which have seen their share increased from 38% to 42% over the whole timeseries.

Figure 11: Fuel consumptions in the Manufacturing industries and Construction (CRT 1A2), per fuel type, for the period 1990-2023 (in TJ)



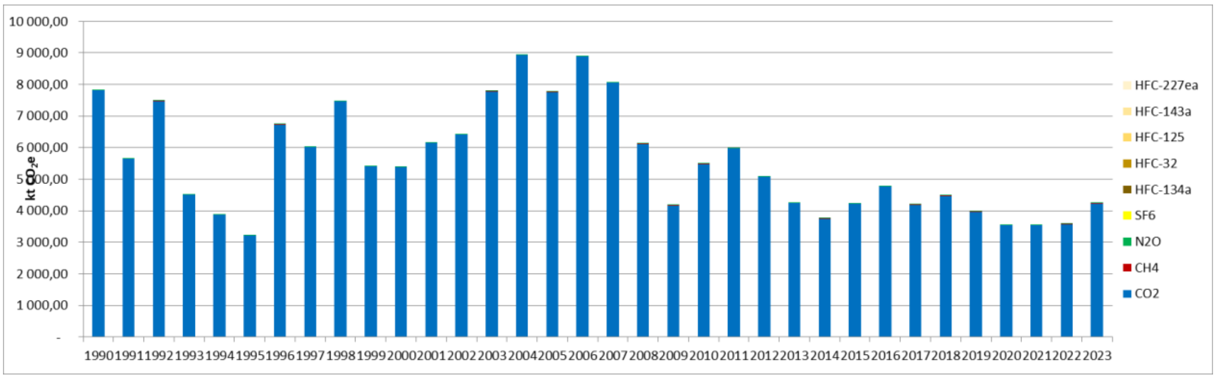
In terms of subsectors, the major contributors to the total industry fuel consumptions are the non-metallic minerals (CRT 1A2f), the other industries (including auto-producers) (CRT 1A2m), the food and beverages (CRT 1A2e), the chemicals (CRT 1A2c) and the iron and steel (CRT 1A2a). All these subsectors have decreased their fuel consumptions by 40% to 57% between 1990 and 2023, except for the non-metallic mineral industries which increased theirs by 51%. Another significant change is the increase in fuel consumption by the mining and quarrying industries (CRT 1A2i), which are 184% higher in 2023 compared with 1990.

Figure 12: Fuel consumptions in the Manufacturing industries and Construction (CRT 1A2), per subsector, for the period 1990-2023 (in TJ)



The following graph presents the trend evolution of the GHG emissions of the CRT 1A2, between 1990 and 2023:

Figure 13: GHG emissions in the Manufacturing industry and construction (CRT 1A2), for the period 1990-2023 (in kt CO_2e)



As for the other subsectors from the Energy, most of the GHG emissions are related to CO_2 emissions.

The overall CRT 1A2 GHG emissions follow the trend of fossil fuel consumption, and have decreased by 46% between 1990 and 2023, although they experienced a 18% increase in 2023 compared with 2022. GHG emissions have decreased at a faster rate than the sector's fuel consumptions, due to changes in the energy mix with the substitution of relatively high-carbon contents fuels, such as coal and residual fuel oil, with lower-carbon content fuels, such as natural gas, and obviously biomass (as the CO_2 is not included in the total). Consequently, the GHG implied emission factor have been reduced from 73 to 63 kg/GJ over the timeseries, reflecting a 7% reduction.

In 2023, the different categories constituting the CRT 1A2 sector are key categories for CO_2 emissions in Serbia, for the combustion of liquid, solid, and gaseous fuels, both in terms of levels and trends of emissions, and are as follows:

Table 20: Key categories in level and trend for the Manufacturing industries and construction, in 2023, excluding LULUCF

CRT category/fuel/substance	Key category in level ranking (% of contribution)	Key category in trend ranking (% of contribution)
1.A.2.f Non-metallic Minerals / Solid fuels / CO2	12 (1.0%)	11 (2.4%)
1.A.2.f Non-metallic Minerals / Liquid fuels / CO2	15 (1.0%)	15 (1.8%)
1.A.2.m Not elsewhere specified (Industry) / Gaseous fuels / CO2	21 (0.6%)	30 (0.8%)
1.A.2.m Not elsewhere specified (Industry) / Solid fuels / CO2	25 (0.5%)	60 (0.2%)
1.A.2.a Iron and Steel / Gaseous fuels / CO2	27 (0.4%)	-
1.A.2.c Chemicals / Solid fuels / CO2	28 (0.4%)	25 (1.0%)
1.A.2.e Food Processing, Beverages and Tobacco / Gaseous fuels / CO2	33 (0.4%)	39 (0.6%)
1.A.2.i Mining (excluding fuels) and Quarrying / Liquid fuels / CO2	35 (0.3%)	38 (0.6%)
1.A.2.c Chemicals / Gaseous fuels / CO2	37 (0.3%)	29 (0.8%)
1.A.2.f Non-metallic Minerals / Gaseous fuels / CO2	43 (0.2%)	33 (0.7%)
1.A.2.k Construction / Liquid fuels / CO2	44 (0.2%)	22 (1.1%)
1.A.2.m Not elsewhere specified (Industry) / Liquid fuels / CO2		7 (4.0%)
1.A.2.e Food Processing, Beverages and Tobacco / Liquid fuels / CO2		13 (2.0%)
1.A.2.e Food Processing, Beverages and Tobacco / Solid fuels / CO2		16 (1.7%)
1.A.2.k Construction / Gaseous fuels / CO2		18 (1.6%)
1.A.2.a Iron and Steel / Liquid fuels / CO2		34 (0.6%)
1.A.2.b Non-Ferrous Metals / Solid fuels / CO2		41 (0.5%)
1.A.2.b Non-Ferrous Metals / Liquid fuels / CO2		43 (0.4%)
1.A.2.l Textiles and leather / Liquid fuels / CO2		46 (0.4%)
1.A.2.k Construction / Solid fuels / CO2		48 (0.4%)
1.A.2.d Pulp, Paper and Print / Solid fuels / CO2		53 (0.3%)
1.A.2.c Chemicals / Liquid fuels / CO2		55 (0.3%)
1.A.2.d Pulp, Paper and Print / Gaseous fuels / CO2		56 (0.3%)
1.A.2.b Non-Ferrous Metals / Gaseous fuels / CO2		61 (0.2%)

3.2.6.2 Methodological issues

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate the GHG emissions [E1].

The activity data are the consumptions of fuels, which come from the national energy balance [E2]. It has to be noticed that the non-energy use fuel consumptions are not reported in the 1A2 sector, but in the CRT 2-Industrial processes sector.

Default emissions factors (CO_2, CH_4, N_2O) are used to calculate emissions. Default values come from the 2006 IPCC Guidelines [E3], and the applied CO_2 EF are presented in Chapter 3.2.4.

3.2.6.3 Uncertainties and time-series consistency

CO_2

In 2022, the uncertainty estimate associated with activity data for category 1A2-Manufacturing industry is 2%, based on 2006 IPCC Guidelines [E5].

Uncertainty estimate associated with CO_2 default emission factor for category 1A2-Manufacturing industry is 7%, accordingly to values reported in 1996 IPCC Guidelines [E6].

Combined uncertainty for CO_2 emissions is 0.5% in the total national levels of emission in 2023, excluding LULUCF contribution.

CH_4

In 2022, the uncertainty estimate associated with activity data for category 1A2-Manufacturing industry is 2%, based on 2006 IPCC Guidelines [E5].

Uncertainty estimate associated with CH_4 default emission factor for category 1A2-Manufacturing industry is 100%, accordingly to values reported in 2006 IPCC Guidelines [E7].

Combined uncertainty for CH_4 emissions is 0.006% in the total national levels of emission in 2023, excluding LULUCF contribution.

N_2O

In 2022, the uncertainty estimate associated with activity data for category 1A2-Manufacturing industry is 2%, based on 2006 IPCC Guidelines [E5].

Uncertainty estimate associated with N_2O default emission factor for category 1A2-Manufacturing industry is 100%, accordingly to a conservative assumption.

Combined uncertainty for N_2O emissions is 0.01% in the total national levels of emission in 2023, excluding LULUCF contribution.

3.2.6.4 Category-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on proper use of notation keys in the CRT tables according to QA/QC plan.

3.2.6.5 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission of November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	7 833	3 217	5 407	7 778	5 504	5 999	5 152	4 686	3 764	4 238	4 792	4 211	4 498	3 993	3 559	3 559	3 590	0
Nouveau	kt CO2e	7 833	3 217	5 407	7 778	5 504	5 999	5 098	4 264	3 766	4 241	4 795	4 214	4 503	3 997	3 564	3 564	3 594	4 256
Différence	kt CO2e	0	0	0	0	0	0	-54	-422	+2,5	+3,0	+3,2	+3,5	+4,2	+3,9	+4,7	+4,7	+3,7	+4 256
	%	0%	0%	0%	0%	0%	0%	-1,0%	-9,0%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 1.A.2

1A2c - Chemicals

For the years 2007 and 2012-2014, natural gas consumptions for non-energy uses from the energy balances are smaller than the estimated consumptions from the ammonia (2B1) and methanol (2B8) productions. The balance is now subtracted to the chemical (1A2c), auto-producers (1A2m) or not elsewhere specified industry (1A2m) subsectors, depending on the available energy consumptions.

The impact is mostly important in 2013 where the new estimate is 422 kt CO_2 lower than in the previous submission, as well as in 2012 to another extent with -54 kt CO_2.

1A2gvi - Textile and leather:

All emission factors were corrected for 2022.

1A2m – Not elsewhere specified industry and autoproducers:

Cf. comment for recalculations from CRT 1A2c.

In addition, for 2014-2022, the waste consumptions for the industry sector have been considered, resulting in an increase of about 3 to 5 kt CO_2.

3.2.6.6 Category-specific planned improvements

For the autoproduction of heat and electricity in manufacturing industries, the completeness of the activity data set could be improved. To do so, discussions with experts from the Ministry of Mines and Energy, which develop the energy balances, need to be engaged.

3.2.7 Transport (CRT 1A3)

This category covers the emission from combustion and evaporation of fuel for all transport activities. This sector includes the emission from:

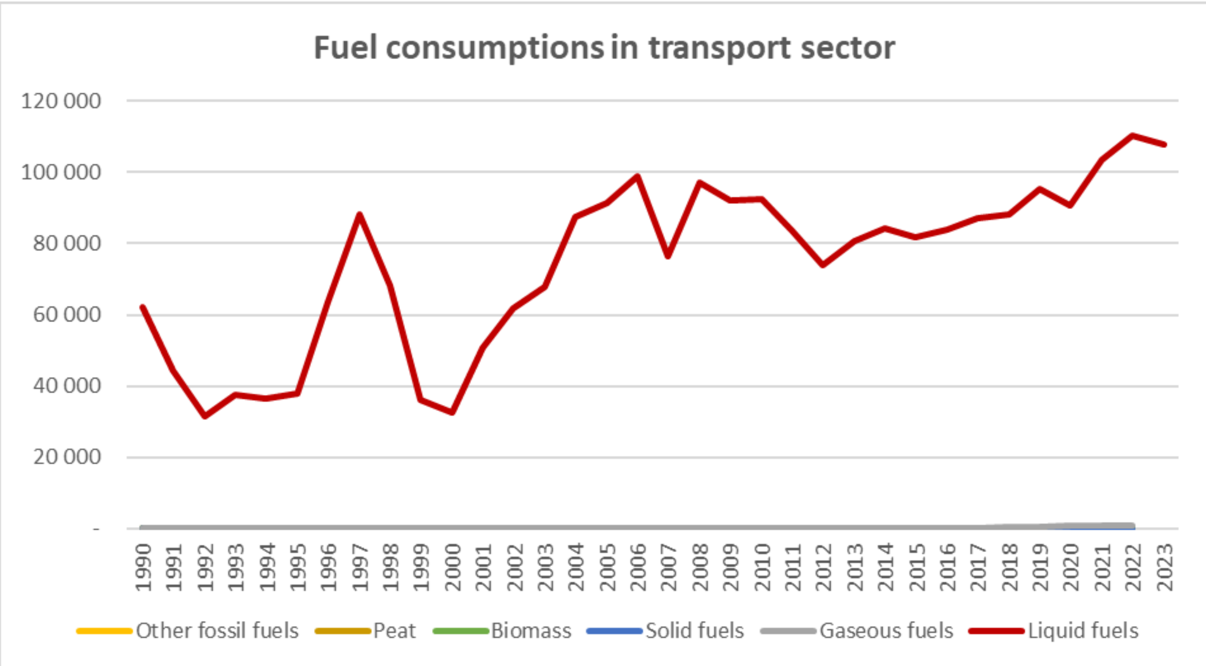
- Air transport (CRT 1A3a),
- Road transport (CRT 1A3b),
- Rail transport (CRT 1A3c),
- Marine transport (CRT 1A3d).

By lack of details in the energy balance, fuel consumptions for aviation are all considered in international bunkers, and emissions from CRT 1A3a reported in the Republic of Serbia are hence included elsewhere. For aviation, only internationals bunker emissions are estimated and excluded from the national total emission (memo items). On the opposite, because there is no direct access to the sea in the Republic of Serbia, all fuel consumptions related to water-borne transport are included in the domestic transport (CRT 1A3d).

In 2023, the transport sector (CRT 1A3) contributes to 13% of the total GHG emissions with LULUCF, and it contributes to 16% of the Energy category (CRT 1) in the Republic of Serbia.

The fuel consumptions for the transport sector (CRT 1A3) are presented in the following graph. The trend is observed to be quite fluctuating with low levels observed in 1992-1995 and 1999-2000 due to the hyperinflation crisis and the NATO bombing, respectively. Since then, the transport sector activity has been relatively increasing, in particular since 2012, even considering the 2% decrease in 2023 compared with 2022. The fuel consumptions for the transport sector are almost only related to liquid fuel consumptions, except a relatively marginal consumption of solid fuels for railway transport until 2009, and the more recent development of liquefied natural gas for road transport from 2008, which remains overall marginal. In overall, almost only road transport contributes to the total fuel consumptions of the transport sector, with more than 99-100% of the share for the whole period.

Figure 14: Fuel consumptions in the Transport sector (CRT 1A3), per fuel type, for the period 1990-2023 (in TJ)



3.2.7.1 Road transportation (CRT 1A3b)

3.2.7.1.1 Category description

This category refers to GHG emissions due to road transport. Road transport includes all types of passenger cars, light-duty vehicles, heavy-duty vehicles, buses, mopeds and motorcycles. These mobile sources use different types of liquid and gaseous fuels, mostly gasoline and diesel oil, and emit significant amounts of greenhouse gases and air pollutants. In the CRT tables, due to a lack of details in activity data, all emissions from road transport are included in category "1.A.3.b.i. Cars".

Road transport represents the most developed mode of transportation in the Republic of Serbia. Road network in Serbia today, although relatively well developed (total length of roads reaches about 45,419 km), is in quite poor condition. Lack of financial resources starting from 1990 onwards, as well as utilization of all available funds for maintenance and repair of infrastructure damaged during the 1999 bombardment, represent the main reasons for the situation encountered today. Poor condition of road network directly affects the safety of road transport, low level of transportation services provided through the existent and perspective road network, as well as high exploitation costs.

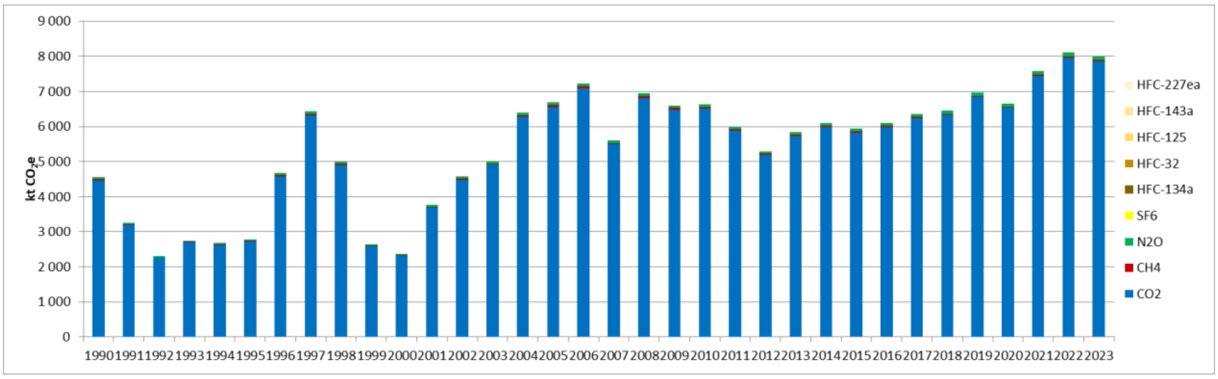
In addition, the old age of vehicle fleet represents a key problem with respect to energy efficiency, environmental protection as well as transportation safety. In the period 1990 – 1999, the average annual increase in the number of vehicles was about 7%. However, much of the increase was due to importation of used vehicles from the western countries, which had largely influenced the average age of vehicle fleet.

The period 1990 – 2000 was also characterized by "grey economy" associated with the import of low rank fuels (in addition to domestic production of low rank fuels). Use of diesel fuel had rapidly increased. All of this had negatively affected pollutant emission at national level, in spite of the fact that reduced transport sector contribution to the national economy was recorded in the period considered.

In 2023, the road transport sector (CRT 1A3b) is a key category for CO_2 emissions in the Republic of Serbia, both in terms of level and trend of emissions. The CO_2 emissions from the liquid fuel combustion in this sector contribute to 12.6% in terms of emissions level (rank 2) and 17.4% in terms of emissions trend (rank 1). The N_2O emissions of liquid fuel combustion in road transport are also a key category in terms of emission trend with a contribution of 0.2% (rank 63).

The following graph presents the trend of the road transportation GHG emissions in the Republic of Serbia over the entire timeseries. In overall, between 1990 and 2023, the road transport GHG emissions increased by 75%. From 2004, after having recovered from the NATO bombing, to 2018, GHG emissions have been relatively stable although varying for some specific years. Since 2019, except in 2020 with the Covid crisis, an increasing trend in GHG emissions is observed. GHG emissions have increased slightly less than fuel consumption as the introduction of LPG and LNG from 2008 enables to decrease the implied emission factor of the overall mix. In 2023, LPG consumption represents about 3% of the total consumption whereas LNG contributes to around 1%.

Figure 15 : GHG emissions for road transportation (CRT 1A3b), for the period 1990-2023 (in kt CO_2e)



3.2.7.1.2 Methodological issues

Emissions of GHG from liquid and gaseous fuels are calculated on the basis of the fuel consumptions using Tier 1 (top-down) approach, which is in accordance with the 2006 IPCC Guidelines.

Activity data used are the fuel consumption by type of fuel (diesel, gasoline, LPG and LNG). Amounts of all types of liquid and gaseous fuels consumed for the whole timeseries were extracted from national energy balance [E2], as well as the NCV [E10], which are summarized in Chapter 3.2.4.

Emissions factors used for calculating CO_2 emissions from liquid and gaseous fuels come from 2006 IPCC guidelines [E8], and are presented in Chapter 3.2.4.

Emissions factors used for calculating CH_4 and N_2O emissions from liquid and gaseous fuels also come from 2006 IPCC guidelines [E9].

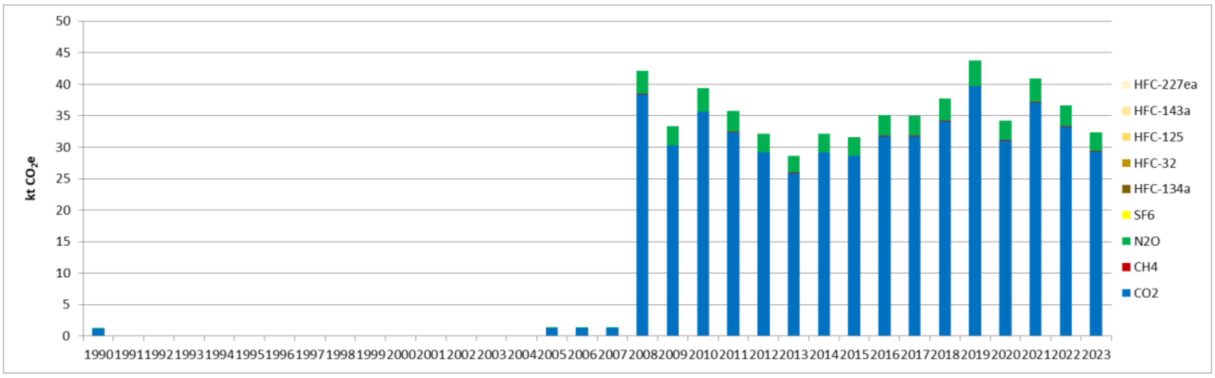
3.2.7.2 Railways (CRT 1A3c)

3.2.7.2.1 Category description

This category refers to GHG emissions due to rail transport.

In 2023, this category is not a key category in terms of emissions level nor in terms of emissions trend for GHG emissions in Serbia.

Figure 16 : GHG emissions for railways (CRT 1A3c), for the period 1990-2023 (in kt CO_2e)



Investments in rail transport made since 1990 were insignificant, causing this mode of transportation today to be in a particularly unenviable situation. That is specifically reflected in the poor conditions of rail infrastructure and rail transport vehicles, the low service quality, the increased debt, the high operation costs, the business losses and the improper system organization. All of this has led to a decreased share of rail transport starting from 1990 onwards.

In recent years, state policy changes imply the contribution and development of this subsector. As a result, intermodal transport, which incorporates ecological principles, has gained special important, leading to its intensified development in most European countries.

Until 2005, intermodal transport accounted for approximately 0.5% of overall transport in the Republic of Serbia. Its development, as a mode of transport serving the broader public interest—environmentally sustainable, economically viable, and safe—requires government support.

3.2.7.2.2 Methodological issues

Emissions of GHG from liquid and solid fuels are calculated on the basis of the fuel consumption using Tier 1 (top-down) approach, which is in accordance with the 2006 IPCC Guidelines [E10].

Activity data used are the fuel consumptions by type of fuel. Amounts of all types of fuels consumed (lignite, brown coal briquettes and diesel) for the whole timeseries were taken from national energy balance [E2], as well as NCV values, which are presented in Chapter 3.2.4.

Emissions factors used for calculating CO_2, CH_4 and N_2O emissions from fuels come from 2006 IPCC guidelines [E3]. CO_2 emission factors applied are given in Chapter 3.2.4.

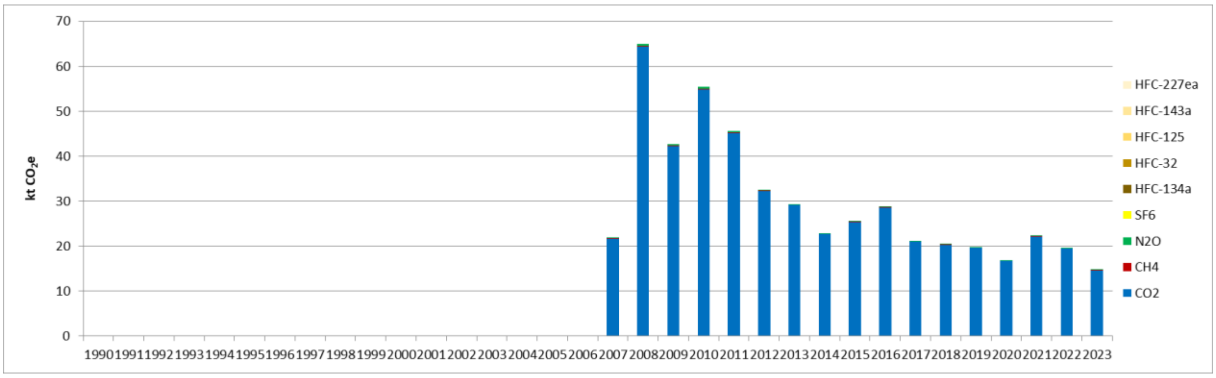
3.2.7.3 Domestic navigation (CRT 1A3d)

3.2.7.3.1 Category description

This category refers to GHG emissions due to domestic navigation.

In 2023, the category domestic navigation is not a key category in terms of emission levels nor in terms of emission trend for GHG emissions in the Republic of Serbia.

Figure 17 : GHG emissions for domestic navigation (CRT 1A3d), for the period 1990-2023 (in kt CO_2e)



River transport in Serbia is only modestly utilized, mainly due to poor condition of related infrastructure resulting from improper maintenance of waterways and auxiliary infrastructure during the 1990s.

Total length of waterways in the Republic of Serbia, measured at the mean river water levels, is approximately 1,680 km. The federal waterways are mainly constituted of the navigable river streams of the Danube, Sava and Tisa river (960 km in total), as well as a network of navigable canals of the hydro–engineering system Danube–Tisa–Danube (600 km in total).

With respect to the annual volume of river transport and available capacity, the most important river ports are the port of Belgrade, Novi Sad, Pančevo, Smederevo and Prahovo. Most of the river ports are either directly connected or are close to the main railways and roads, which represent a strategic and logistic advantage not sufficiently exploited over the last twenty years. The said is clearly demonstrated in the fact that total traffic that came in Serbian river ports in 2000 equaled about 40% of the traffic achieved in 1989. Such significant decrease was primarily a result of reduced national river transport caused by negative trends in the country's economy.

3.2.7.3.2 Methodological issues

Emissions of GHG from liquid fuels are calculated on the basis of the fuel consumption using Tier 1 (top-down) approach which is in accordance with the 2006 IPCC Guidelines [10].

Activity data used are fuel consumptions, by type of fuel. Amounts of all types of fuels consumed for the whole timeseries were given in the national energy balance [E2], as well as NCV values, which are presented in Chapter 3.2.4.

Emissions factors used for calculating CO_2, CH_4 and N_2O emissions from fuels are taken from 2006 IPCC guidelines [E11]. CO_2 emission factors applied are given in Chapter 3.2.4.

3.2.7.4 Uncertainties and time-series consistency

CO_2, CH_4, N_2O

Uncertainty estimate associated with activity data for CRT 1A3 amounts to 5%, according to values available in 2006 IPCC Guidelines.

Uncertainty estimate associated with default emission factor for CO_2 amounts to 5%, according to values available in 2006 IPCC Guidelines. For CH_4 and N_2O, the uncertainties on Tier 1 emission factors are about 200% according to 2006 IPCC Guidelines.

Combined uncertainty for CO_2 emissions is 1.0% in the total national levels of emission in 2023, excluding LULUCF contribution. Combined uncertainties for CH_4 and N_2O emissions are 0.13% and 0.38%, respectively, in the total national levels of emission in 2023, excluding LULUCF contribution.

3.2.7.5 Category-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on proper use of notation keys in the CRT tables according to QA/QC plan.

3.2.7.6 Category-specific recalculations

No recalculations were made since the previous NID submission (November 2024).

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	4 560	2 787	2 374	6 694	6 728	6 073	5 352	5 896	6 157	5 999	6 162	6 415	6 508	7 034	6 701	7 650	8 167	0
Nouveau	kt CO2e	4 560	2 787	2 374	6 694	6 728	6 073	5 352	5 896	6 157	5 999	6 162	6 415	6 508	7 034	6 701	7 650	8 167	8 045
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+8 045
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 1.A.3.

3.2.7.7 Category-specific planned improvements

One important planned improvement is to improve the timeseries consistency and completeness for the collected data from the energy balance for the sectors of railways (1A3c) and domestic navigation (1A3d).

Another further improvement will be to move to tier 2 methodologies for road transport, which is the second most emitting sector in 2023.

3.2.8 Other sectors (CRT 1A4)

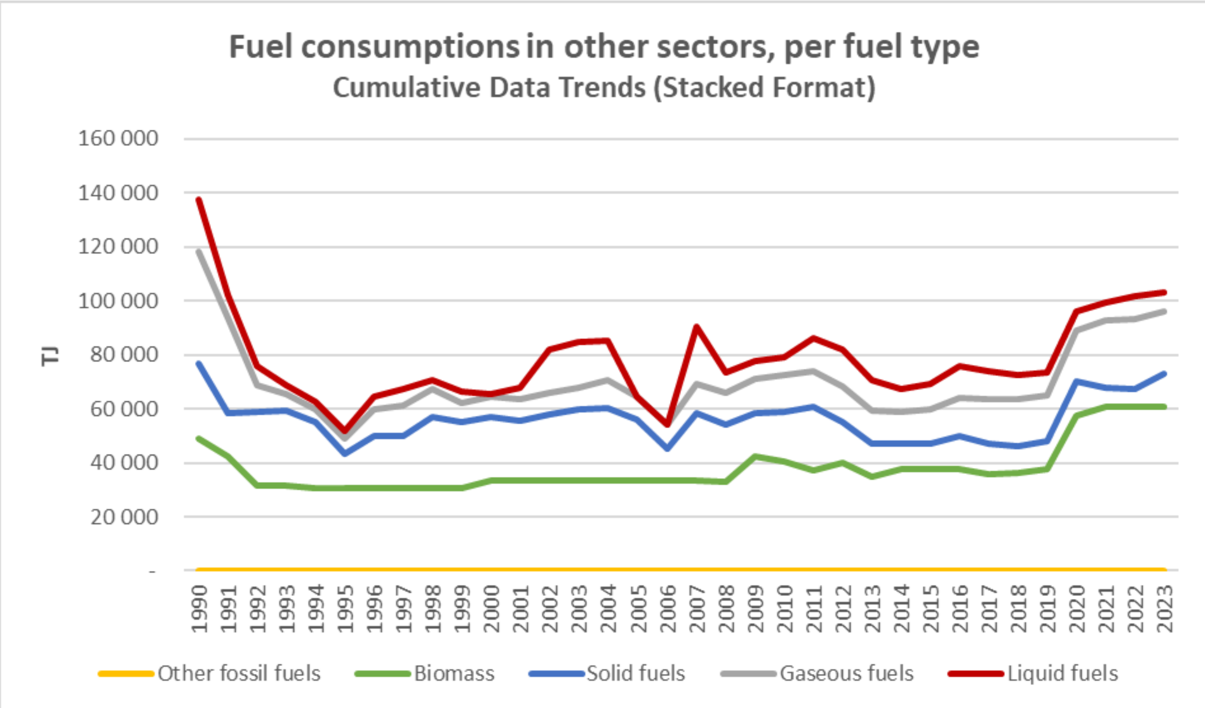
This category covers the emission from combustion of fuel for other activities. This sector includes the emissions from:

- Commercial and institutional activities (CRT 1A4a),
- Residential (CRT 1A4b),
- Agriculture, forestry and fishing (CRT 1A4c).

In 2023, the other sectors (CRT 1A4) contribute 5.9% to total GHG emissions without considering LULUCF, and to 7.4% of the Energy category (CRT 1) in the Republic of Serbia.

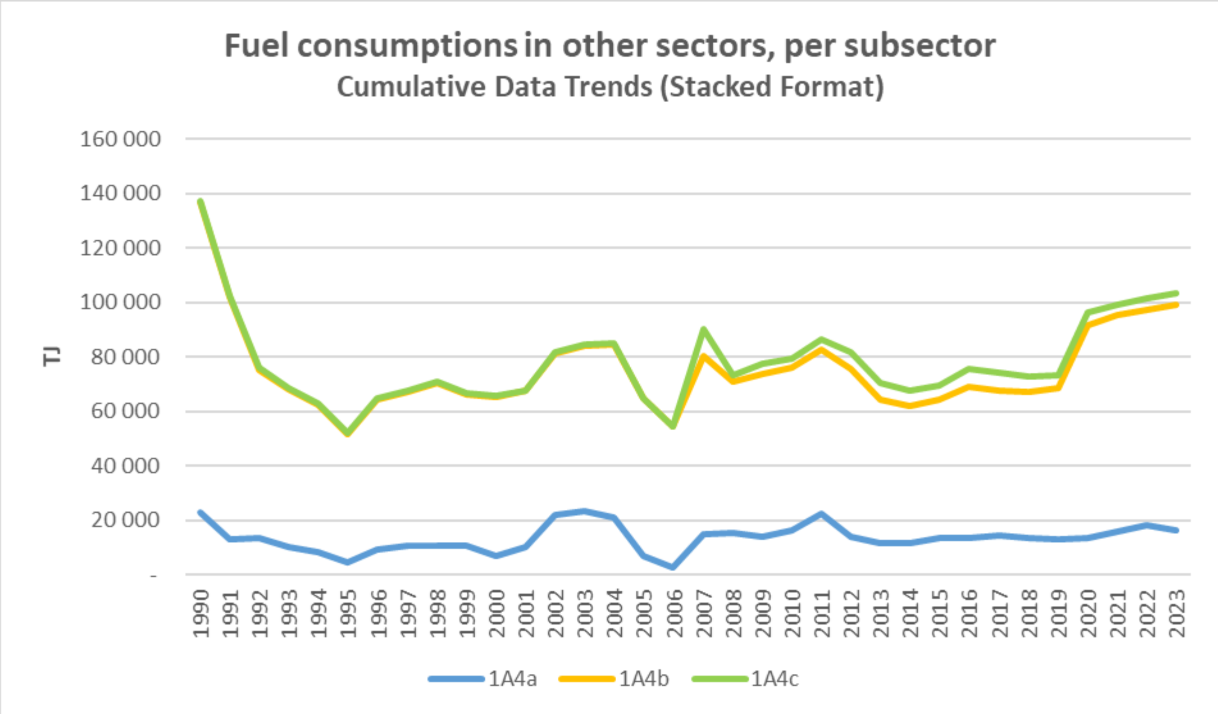
The following graphs present the other sectors fuel consumptions over the entire studied period, per fuel type and per subsector. The overall fuel consumption decreased by 25% between 1990 and 2023, meanwhile the fossil fuel consumption has been reduced by 52% over the same period. All fossil fuels (liquid, gaseous and solid) contributed to that reduction, with the solid fuels contributing the most to that overall reduction with a drop of 63% for the period 1990-2023. In the latest year, they only represent 12% of the total fuel consumption (including biomass), whereas their share was of more than 20% in 1990. On the opposite, biomass consumption, which is mainly consumed in the residential sector, is rather stable over the timeseries, until 2020 where an important increase is observed, until reaching a plateau again. The biomass consumption for other sectors is 24% higher in 2023 than it was in 1990.

Figure 18: Fuel consumptions in the Other sectors (CRT 1A4), per fuel type, for the period 1990-2023 (in TJ)



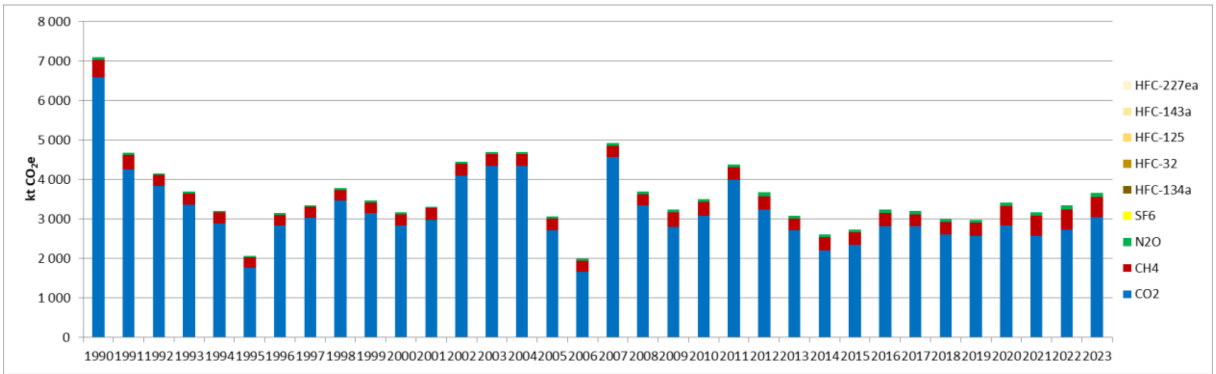
In terms of subsectors, residential combustion is the main responsible for the fuel consumptions of the other sectors, with a slight decreasing contribution from 83% in 1990 to 80% in 2023. The tertiary subsector is the second contributor to the other sector total fuel consumptions with a share of about 17% in 1990 and 16% in 2023. The latest subsector, agriculture, forestry and fishing, has increased its fuel consumption by 434% over the period 1990-2023.

Figure 19: Fuel consumptions in the Other sectors (CRT 1A4), per subsector, for the period 1990-2023 (in TJ)



Overall GHG emissions from *Other sectors* fluctuate, as shown in the following graph. It can be observed that the emissions follow the trend of total fuel consumption, as the biomass consumption is relatively stable over time, and as a reminder the associated CO_2 emissions are not included in the totals, except for the period 2020-2022 where there was a significant increase in biomass consumption. Overall, GHG emissions have been reduced by 48% between 1990 and 2023, mainly due to CO_2 emissions but also CH_4 emissions. The GHG emissions have been reduced at a faster rate than the fuel consumptions, and the GHG implied emission factor went from 52 to 35 kg/GJ (31% reduction) for the whole sector, due to the increased use in biomass while high carbon content fuel such as lignite, brown coal briquettes and residual fuel oil have been progressively substituted.

Figure 20: GHG emissions for Other sectors (CRT 1A4), for the period 1990-2023 (in kt CO_2e)



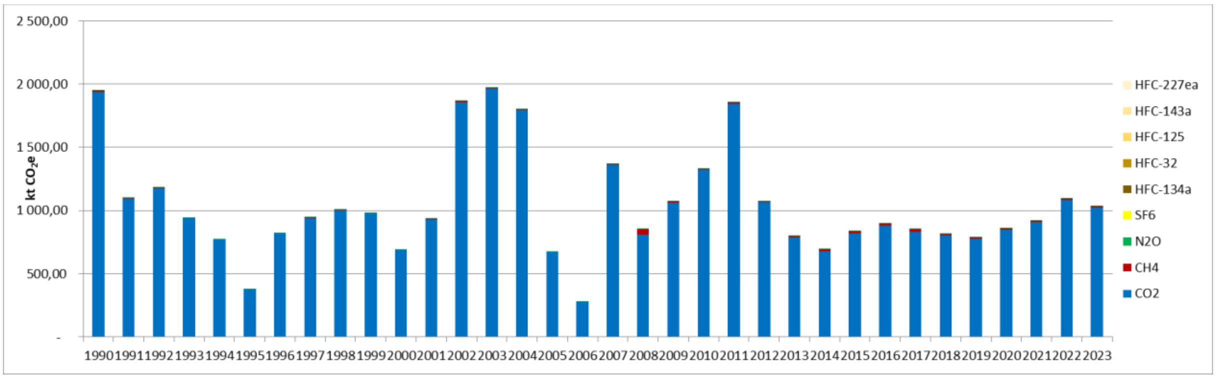
3.2.8.1 Commercial/institutional (CRT 1A4a)

3.2.8.1.1 Category description

This category refers to GHG emissions due to the combustion of fuels in commercial and institutional equipment (stationary and mobile). These sources use different types of fuels and emit significant amounts of greenhouse gases and air pollutants.

In 2023, the commercial/institutional category is a key category for CO_2 emissions in the Republic of Serbia, both in emission levels and trends. In terms of emission level, this sector contributes 0.9% with the gaseous fuel combustion (rank 16), 0.5% with solid fuels (rank 25) and 0.3% with liquid fuel combustion (rank 39). In terms of emissions trend, CO_2 emissions are key categories for the combustion of liquid fuels with a contribution of 3.5% (rank 8), and gaseous fuels with a contribution of 2.2% (rank 12).

Figure 21: GHG emissions for commercial and institutional (CRT 1A4a), for the period 1990-2023 (in kt CO_2e)



Fuel consumptions for mobile and stationary equipment are considered in this category. However, it is not possible to split the consumption between the two types of equipment, hence all consumptions are considered in stationary equipment.

In 2023, this sector mainly consumes natural gas (63%), lignite (17%), heavy fuel oil (7%),, solid biofuels (5%) and LPG (4%). In 1990, residual fuel oil (73%), lignite (17%) LPG (6%) and other bituminous coal (4%) were consumed, highlighting the significant change in the energy mix over the period. Due to the development of natural gas and, to another extent, biomass, replacing higher carbon content fuels such as lignite and fuel oil, the tertiary sector's GHG implied emission factor has been significantly reduced, decreasing from 86 to 64 kg/GJ.

Finally, in 2023, three subcategories from the CRT 1A4a are key categories in emission levels and trend :

- 1A4a – liquid fuel: rank 40 (0.3%) in level and rank 8 (3.5%) in trend;
- 1A4a – solid fuel: rank 26 (0.5%) in level and rank 52 (0.4%) in trend;
- 1A4a – gaseous fuel: rank 16 (0.9%) in level and rank 12 (2.2%) in trend.

3.2.8.1.2 Methodological issues

Emissions of GHG from fuels are calculated on the basis of the fuel consumption using Tier 1 (top-down) approach, which is in line with the 2006 IPCC Guidelines [E10].

Activity data used are fuel consumptions by type of fuel. Amounts of all types of fuels consumed for the whole timeseries are extracted from the national energy balance [E2], as well as NCV values, which are given in Chapter 3.2.4.

Emissions factors used for calculating CO_2, CH_4 and N_2O emissions from fuels come from 2006 IPCC guidelines [E3]. CO_2 emission factors applied are given in Chapter 3.2.4.

3.2.8.2 Residential (1A4b)

3.2.8.2.1 Category description

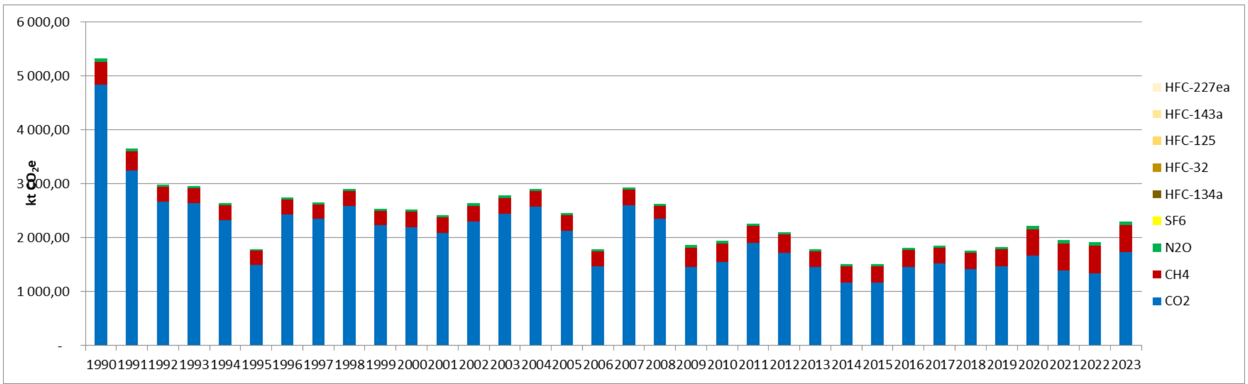
This category refers to GHG emissions due to the combustion of fuels in residential equipment (stationary and mobile). These sources use different types of fuels and emit significant amounts of greenhouse gases and air pollutants.

In 2023, the category residential is a key category for CO_2 and CH_4 emissions in the Republic of Serbia, both in terms of emission level and trend. Here is a summary of the categories which are considered as key categories for this subsector:

Table 21: Key categories in level and trend for the Residential combustion, in 2023, excluding LULUCF

CRT category/fuel/substance	Key category in level ranking (% of contribution)	Key category in trend ranking (% of contribution)
1.A.4.b Residential combustion/gaseous fuels/CO_2	11 (1.1%)	6 (4.0%)
1.A.4.b Residential combustion/solid fuels/CO_2	7 (1.5%)	9 (3.1%)
1.A.4.b Residential combustion/biomass/CH_4	18 (0.8%)	32 (0.8%)

Figure 22 : GHG emissions for residential (CRT 1A4b) activities, for the period 1990-2023 (in kt CO_2e)



Activity data come directly from the national energy balance. The energy mix is composed of sub-bituminous coal, lignite, brown coal briquettes, natural gas, biomass, LPG and diesel oil. Over the entire period, the fuel consumption of this subsector has decreased by 27%. However, it was relatively stable between 1992 and 2019, before knowing a rather important increase in the latest years (+49% between 2019 and 2023), mostly linked with an increase in biomass consumption (+64%) and, to a lesser extent, natural gas (+43%).

In terms of GHG emissions, the trend follows mostly the subsector fossil fuel consumption (corresponding to the CO_2 emissions, in blue in the above figure – as CO_2 from biomass combustion is not accounted in CRT 1A). Therefore, there is a decorrelation between total fuel consumption and GHG emissions, although methane emissions related to biomass combustion in small equipment are not negligible. This can be observed in the evolution of the GHG implied residential combustion emission factor which decreases from 47 kg/GJ in 1990 to 28 kg/GJ in 2023. The significant reduction is also the result from the drop in solid fuel consumption in this sector (-60% between 2023 and 1990).

Fuel consumptions for both mobile and stationary combustion equipment are considered in this category. However, it is currently not possible to split the consumptions between the two types of equipment then all consumptions are considered in stationary equipment.

In 2023, the energy mix of the subsector is as follows: solid biomass (72%), natural gas (15%), lignite (8%), brown coal briquettes (4%) and LPG (2%). It should be noted that consumption of lignite has increased by 132% in 2023 compared with 2022.

3.2.8.2.2 Methodological issues

Emissions of GHG from fuels are calculated on the basis of the fuel consumption using Tier 1 (top-down) approach, which is in line with the 2006 IPCC Guidelines [E10].

Activity data used are fuel consumptions by type of fuel. Amounts of all types of fuels consumed for the whole timeseries are given in the national energy balance [E2], as well as NCV values, which are given in Chapter 3.2.4.

Emissions factors used for calculating CO_2, CH_4 and N_2O emissions from fuels come from 2006 IPCC guidelines [E3]. CO_2 emission factors applied are given in Chapter 3.2.4.

3.2.8.3 Agriculture/forestry/fishing (CRT 1A4c)

3.2.8.3.1 Category description

This category refers to GHG emissions due to the combustion of fuels in the sector of agriculture/forestry/fishing. This main category is split in two sub-sectors: stationary equipment (CRT 1.A.4.c.i) and off-road vehicles & other machineries (CRT 1.A.4.c.ii). These sources use different types of fuels and emit significant amounts of greenhouse gases and air pollutants. It should be noted that fuel consumption in the fishing sector is included in the categories 1.A.4.c.i and 1.A.4.c.ii.

The subcategory of off-road vehicles & other machineries (1A4cii) is a key category in 2023 for CO_2 emissions from liquid fuels, both in terms of emission levels and trend. It contributes to 0.4% in terms of CO_2 emissions level (rank 31) and 0.9% in terms of emission trend (rank 27).

Figure 23 : GHG emissions for agriculture/forestry/fishing activities - stationary combustion (CRT 1A4ci), for the period 1990-2023 (in kt CO_2e)

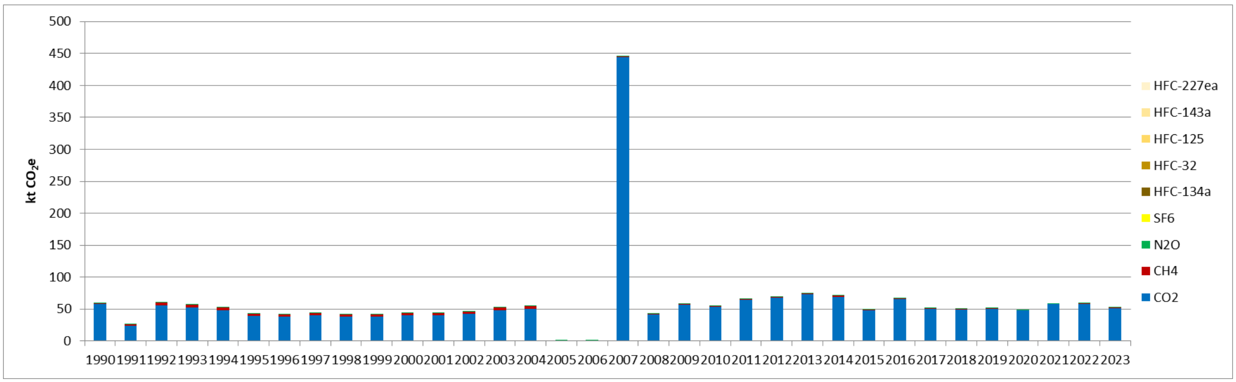
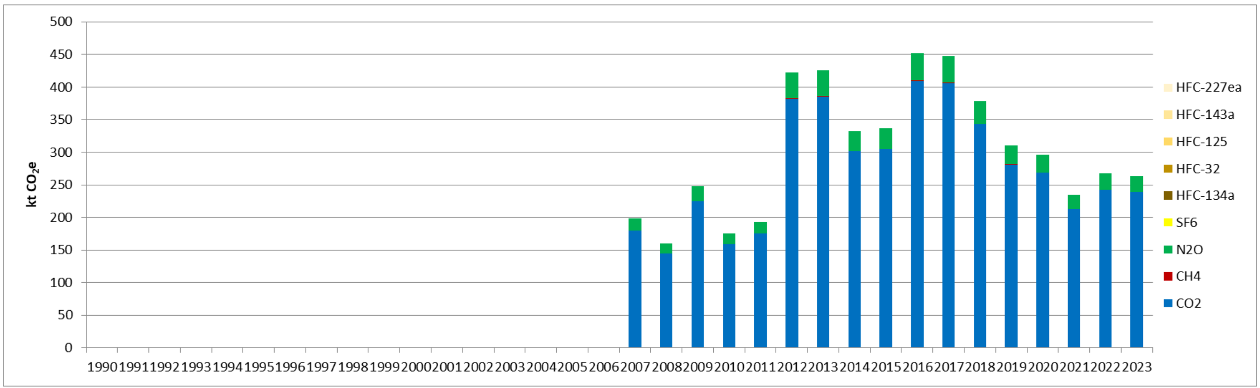


Figure 24 : GHG emissions for agriculture/forestry/fishing activities – mobile combustion (CRT 1A4cii), for the period 1990-2023 (in kt CO_2e)



The activity data come directly from the national energy balance. As observed in the two graphs, the time-series is not consistent due to changes in methodological choices and information over time. From 1990 to 2006, fuel consumptions for off-road were considered in another category before additional information was made available and enable the split for consumptions between stationary and off-road.

In 2023, the stationary subsector mainly consumes natural gas (75%), solid biomass (8%) and LPG (17%), whereas only diesel oil is considered for the off-road subsector.

3.2.8.3.2 Methodological issues

Emissions of GHG from fuels are calculated on the basis of the fuel consumption using Tier 1 (top-down) approach, which is in line with the 2006 IPCC Guidelines [E10].

Activity data used are fuel consumptions by type of fuel. Amounts of all types of fuels consumed for the whole timeseries are taken from the national energy balance [E2], as well as NCV values, which are given in Chapter 3.2.4.

Emissions factors used for calculating CO_2, CH_4 and N_2O emissions from fuels come from 2006 IPCC guidelines [E3]. CO_2 emission factors applied are given in Chapter 3.2.4.

3.2.8.4 Uncertainties and time-series consistency

Activity data

In 2022, the uncertainty estimate associated with activity data for category 1A4-Other sectors is 10%, based on 2006 IPCC Guidelines [E5].

CO_2

Uncertainty estimate associated with CO_2 default emission factor for category 1A4-Other sectors is 7%, accordingly to values reported in 1996 IPCC Guidelines [E6].

Combined uncertainty for CO_2 emissions is 0.7% in the total national levels of emission in 2023, excluding LULUCF contribution.

CH_4

Uncertainty estimate associated with CH_4 default emission factor for category 1A4-Other sectors is 100%, accordingly to values reported in 2006 IPCC Guidelines [E7].

Combined uncertainty for CH_4 emissions is 0.9% in the total national levels of emission in 2023, excluding LULUCF contribution.

N_2O

Uncertainty estimate associated with N_2O default emission factor for category 1A4-Other sectors is 100%, accordingly to a conservative assumption.

Combined uncertainty for N_2O emissions is 0.17% in the total national levels of emission in 2023, excluding LULUCF contribution.

3.2.8.5 Category-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on proper use of notation keys in the CRT tables according to QA/QC plan.

3.2.8.6 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission of November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	7 086	2 066	3 169	3 056	3 506	4 378	3 668	3 086	2 607	2 738	3 232	3 204	2 998	2 970	3 419	3 174	3 340	0
Nouveau	kt CO2e	7 329	2 212	3 256	3 127	3 506	4 378	3 668	3 086	2 607	2 738	3 232	3 204	2 998	2 970	3 419	3 174	3 340	3 654
Différence	kt CO2e	+243	+146	+87	+72	0	0	0	0	0	0	0	0	0	0	0	0	0	+3 654
	%	+3,4%	+7,1%	+2,7%	+2,3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 1.A.4

<u>**1A4a – Commercial and public services**</u>

For the year 1990, the consumption of other bituminous coal from the energy balance has been added.

<u>**1A4b – Residential**</u>

For the period 1990-2007, the consumptions of other kerosene from the energy balance have been added, which imply a recalculation of 156 kt CO2 in 1990, and peaks at +463 kt CO2 in 1996.

1A4c – Agriculture, forestry and fishing

No recalculation

3.2.8.7 Category-specific planned improvements

The completeness and consistency of the energy consumptions from the energy balance could be improved, in particular for the agriculture/forestry (1A4c) sector. To do so, discussions with experts from the Ministry of Mines and Energy, which develop the energy balances, need to be engaged.

3.3 Fugitive emissions from solid fuels and oil and natural gas and other emissions from energy production (CRT 1.B)

3.3.1 Category description

Intentional or unintentional release of greenhouse gases may occur during the extraction, processing and delivery of fossil fuels to the point of final use. These are known as fugitive emissions.

In the Republic of Serbia, there are fugitive emissions associated with:

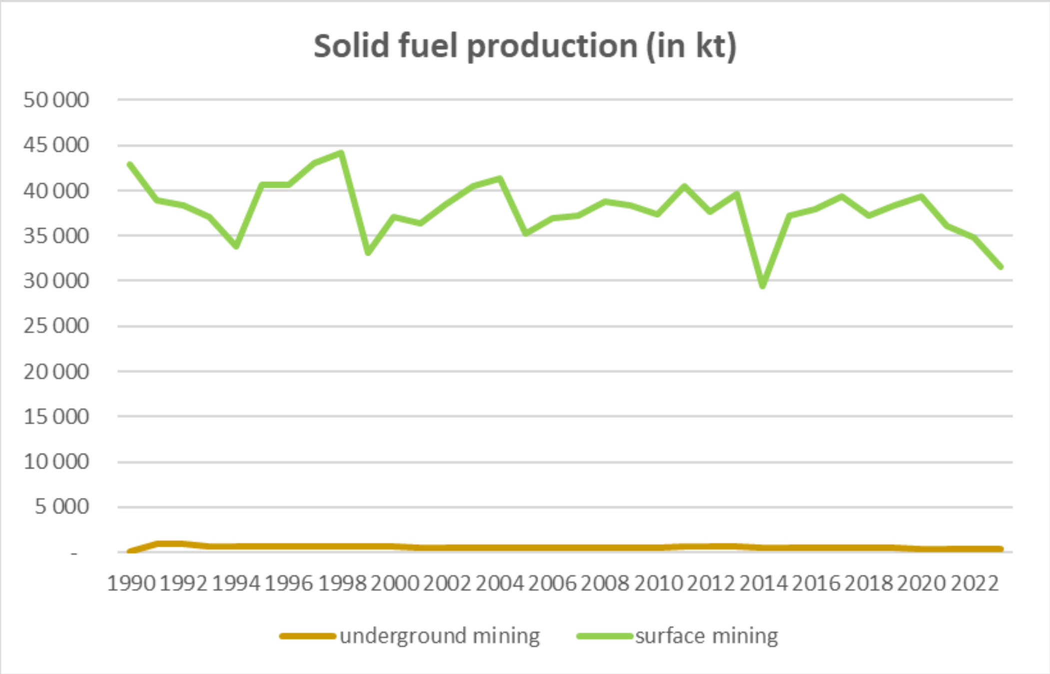
- Coal mining and handling: mining activities in underground and surface mines, post-mining emissions and emissions from abandoned underground mines,
- Oil systems: production and upgrading of oil, transport of oil, venting and flaring,
- Natural gas systems: production of natural gas, processing of natural gas, transmission and storage of natural gas, distribution of natural gas, venting and flaring.

The following graphs present the evolution of the main activities of the different subsectors of the fugitive emissions:

- Solid fuels (CRT 1B1): amounts of solid fuels produced in underground and surface mines;
- Liquid fuels (CRT 1B2a): amounts of crude oil produced and transported;
- Gaseous fuels (CRT 1B2b): amounts of gas produced, transported (high-pressure pipeline system) and distributed (low-pressure pipeline system).

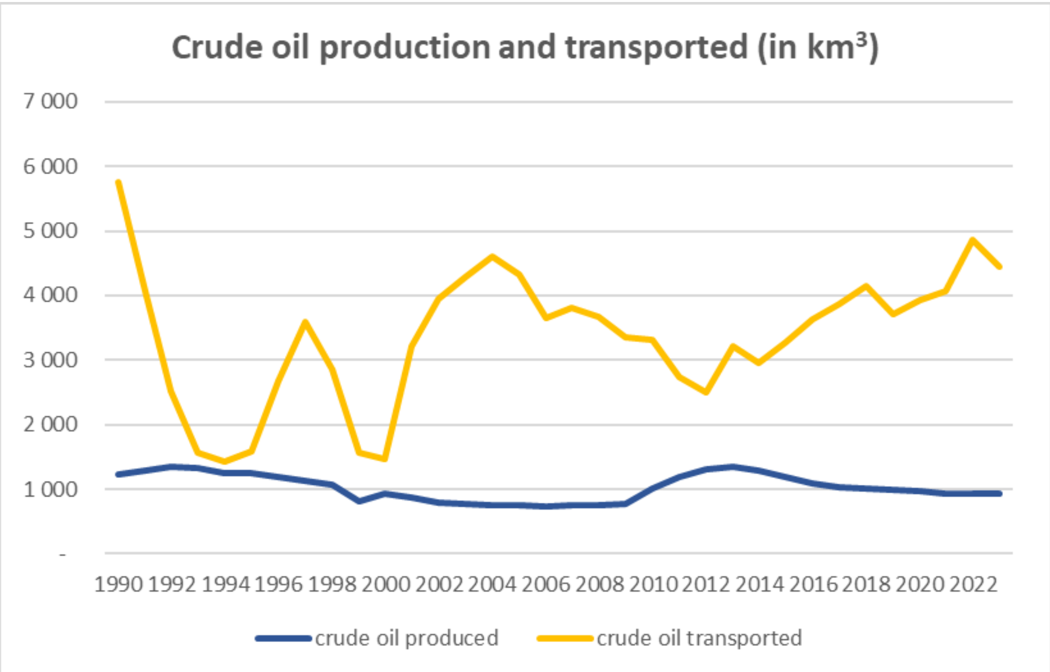
N.B: in the following graphs, the trend lines are all displayed independently and not aggregated or combined with each other.

Figure 25: Evolution of the solid fuel production in Serbia, distinguished with underground and surface mining, for the period 1990-2023 (in kt)



For the mining of solid fuels, it can be observed that most of the production occurs in surface mines. The overall production has been reduced by 26% between 1990 and 2022. The evolution of the trend corresponds with the various events evoked in Chapter 3.1, with a first decrease observed during the hyperinflation period (1992-1994), followed by a drastic drop during the NATO bombing in (1999), and then during the 2014 floods. In the most recent years, a decreasing trend can be observed (-19% between 2020 and 2023), related to the smaller use of this fuel in the electricity production, but also in industrial, commercial and residential use. However, a rather large amount is still produced as it remains the main fuel used for electricity production.

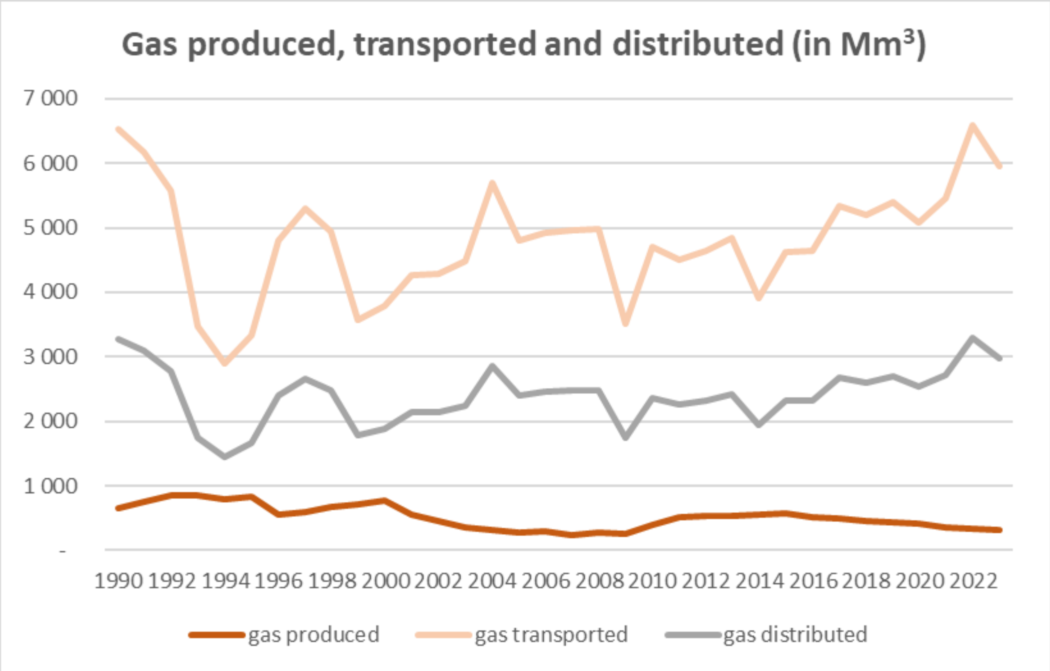
Figure 26: Evolution of the amounts of crude oil produced and transported, for the period 1990-2023 (in km^3)



The amount of crude oil produced in the Republic of Serbia is relatively stable for the period 1990-2023. A sudden reduction can be observed in 1999 during the NATO bombing. Then, a significant increase has been observed from 2010 to 2012, following the global economic crisis of 2009. Since 2013, a slow but progressive declining trend can be observed, with a 31% decrease in crude oil production.

The trend of the amounts of crude oil transported in the Republic of Serbia is much more instable and follows the evolution of the amount of crude oil treated, as presented in Chapter 3.2.5.2.1.

Figure 27: Evolution of the amounts of gas produced, transported and distributed, for the period 1990-2023 (in Mm³)



The evolution of the trends of gas transported and distributed are rather similar and show a relative progressive increase in the most recent years although there was a decrease of 10% in 2023 compared with 2022. This is coherent with the evolution of the fuel consumptions observed for the latest years, in particular in electricity production and residential heating. The trendline for the period 1990-2014 follows the list of events described in Chapter 3.1 and other subchapters.

The amount of gas produced on the Serbian territory is rather small compared with the amount of gas transported, and represents 10% in 1990 and 5% in 2023. Despite the increasing volume of transported and distributed (i.e., consumed) gas, gas production has been in a steady decline since 2015 (-51% in 2023 compared with 1990).

In 2023, the different categories from the Fugitive sector which are key categories in the Republic of Serbia, either in terms of levels or trend of emissions, are as follows:

Table 22: Key categories in level and trend for the Fugitive sector (CRT 1B), in 2023, excluding LULUCF

CRT category/fuel/substance	Key category in level rank (% of contribution)	Key category in trend rank (% of contribution)
1.B.1 Fugitive emissions from solid fuels/CH_4	8 (1.5%)	50 (0.4%)
1.B.2.a.2 Fugitive emissions from Oil systems /Production and upgrading/CH_4	10 (1.3%)	
1.B.2.b.5 Fugitive emissions from Natural gas /Distribution/CH_4	42 (0.2%)	
1.B.2.c.2.i Fugitive emissions from Oil systems /Flaring/CO_2		4 (4.2%)

The following graphs present the evolution of GHG emissions for the different subcategories from the Fugitive sector.

In the two following figures, related to the mining and post-mining activities in underground mines, only methane emissions are estimated and the trend follows exactly the evolution of the amount of solid fuel mined from underground mines, as presented previously, as a constant emission factor is applied. The emissions are very low in 1990, and very high in 1991-1992, but since 1993 are rather stable, although an overall declining trend can be observed. For the period 1993-2023, the amounts of solid fuel mined, and hence the associated methane emissions, have been reduced by 49%.

Figure 28 : GHG emissions from mining in underground mines – COAL (CRT 1B1a1i) (kt CO_2e)

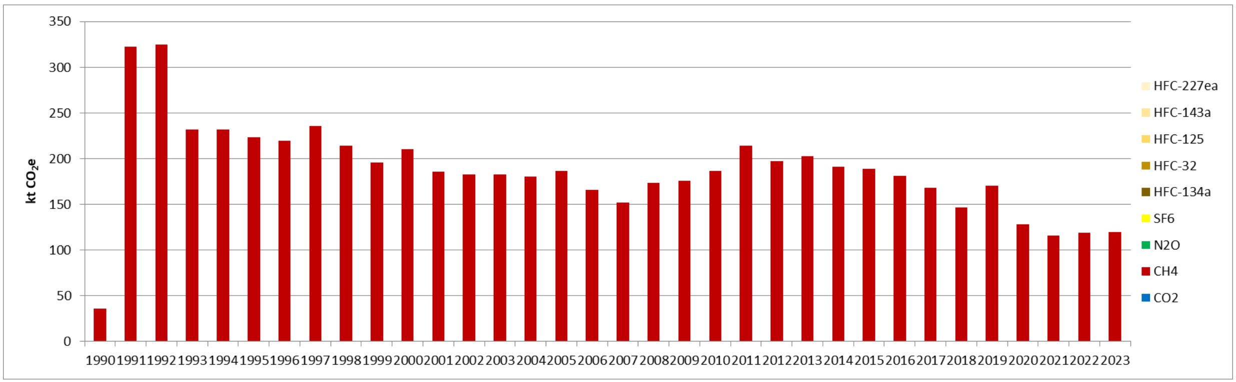
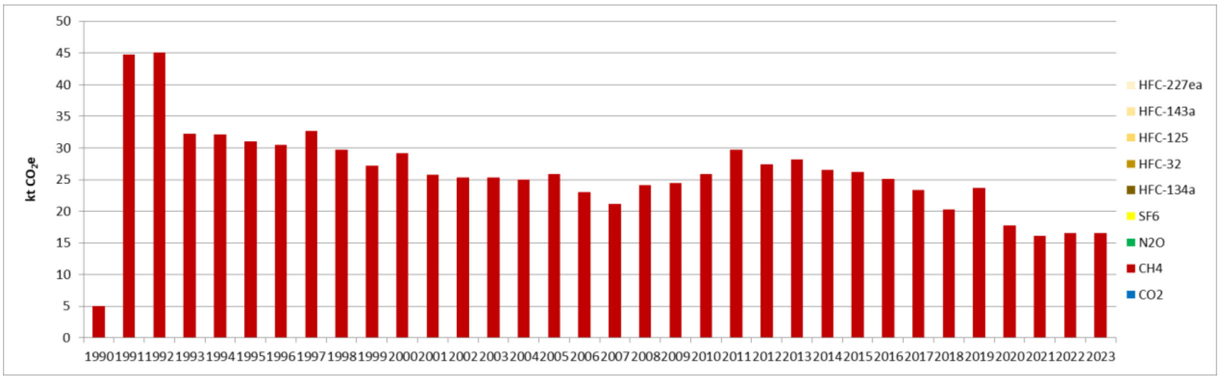
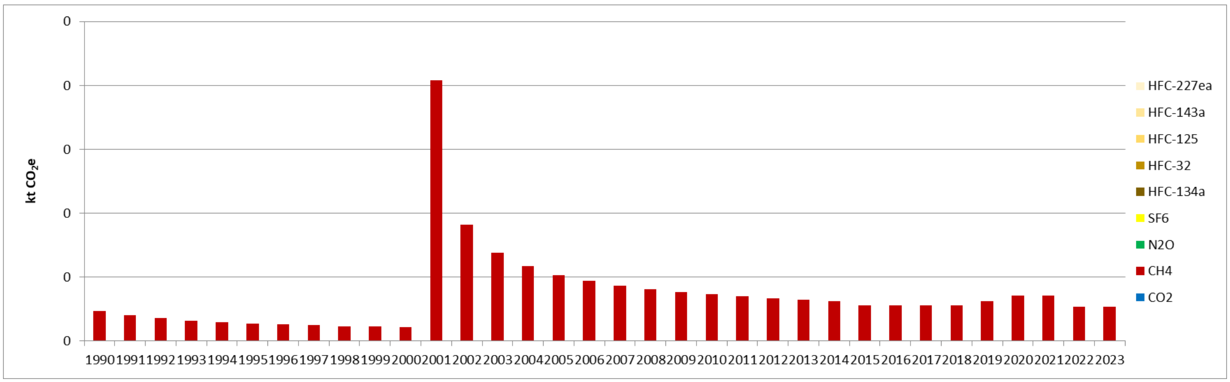


Figure 29 : GHG emissions from post-mining in underground mines - COAL (CRT 1B1a1ii) (kt CO_2e)



The emissions related to the abandoned underground mines are almost negligible. The jump in 2001 is related to the fact that two additional mines were abandoned this year, making the total number to 3.

Figure 30 : GHG emissions from abandoned underground mines - COAL (CRT 1B1a1iii) (kt CO_2e)



The GHG emissions from mining and post-mining in surface mines are directly proportional to the evolution of the amounts of coal mined as a constant EF is applied for this subsector. Therefore, the trend evolves accordingly to the description of the activity data given above for

Figure 25. The methane emissions have been reduced by 26% for the period 1990-2023.

Figure 31 : GHG emissions from mining in surface mines - COAL (CRT 1B1a2i) (kt CO_2e)

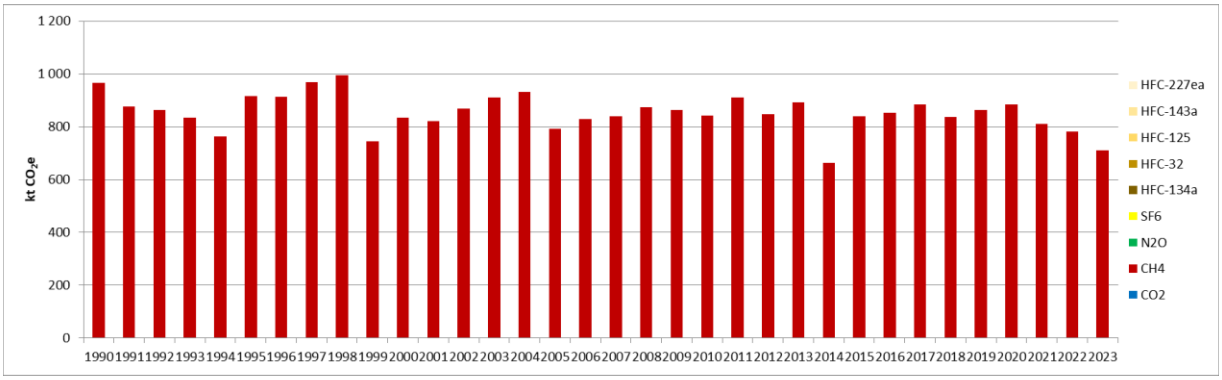


Figure 32 : GHG emissions from post-mining in surface mines - COAL (CRT 1B1a2ii) (kt CO_2e)

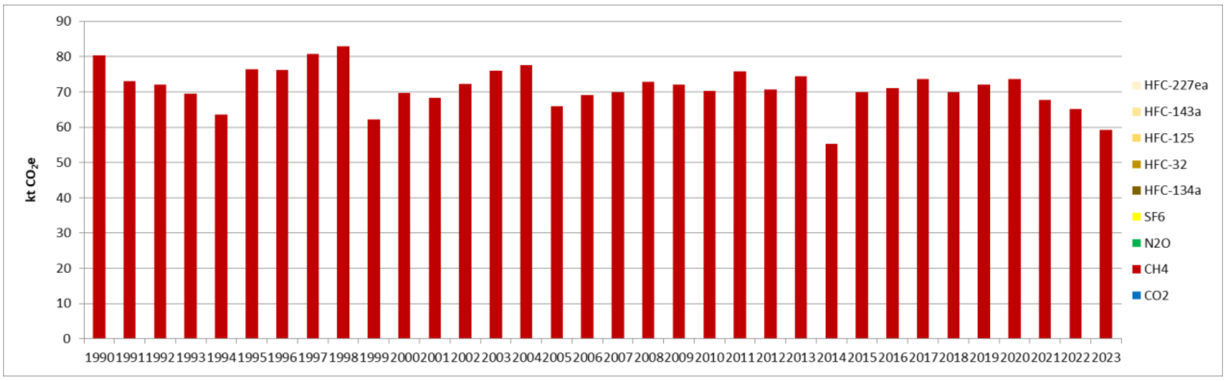
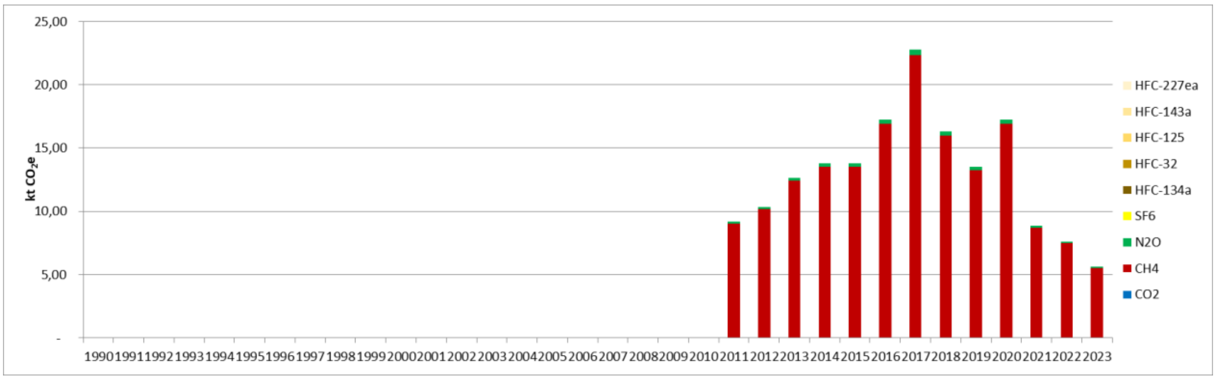
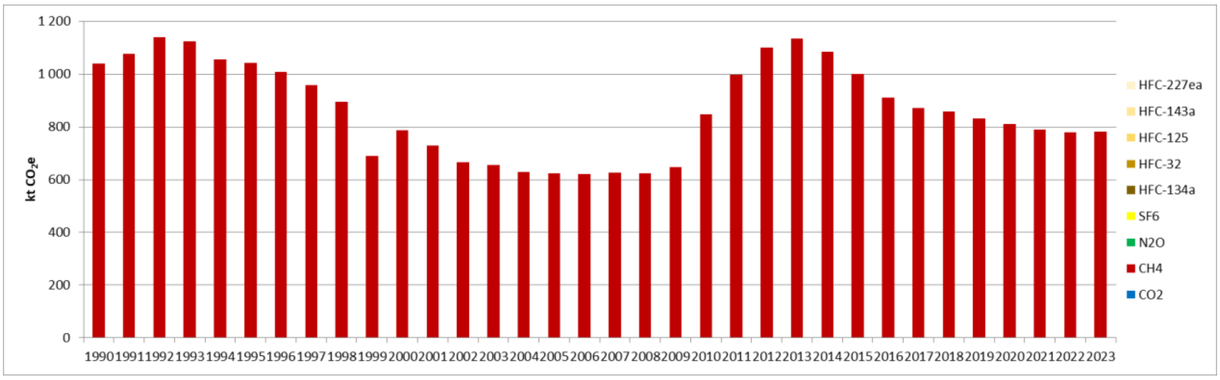


Figure 33 : GHG emissions from solid fuel transformation – charcoal production (CRT 1B1b) (kt CO_2e)



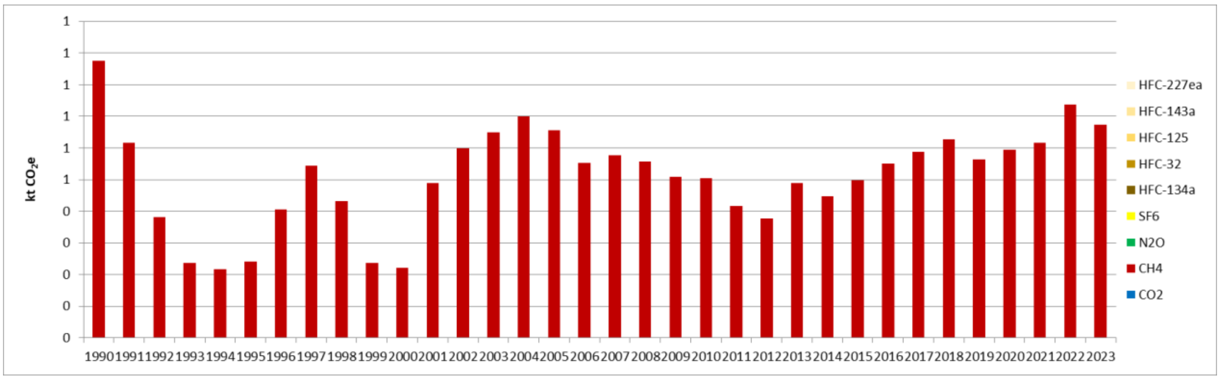
The following graph presents the evolution of GHG emissions for the production and upgrading of crude oil, which is directly proportional to the crude oil production presented in Figure 26. For the entire period, the methane emissions have been decreased by 25%.

Figure 34 : GHG emissions from production and upgrading of OIL (CRT 1B2a2) (kt CO_2e)



The graph hereafter represents the GHG emissions trend related to the transport of crude oil, which evolve proportionally to the amounts of crude oil transported as presented in Figure 26. The evolution up until 2005 is relatively similar to other trends observed in the Energy sector, with more or less rapid declines during the hyperinflation period (1992-1994) and the NATO bombing, followed by recovery periods where similar levels to the pre-crisis period occur. In addition, for the transport of oil, the amounts of crude oil transported follows the amounts of intake into oil refineries as presented in Figure 8. For the period 2005-2022, it can be seen there is first a progressive decline until 2012, with a reduction of 42% between 2005 and 2012. Then, it is follows by an increasing trend of the amount of oil transported from 2012 to 2022, where it almost doubled in that period, although there are some inflexion points during the 2014 floods as well as in 2019. The level reached in 2022 is the second highest observed in the timeseries after the year 1990, in accordance with the recent further development of the oil refining activity. The emissions experienced a decrease in 2023 (-9% compared with 2022).

Figure 35 : GHG emissions from transport of OIL (CRT 1B2a3) (kt CO_2e)



The two following graphs present the fugitive GHG emissions related to the production and processing of gas, which follow the evolution of the amounts of gas produced over the territory as presented in Figure 36. In the most recent years, a decline is observed, and the activity (hence the GHG emissions) are half the levels they were in 1990.

Figure 36 : GHG emissions from production of NATURAL GAS (CRT 1B2b2) (kt CO_2e)

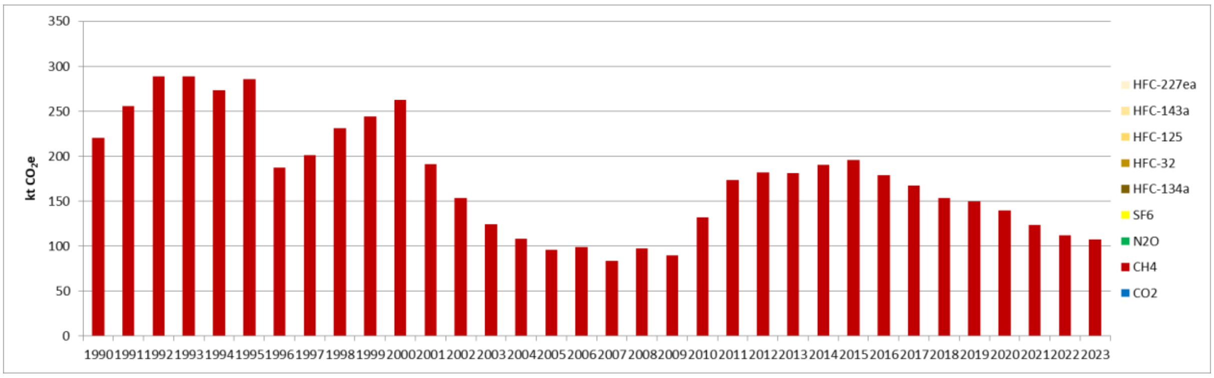
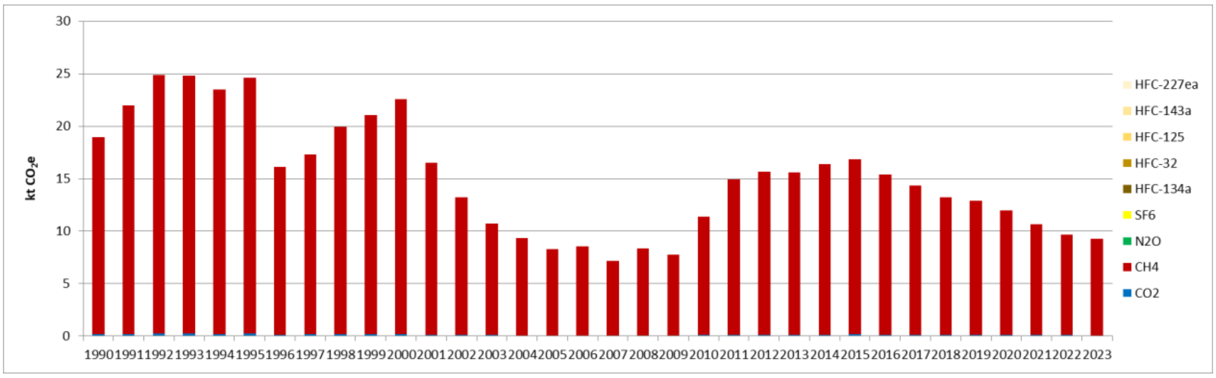


Figure 37 : GHG emissions from processing of NATURAL GAS (CRT 1B2b3) (kt CO_2e)



The two following graphs present the trend of the GHG emissions of the transmission and storage and the distribution of natural gas. They evolve respectively according to the volume of gas transported and distributed, which have similar trends as presented in Figure 27. Contrary to the production of gas, the activity (i.e., the consumption of gas) has been intensifying, in correlation with the most recent development of natural gas in electricity production and residential combustion, in the light of the will to substitute partly and progressively solid fuels.

Figure 38 : GHG emissions from transmission and storage of NATURAL GAS (CRT 1B2b4) (kt CO_2e)

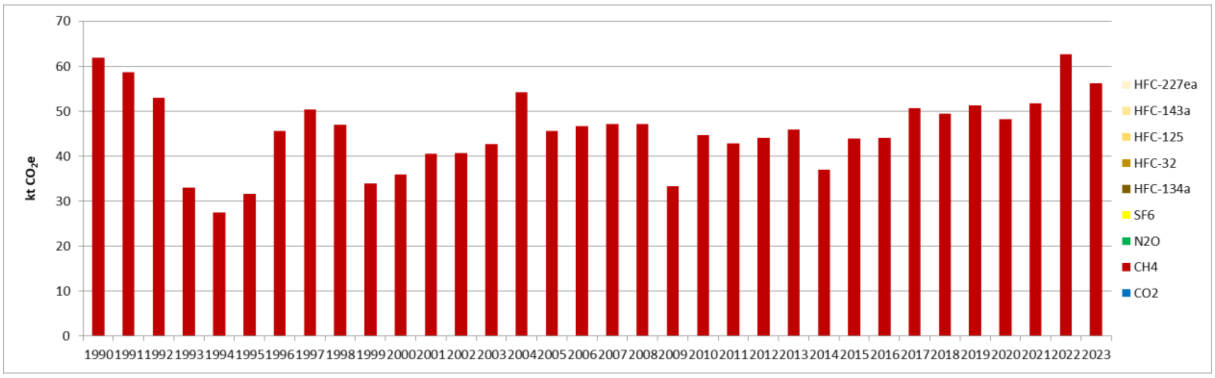
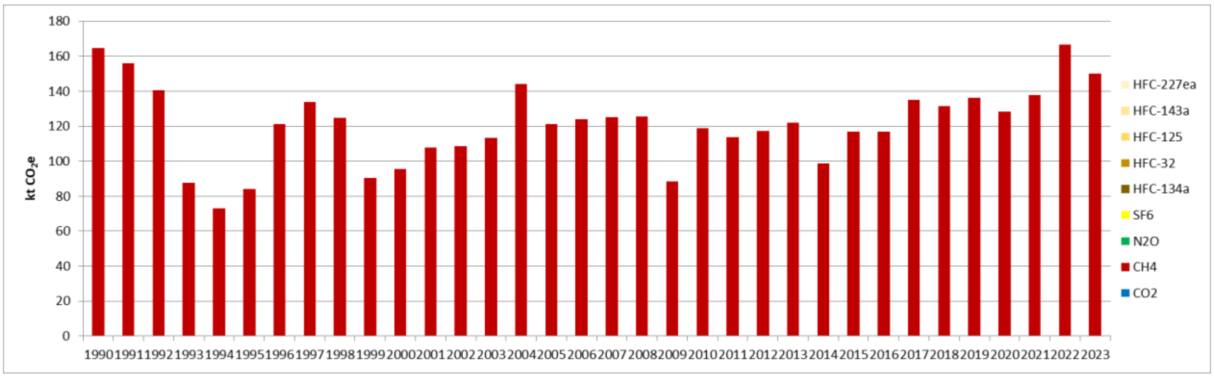
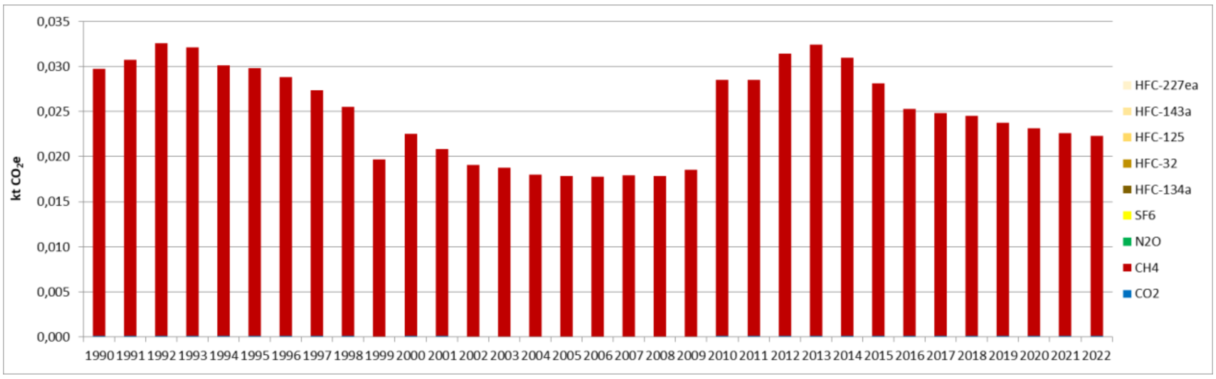


Figure 39 : GHG emissions from distribution of NATURAL GAS (CRT 1B2b5) (kt CO_2e)



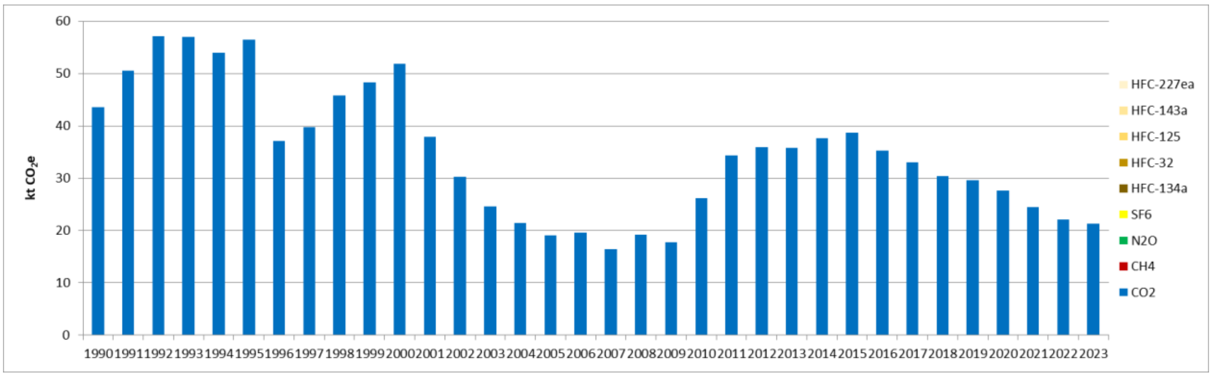
The following graph presents the GHG emissions related to the venting in oil systems, which are rather negligible, and follow the production of crude oil, as presented in Figure 26.

Figure 40 : GHG emissions from venting in OIL systems (CRT 1B2c1i) (kt CO_2e)



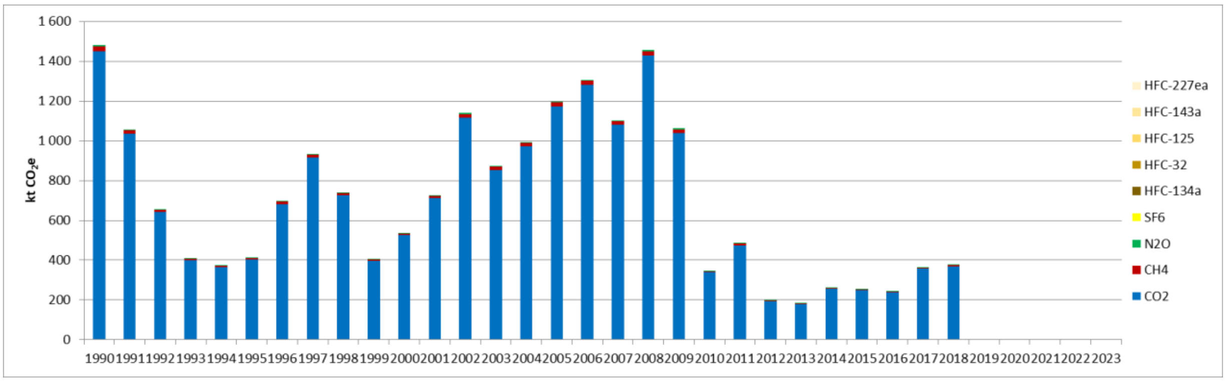
The next graph depicts the trend of the GHG emissions from venting in natural gas production to distribution system, which are proportional to the volume of gas produced, as presented in Figure 27.

Figure 41 *: GHG emissions from venting in NATURAL GAS systems* (CRT 1B2c1ii) (kt CO_2e)



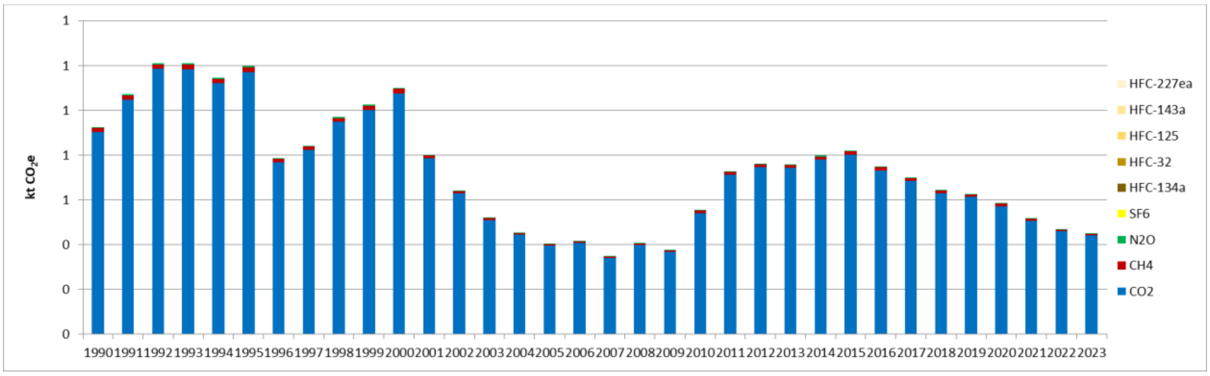
The following graph presents the GHG emission evolution associated with the flaring in oil systems, which evolve according to the amounts of gas flared in oil refineries. Until 2005, the GHG emissions evolve in a similar way as the amounts of crude oil treated in refineries, as presented in Figure 8.

Figure 42 : GHG emissions from flaring in OIL systems (CRT 1B2c2i) (kt CO_2e)



Finally, the last graph describes the trend of the GHG emissions from flaring in natural gas production to distribution system, which evolves according to the volume of gas produced, as presented in Figure 27. Since 2008, where the level was equal to the level of 1990, a rapid decline has been observed until 2010, where it became rather stable and to lower emission levels than what could be observed over the whole timeseries. Since 2019, the oil refinery of Novi Sad became Tank farm Novi Sad and no more flaring occurs.

Figure 43 : GHG emissions from flaring in NATURAL GAS systems (CRT 1B2c2ii) (kt CO_2e)



3.3.2 Methodological issues

Emissions of GHG for fugitive emissions are calculated based on the 2006 IPCC Guidelines [E12].

Activity data used is different regarding the sub-categories and are summarized in the following table:

CRT code	Activity data considered	Reference
1.B.1.a.1.i – Mining in underground mines	Underground production of lignite	Serbian Energy Balance of Coal (1990-2023)
1.B.1.a.1.ii – Post-mining in underground mines	Underground production of lignite	Serbian Energy Balance of Coal (1990-2023)
1.B.1.a.1.iii – Abandoned underground mines	Number of abandoned underground mines	Mine Kovin, mine Resavica
1.B.1.a.2.i – Mining in surface mines	Surface production of lignite	Serbian Energy Balance of Coal (1990-2023)
1.B.1.a.2.ii – Post-mining in surface mines	Surface production of lignite	Serbian Energy Balance of Coal (1990-2023)
1.B.1.b – Solid fuel transformation	Charcoal production	Serbian Energy Balance of Biomass (1990-2023)
1.B.2.a.2 – Production and upgrading of oil	Production of Crude Oil / density (860 kg/m^3)	Serbian Energy Balance of Oil (1990-2023)
1.B.2.a.3 – Transport of oil	Production and import of Crude Oil / density (860 kg/m^3)	Serbian Energy Balance of Oil (1990-2023)
1.B.2.b.2 – Production of natural gas	Production of Natural gas	Serbian Energy Balance of Natural gas (1990-2023)
1.B.2.b.3 – Processing of natural gas	Production of Natural gas	Serbian Energy Balance of Natural gas (1990-2023)
1.B.2.b.4 – Transmission and storage of natural gas	Production and import of Natural gas	Serbian Energy Balance of Natural gas (1990-2023)
1.B.2.b.5 – Distribution of natural gas	Production, import and export of Natural gas	Serbian Energy Balance of Natural gas (1990-2023)
1.B.2.c.1.i – Venting in oil systems	Production of Crude Oil / density (860 kg/m^3)	Serbian Energy Balance of Oil (1990-2023)
1.B.2.c.1.ii – Venting in natural gas systems	Production of Natural gas	Serbian Energy Balance of Natural gas (1990-2023)
1.B.2.c.2.i – Flaring in oil systems	Volume of gas flared, Crude oil (Refinery intake)	Serbian oil industry, Serbian Energy Balance of Oil (1990-1999)
1.B.2.c.2.ii – Flaring in natural gas systems	Production of Natural gas	Serbian Energy Balance of Natural gas (1990-2023)

Emissions factors used for calculating CO_2, CH_4 and N_2O emissions from fuels come from the 2006 IPCC guidelines [E12]. For the solid fuel transformation, the emission factors for CO_2 biomass (i.e., memo), CH_4 and N_2O come from the 2019 IPCC guidelines.

3.3.3 Uncertainties and time-series consistency

1B1-Solid fuels fugitives

Activity data

In 2023, the uncertainty estimate associated with activity data for category 1B1-Solid fuels fugitives is 5%, based on expert judgement.

CH_4

Uncertainty estimate associated with CH_4 default emission factor for category 1B1-Solid fuels fugitives is 20%, based on expert judgement.

Combined uncertainty for CH_4 emissions is 0.3% in the total national levels of emission in 2023, excluding LULUCF contribution.

N_2O

Uncertainty estimate associated with N_2O default emission factor for category 1B1-Solid fuels fugitives is 20%, as default the same as for CH_4.

Combined uncertainty for N_2O emissions is 0.00003% in the total national levels of emission in 2023, excluding LULUCF contribution.

1B2-Oil and natural gas fugitives

Activity data

In 2023, the uncertainty estimate associated with activity data for category 1B2-Oil and Natural gas fugitives is 10%, based on the 2006 IPCC Guidelines [E5].

CO_2

Uncertainty estimate associated with CO_2 default emission factor for category 1B2-Oil and Natural gas fugitives is 2%, based on expert judgement.

Combined uncertainties for CO_2 emissions are 0.0004% for 1B2a and 0.004% for 1B2b, in the total national levels of emission in 2023, excluding LULUCF contribution.

CH_4

Uncertainty estimate associated with CH_4 default emission factor for category 1B2-Oil and Natural gas fugitives is 100%, accordingly to values reported in 2006 IPCC Guidelines [E7].

Combined uncertainties for CH_4 emissions are 1.41% for 1B2a and 0.57% for 1B2b in the total national levels of emission in 2023, excluding LULUCF contribution.

N_2O

Uncertainty estimate associated with N_2O default emission factor for category 1B2-Oil and Natural gas fugitives is 100%, accordingly to a conservative assumption.

Combined uncertainties for N_2O emissions are null for 1B2a and 1B2b, as the emissions in 2023 are null, in the total national levels of emission, excluding LULUCF contribution.

3.3.4 Category-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on proper use of notation keys in the CRT tables according to QA/QC plan.

3.3.5 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission of November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	4 121	3 189	2 939	3 185	2 654	3 096	2 837	2 920	2 661	2 791	2 676	2 786	2 688	2 344	2 271	2 152	2 143	0
Nouveau	kt CO2e	4 121	3 189	2 939	3 185	2 654	3 105	2 847	2 933	2 675	2 805	2 693	2 809	2 704	2 358	2 288	2 161	2 146	2 060
Différence	kt CO2e	0	0	0	0	0	+9,2	+10	+13	+14	+14	+17	+23	+16	+14	+17	+8,8	+2,6	+2 060
	%	0%	0%	0%	0%	0%	+0,3%	+0,4%	+0,4%	+0,5%	+0,5%	+0,6%	+0,8%	+0,6%	+0,6%	+0,8%	+0,4%	+0,1%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 1.B

<u>1B1a – Underground mines</u>:

Emissions from Abandoned underground mines were included for 2022.

1B1b – Solid fuel transformation:

For the period 2011-2022, CH_4 and N_2O emissions from charcoal production have been estimated (transfer from 1A1c because in the previous submission, emissions were considered for energy-use of solid biomass).

<u>1B2b – Natural gas</u>:

The emission factor was corrected for the subcategory *Natural gas processing (1B2biii)*.

3.3.6 Category-specific planned improvements

One of the main improvements to be considered in the future submissions is to use the 2019 IPCC Refinement with the most recent methodologies for the Fugitive sector.

In addition, another improvement will be to collect data for gas flared and vented from operators in different steps of the fuel production (oil refineries, oil and gas extraction fields, coal fields, etc.).

Chapter 4: Industrial processes and product use (CRT sector 2)

Note: Unless stated otherwise, all results discussed in the sectorial chapters consider national totals, excluding indirect CO_2 emissions.

4.1 Overview of sector

This CRT 2 category covers all the industrial activities where the industrial process can imply GHG emissions which do not result from the combustion of fuels, as well as the use of industrial products such as lubricants, fluorinated gases and others. In overall, in the Republic of Serbia, the following sectors are covered:

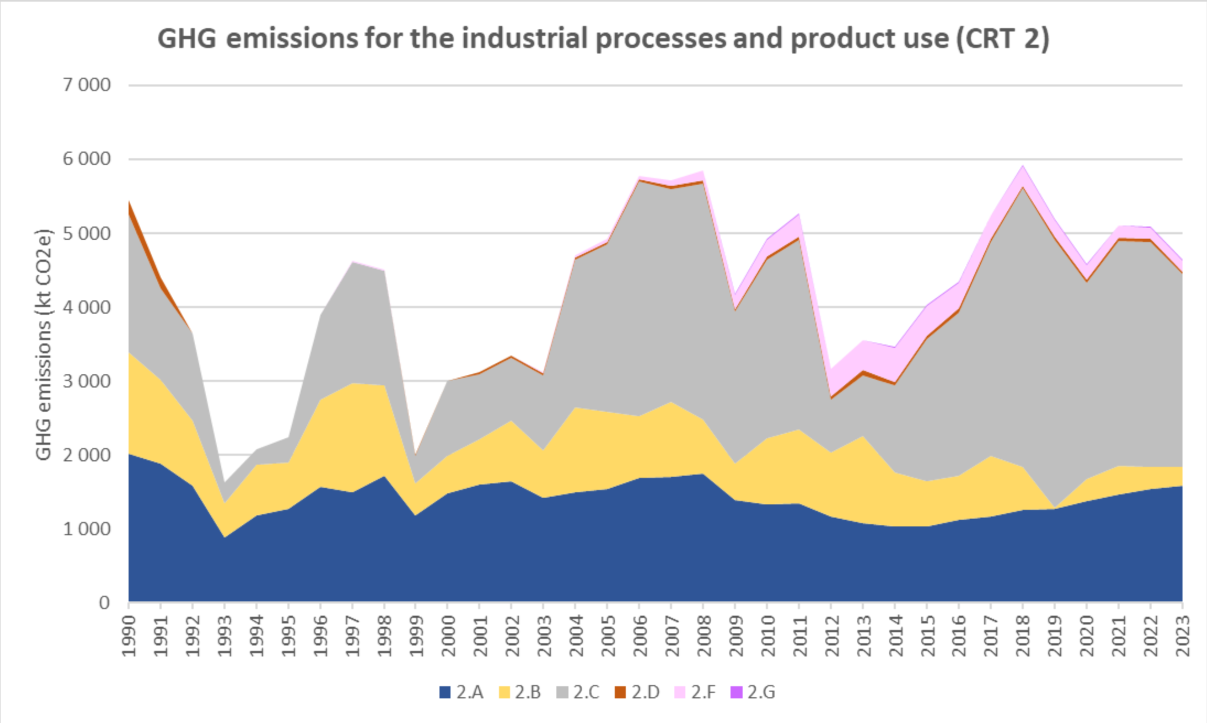
- Mineral industry (2A), including cement, lime and glass productions, as well as other use of carbonates,
- Chemical industry (2B), about ammonia, nitric acid, petrochemical and other chemical productions,
- Metal industry (2C), including iron and steel, lead, magnesium and zinc productions,
- Non-energy products from fuels and solvent use (2D), related to lubricant, paraffin and solvent uses,
- Product uses as substitutes for ODS (2F),
- Other Product Manufacture and Use (2G)

The Electronics industry (2E) does not occur in Serbia.

In 1990, excluding the LULUCF contribution, the CRT 2 sector contributed to the national total emissions by: 7.0% for CO_2, 0.2% for CH_4, 16.7% for N_2O, 100% for SF_6, and hence in total to 6.5% in terms of GHG emissions. In 2023, the same contributions evolved as follows: 8.8% for CO_2, 0.1% for CH_4, 0.0% for N_2O, 100% for SF_6, 100% for HFCs, and hence in total to 7.5% in terms of GHG emissions.

The following graph presents the GHG emission evolution for the industrial processes and product uses in the Republic of Serbia, for the period 1990-2023, per subcategory.

Figure 44: GHG emissions trends for industrial processes and product use (CRT 2), for the period 1990-2023, per subcategory (in kt CO_2e)



GHG emissions fluctuate during the studied period as follows:

- CO_2 emissions from industrial processes declined from 1990 to 1993 due to the decrease in industrial activities caused by the war in Serbia,
- During the period 1993 – 1998, the industrial emissions progressively recovered and increased to emission levels almost to similar ones to 1990, before drastically plunging in 1999 during the NATO bombing,
- From 2000 to 2002, the GHG emissions related to the industrial activities recovered from the previous sudden decline, before stagnating between 2003 and 2008, except for the metal industry which has known a significant increase of +211% in GHG emissions between 2003 and 2006, due to the increase in pig iron and steel productions, but also to the new development of sinter and pellet installation facilities,
- In 2009, emissions sharply decreased due to diminution of economic activity caused by the global economic crisis,
- From 2010 to 2011, the economy of the Republic of Serbia began to recover from the impact of the global crisis, before drastically reducing in 2012 mostly related to the iron and steel industry,
- For the period 2012-2018, the GHG emissions of the sector increased progressively and significantly, due to all principal activities but in particular the iron and steel production, before slightly decreasing in 2019 due to the stop of the activities of ammonia (CRT 2B1) and nitric acid (CRT 2B2) productions,
- In 2020, due to the sanitary crisis related to Covid, the industrial GHG emissions slightly reduced, in particular due to the iron and steel production, before increasing back in 2021 to pre-crisis levels.
- In 2023, industrial emissions decreased by 8.7% due mostly to the drop of 13% in the crude steel production.

In overall, the GHG emissions of the industrial processes and product uses have been reduced by 15% between 1990 and 2023, but with different relative variations depending on the subsectors. Among the principal sector-specific changes which can be highlighted, there are:

- The development of the use of fluorinated gases (CRT 2F) started in 1997, and was rather slow until 2007, before accelerating up to 2014 (+542% from 2007 to 2014). Afterwards, a slow and progressive decline can be observed, mainly due to regulations promoting the use of less emitting substances, which enabled to reduce the GHG emissions of this subsector by 68% from 2014 to 2023,

- The overall increasing development of iron and steel productions, and the launch of the production of sinters and pellets starting from 2003,

- The stop of the production of some chemical products, in particular ammonia and nitric acid in 2019, but also, to a lesser extent, of methanol in 2012 and vinyl chloride monomer (VCM) in 2000. This enabled the chemical industry to reduce its GHG emissions by 82% between 1990 and 2023, and the overall industry sector to no longer be an emitter of N_2O whereas it contributed to 23% to the national totals in 1990,

- The use of SF_6 in electrical equipment starting in 2000, which increased progressively until 2022, but remains marginal in the total GHG emissions of the CRT 2.

4.2 Mineral industry (CRT 2A)

In the Republic of Serbia, the Mineral industry covers:

- The production of cement (2A1),
- The production of lime (2A2),
- The production of glass (2A3),
- The other use of carbonates (2A4).

In the Republic of Serbia, mineral productions used to be strong because of a significant production capacity and a significant consumption and demand in the country (primarily by the construction industry). After the decline in productions in the nineties, following the hyperinflation and NATO bombing, the mineral productions recovered since 2008. Then, the economic crisis in 2009 implied a sudden production decrease. Mineral productions, in particular cement, kept decreasing until 2013 before progressively increasing since then, though remaining below 2008 emission levels. The observed GHG emission reduction for the period 1990-2023 for the CRT 2A is of 22%.

GHG emissions from mineral industries are almost only CO_2, and are dominated by the cement production subsector (CRT 2A1), which represented 66% of the sector emissions in 1990 and contributes to 83% in 2023. The other dominant subsector is the lime production (CRT 2A2), which decreased significantly its contributions from 25% to 13% for the same period, and the ceramic industry (CRT 2A4a) with 4% in 2023.

Figure 45: GHG emissions trends for the mineral industries (CRT 2A), for the period 1990-2023, per subcategory (in kt CO_2e)

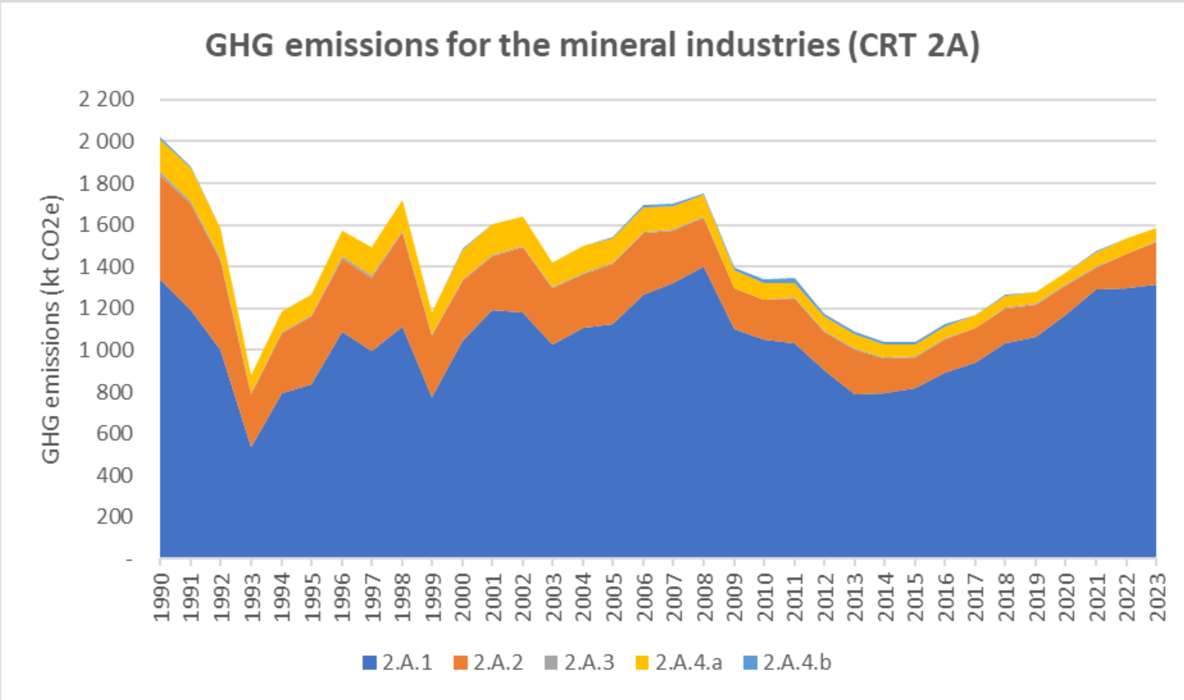
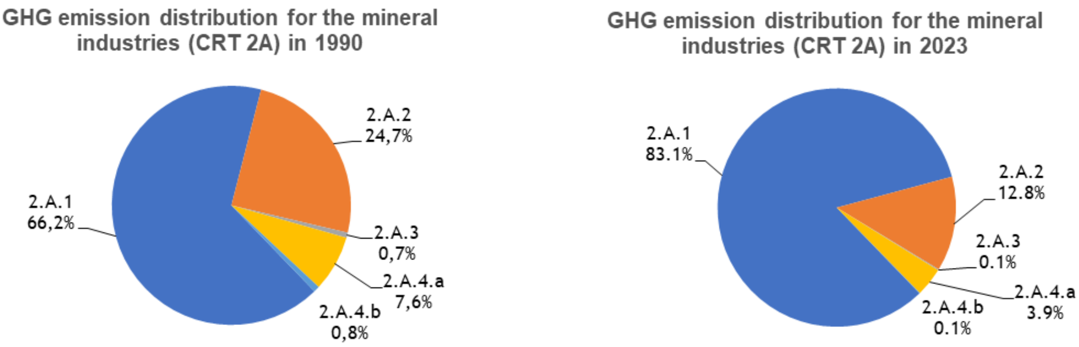


Figure 46: GHG emission distribution for mineral industries (CRT 2A), for the years 1990 and 2023, per subcategory (in %)



The Mineral industry (CRT 2A) contributes to 2.6% of the total GHG emissions excluding LULUCF, and it contributes to 34% of the Industrial processes (CRT 2) sector in the Republic of Serbia in 2023.

4.2.1 Cement production (CRT 2A1)

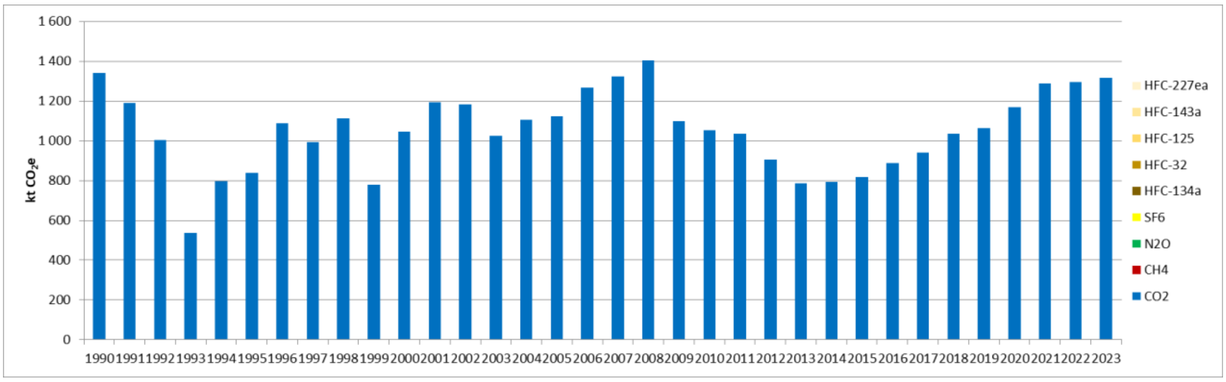
4.2.1.1 Category description

Only Portland cement is produced in Serbia. CO_2 emissions are due to the use of carbonated raw materials in the production process. CH_4 and N_2O emissions are not expected for this process.

In 2023, cement production was the highest individual contributor of the mineral industry with a share of 83%.

In 2023, the Cement production category is a key category for CO_2 emissions in the Republic of Serbia, both in emission levels and trend. This sector contributes to 2.1% in terms of emissions level (rank 6) and to 1.2% in terms of emissions trend (rank 20), excluding LULUCF.

Figure 47: GHG emissions for the cement production (kt GHG)



CO_2 emissions from cement production declined from 1990 to 1993 due to the decrease in industrial activities, caused by the war in Serbia and the hyperinflation. In 1999, the emissions dropped due to the NATO bombing.

The trend of the sectoral GHG emissions for the 2009-2013 period is a consequence of the global economic crisis due to which halted economic recovery and the upward trend of Serbia's GDP (gross domestic product). A key cause for the significant decrease in emissions during the 2010-2013 period was the lower market demand for Portland cement. Since 2014, a gradual increase is observed, and emissions of this subsector have almost reached pre-crisis and 1990 levels.

4.2.1.2 Methodological issues

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate the CO_2 emissions [I1].

The CO_2 emissions are based on the Portland cement production (provided in the yearly Statistical Industry bulletins of Serbia) [I2], and the 2006 IPCC Guidelines CO_2 default emission factor for clinker (0.52 t CO_2/t clinker) [I3].

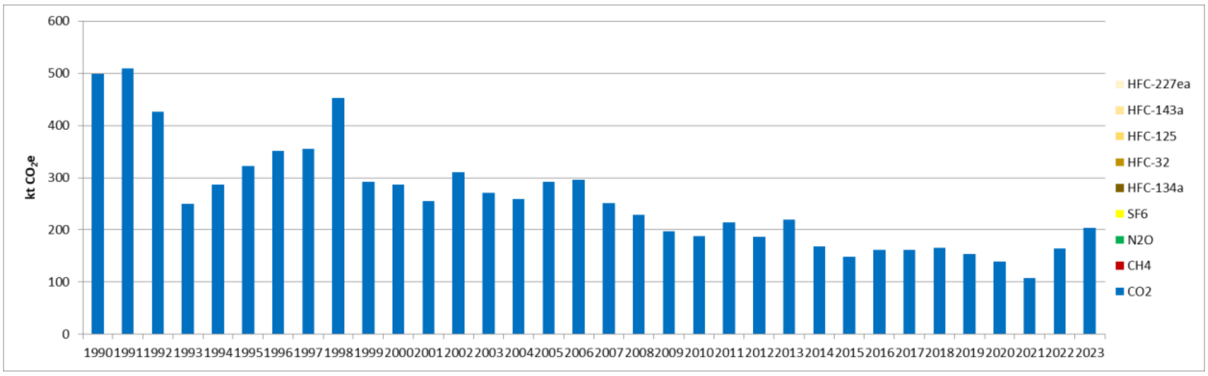
4.2.2 Lime production (CRT 2A2)

4.2.2.1 Category description

In the Republic of Serbia, high-calcium lime (Quicklime) is produced. CO_2 emissions are due to the use of carbonated raw materials in the production process. CH_4 and N_2O emissions are not expected for this process.

In 2023, the Lime production category is a key category for CO_2 emissions both in terms of emissions level and trend. This sector contributes to 0.3% in terms of emission levels (rank 38), and to 0.6% in terms of emissions trend (rank 35), excluding LULUCF.

Figure 48: CO_2 emissions for the lime production (kt CO_2e)



CO_2 emissions from lime production declined from 1990 to 1993 due to the decrease in industrial activities, caused by the war in Serbia and the hyperinflation. After recovering to pre-crisis level until 1998, NATO bombing caused a significant decrease in GHG emissions from lime production. Then, GHG emissions remained stable since 2006, before undergoing a slow but gradual decline until 2021. In 2023, emissions increased by +24% compared with 2022.

4.2.2.2 Methodological issues

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate the CO_2 emissions (equation 2.4 of the 2006 IPCC Guidelines [I4]).

The national lime production comes from the yearly Statistical books of Serbia [I2].

Stoichiometric ratio between CaO and CO_2 for the high calcium lime is used to calculate the CO_2 emissions. It comes from the 2006 IPCC Guidelines [I5]. The value (0.785 t CO_2/t CaO) is considered constant over the entire time-series.

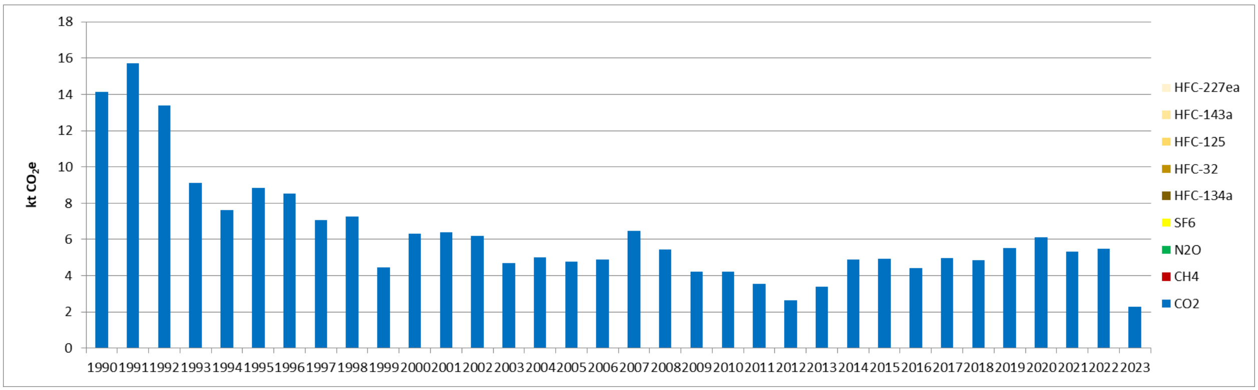
4.2.3 Glass production (CRT 2A3)

4.2.3.1 Category description

CO_2 emissions are due to the use of carbonated raw materials in the production process. CH_4 and N_2O emissions are not expected for this process.

In 2023, the category Glass production is not a key category in terms of emissions level nor in terms of emissions trend.

Figure 49: CO_2 emissions for Glass production (kt CO_2e)



CO_2 emissions from glass production declined from 1990 to 1993 due to the decrease in industrial activities, caused by the war in Serbia and the hyperinflation. Since then, the emissions are rather stable and evolve based on the main events occurring in Serbia, such as the NATO bombing in 1999, and the global economic crisis in 2009, which had an impact until 2013. In 2023 there was a significant decrease (-58%) compared with the previous year, corresponding to a decline in glass production activity.

4.2.3.2 Methodological issues

Tier 1 method from the 2006 IPCC Guidelines is used to calculate CO_2 emissions (equation 2.10 of the 2006 IPCC Guidelines [I6]).

National glass production comes from the yearly Statistical books of Serbia [I2].

A cullet ratio is needed to calculate CO_2 emissions. A default cullet ratio is used and comes from the 2006 IPCC Guidelines [I1] (50%). It is considered constant for the entire time-series.

A default CO_2 emission factor is used and comes from in the 2006 IPCC Guidelines [I6] (0,2 t CO_2/t glass produced). It is considered constant for the entire time-series.

4.2.4 Other use of carbonates (CRT 2A4)

In the Republic of Serbia, the CRT 2A4 sector covers two sub-sectors:

- Ceramics production, including tiles and bricks (CRT 2A4a),
- Other use of soda ash (CRT 2A4b).

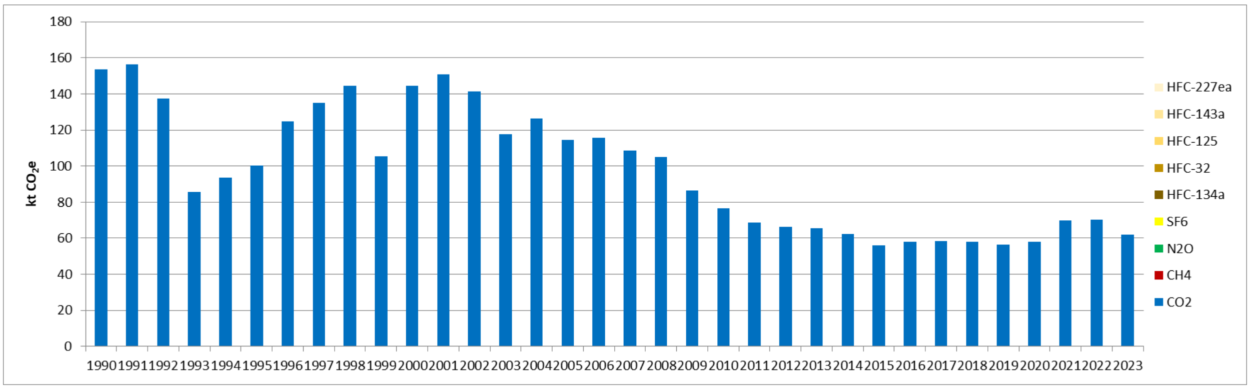
4.2.4.1 Ceramics production (CRT 2A4a)

4.2.4.1.1 Category description

CO_2 emissions are due to the use of carbonated raw materials (such as dolomite ($CaMg(CO_3)_2$, and limestone ($CaCO_3$)) in the production process. CH_4 and N_2O emissions are not expected for this process.

In 2023, the Ceramics production category is neither a key category in terms of emissions level nor in emission trend.

Figure 50: GHG emissions for the ceramics production (kt CO_2e)



CO_2 emissions from ceramics production declined from 1990 to 1993 due to the decrease in industrial activities, caused by the war in the Republic of Serbia and the hyperinflation. After the recovery since 1998, the emissions dropped in 1999 due to the NATO bombing. The trend of the sectoral GHG emissions for the 2009-2013 period is a consequence of the global economic crisis due to which halted economic recovery and the upward trend of Serbia's GDP (gross domestic product). Between 2013 and 2020, the emissions were rather stable, before slightly increasing in 2021 and 2022 due to the increase in the use of carbonates. 2023 registered a decrease of 12% compared with 2022.

4.2.4.1.2 Methodological issues

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate the CO_2 emissions (equation 2.15 of the 2006 IPCC Guidelines [I7]).

The activity data are the national consumptions of limestone and dolomite in the ceramics, bricks and tiles sector, excluding the carbonates consumed elsewhere (e.g. in the glass production). National consumptions of limestone and dolomite come from the yearly Statistical books of Serbia [I2].

Default CO_2 emission factors for each carbonate are used. They come from the 2006 IPCC Guidelines [I8] (0.47732 t CO_2/t dolomite; 0.043971 t CO_2/t limestone), and they are considered constant over the entire time-series.

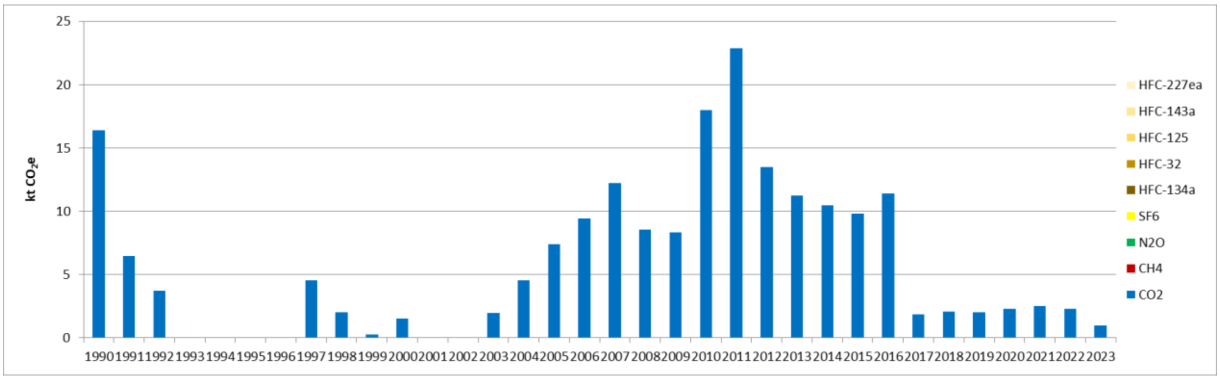
4.2.4.2 Other use of soda ash (CRT 2A4b)

4.2.4.2.1 Category description

CO_2 emissions are due to the use of soda ash (Na_2CO_3) in the production process. CH_4 and N_2O emissions are not expected for this process.

In 2022, the category Other use of soda ash is neither a key category in terms of emissions level nor in terms of emissions trend.

Figure 51: GHG emissions for the other use of soda ash (kt CO_2e)



CO_2 emissions vary significantly and the timeseries is not complete, as soda ash consumptions in other mineral industries are calculated as the balance between overall consumption and that from other subsectors.

4.2.4.2.2 Methodological issues

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate the CO_2 emissions (equation 2.15 of the 2006 IPCC Guidelines [I7]).

The activity data are the national consumptions of soda ash. It comes from the Statistical Office data [I2].

Default CO_2 emission factor for soda ash is used. It comes from the 2006 IPCC Guidelines [I8] (0.41492 t CO_2/t soda ash), and it is considered constant over the entire time-series.

4.2.5 Uncertainties and time-series consistency

In 2023, the uncertainty estimate associated with activity data for category 2A-Mineral industry is 2%, based on 2006 IPCC Guidelines.

Uncertainty estimate associated with CO_2 default emission factor for category 2A-Mineral industry is 2%, accordingly to values reported in 2006 IPCC Guidelines.

Combined uncertainty for CO_2 emissions is 0.1% in the total national levels of emission in 2023, excluding LULUCF contribution.

4.2.6 Category-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 keys in the CRT tables.

4.2.7 Category-specific recalculations

No recalculations were made since previous NID submission (November 2024).

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	2 024	1 269	1 485	1 543	1 339	1 345	1 174	1 086	1 040	1 037	1 125	1 170	1 264	1 280	1 374	1 475	1 538	0
Nouveau	kt CO2e	2 024	1 269	1 485	1 543	1 339	1 345	1 174	1 086	1 040	1 037	1 125	1 170	1 264	1 280	1 374	1 475	1 538	1 586
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+0,072	+1 586
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	+0,0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 2.A

4.2.8 Category-specific planned improvements

For the mineral industry, especially for the soda ash consumption, the completeness of the activity data set has to be improved.

4.3 Chemical industry (CRT 2B)

In 2023, the chemical industry represents 5% of the Industrial Processes and Product Use GHG emissions and 0.4% of the national GHG emissions excluding LULUCF. During the timeseries, the main chemical activities occurring in Serbia are the productions of ammonia, nitric acid, petrochemicals and other chemicals.

In the Republic of Serbia, chemical productions used to be rather significant and represented 25% of the IPPU GHG emissions in 1990, because of significant productions of ammonia, nitric acid and ethylene. The productions declined in the nineties, after the period of hyperinflation (1990-1993) and the NATO bombing. Then, the economic crisis in 2009 implied a sudden production decrease. Finally, after several variations in the trend of emissions, GHG emissions dropped drastically in 2019 following the stop of ammonia and nitric acid productions, before being rather stable from 2020 onwards. The observed GHG emissions for the CRT 2B in 2023 are 82% lower than in 1990.

The emission distribution between the different GHGs in the chemical industries evolved significantly during the timeseries, with almost only CO_2 contributing to the total in 2023 (96%), the rest being CH_4. In contrast, N_2O represented 41% of the sector's total emissions in 1990. This change is due to the drop in nitric acid production.

The other dominant subsectors in 1990 were the ammonia production (CRT 2B1), which had a contribution of 24%, and the ethylene production (CRT 2B8b), with 27%. The other subsectors represented between 2% and 3% in 1990. In 2023, after the cessation of ammonia, nitric acid, methanol, and vinyl chloride monomer production activities, GHG emissions from the sector are almost only derived from ethylene production, accounting for 98%, with the remainder coming from other chemical products.

Figure 52: GHG emissions trends for the chemical industries (CRT 2B), for the period 1990-2023, per subcategory (in kt CO_2e)

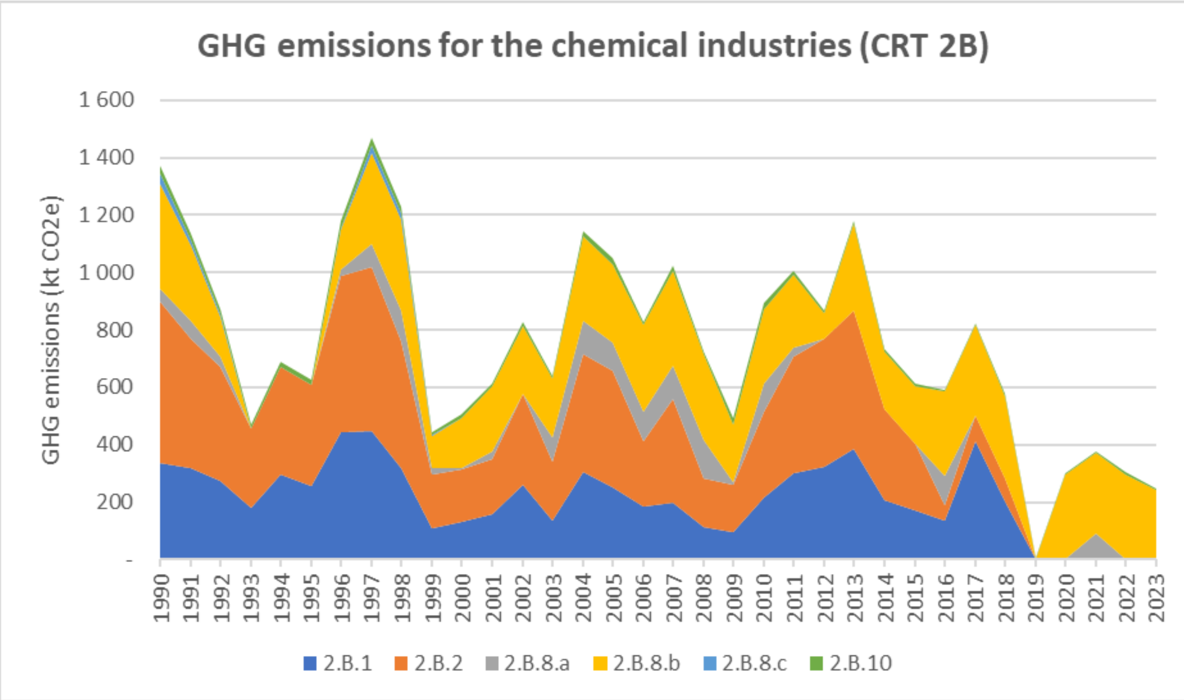
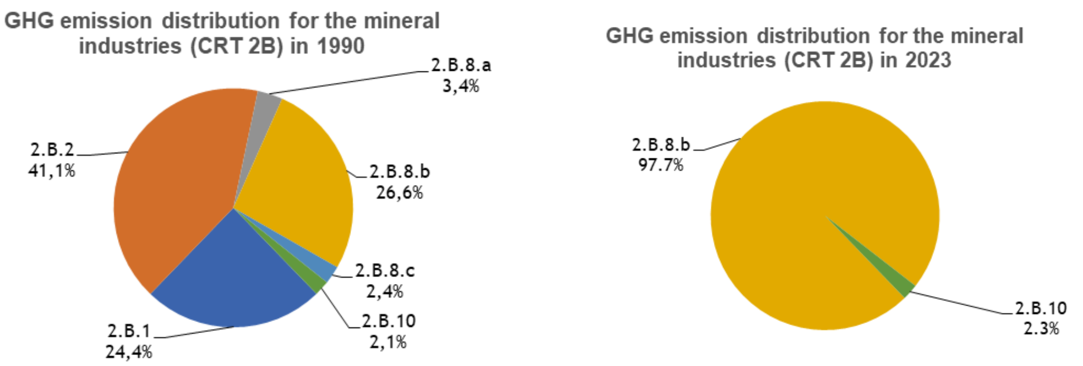


Figure 53: GHG emission distribution for chemical industries (CRT 2B), for the years 1990 and 2023, per subcategory (in %)



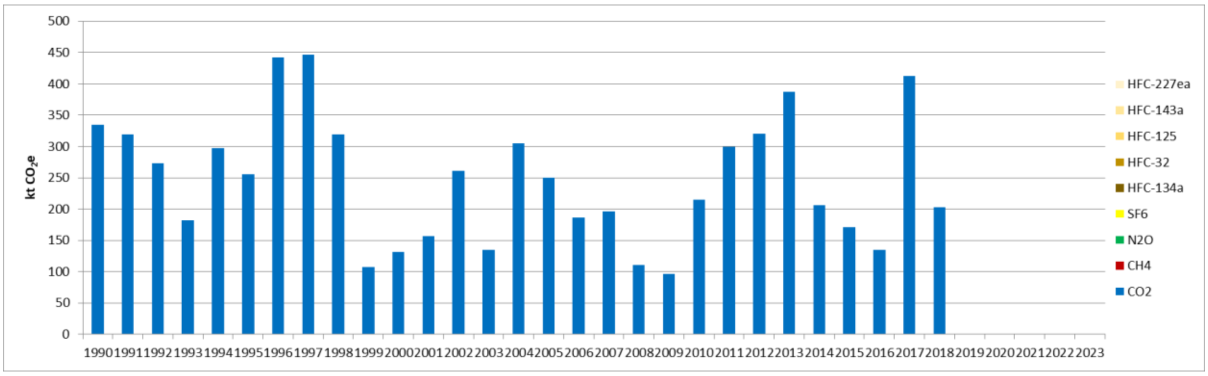
4.3.1 Ammonia production (2B1)

4.3.1.1 Category description

Ammonia is produced by catalytic steam reforming of natural gas in which hydrogen is chemically separated from natural gas and combined with nitrogen to produce ammonia (NH_3). CO_2 emissions occur during the process, as well as CO and NOx. The produced CO_2 is either vented to the atmosphere or used as a feedstock for downstream use such as urea production. CO_2 emissions used for urea production are not accounted in this category but are allocated into the category where the urea is consumed. Please refer to CRT 2D3 description for more details on urea use.

During the year 2018, the production of ammonia has stopped.

Figure 54 : GHG emissions for ammonia production (CRT 2B1), for the period 1990-2023 (in kt CO_2e)



In 2023, the category ammonia production is a key category for CO_2 emissions in emission trend, in the Republic of Serbia. This sector contributes to 1.0% in terms of emission trend (rank 26). Many variations occur for the activity data on the time series.

4.3.1.2 Methodological issues

The methodology used is Tier 1 and CO_2 emission estimates come from Equation 3.1 of ammonia production section in 2006 IPCC Guidelines [I9].

Activity data used for the calculation are the national ammonia productions and come from SORS (from 1990 Industrial Bulletin, and from 2010 from Statistical Yearbook) [I2].

Default emission factor for CO_2 is constant on the time series: 2,104 t CO_2/ t NH_3. The value comes from 2006 IPCC Guidelines [I10].

The natural gas is a raw material (non-energy use) and its consumption should be deducted to the energy balance. The methodology used to determine the natural gas consumption is based on CO_2 emissions and the default emission factor for natural gas.

Amount of CO_2 emissions recovered for urea production and not accounted in 2B1 category is estimated using urea production coming from SORS [I2] and conversion factor between urea and CO_2 molar mass. It is supposed that the whole urea production considered for Serbia is made from CO_2 recovery from Ammonia production.

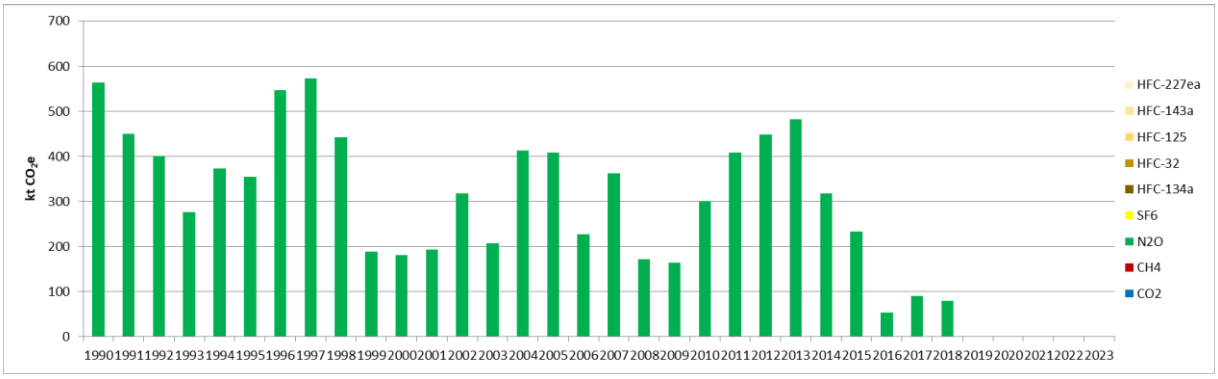
4.3.2 Nitric acid production (2B2)

4.3.2.1 Category description

Nitric acid is produced by high temperature catalytic oxidation of ammonia. Two types of process can be used: single pressure plant and dual pressure plants. The overall reaction include oxidation and absorption stage is $NH_3 + 2 O_2 \rightarrow HNO_3 + H_2O$. During oxidation stages N_2O is generated as an unintended by-product and released to the atmosphere.

The production of nitric acid has been stopped during the year 2018.

Figure 55 : GHG emissions for nitric acid production (CRT 2B2), for the period 1990-2023 (in kt CO_2e)



In 2023, the category nitric acid production is a key category for N_2O emissions in terms of emission trend, in the Republic of Serbia. This sector contributes 1.6% in terms of emission trend (rank 17). Many variations occur for the activity data on the time series.

4.3.2.2 Methodological issues

The methodology used is Tier 1 and N_2O emission estimates come from Equation 3.5 of nitric acid production section in 2006 IPCC Guidelines [I11].

Activity data used for the calculation are the national nitric acid productions and come from SORS (from 1990 Industrial Bulletin, and from 2010 from Statistical Yearbook) [I2].

Default emission factor for N_2O is constant on the time series. The highest default value provided in 2006 IPCC Guidelines [I12] is applied with no abatement technology: 9 kg N_2O / t HNO_3.

4.3.3 Petrochemical and carbon black production (2B8)

The production of other chemicals such as petrochemicals or carbon black can be sources of CO_2 and CH_4 emissions. CH_4 emissions may be fugitive and/or process vent emissions. The only activities occurring in Serbia for this category are:

- methanol production (CRT 2B8a),
- ethylene production (CRT 2B8b),
- ethylene dichloride production (CRT 2B8c).

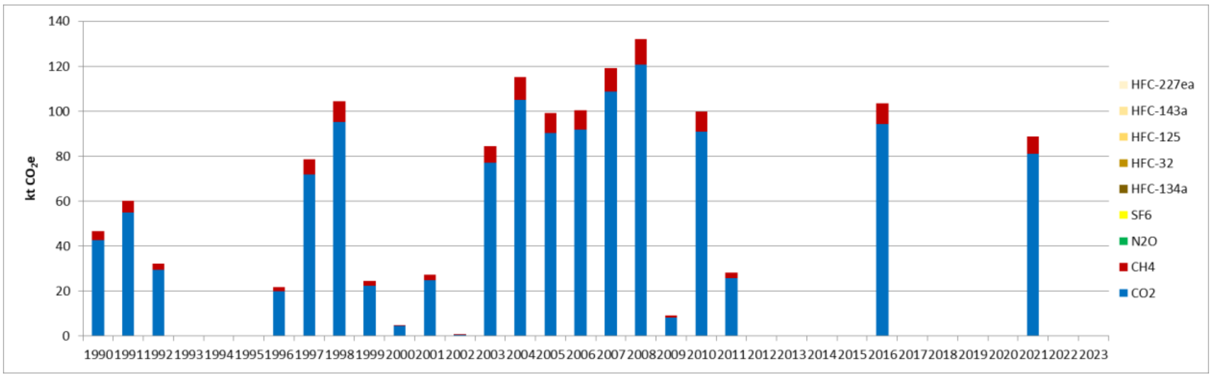
The subcategories and estimate methodology are described in the 3 following sections.

4.3.3.1 Methanol production (2B8a)

4.3.3.1.1 Category description

Methanol production is varying significantly over the timeseries and is even null for several periods (in 1993-1995 and 2012-2015) and since 2017, where the production stopped definitively. On the 2012-2015 period methanol complex in Kikinda was not working due to huge debts. Hence, in 2023, the category methanol production is neither a key category in terms of emissions level nor in terms of emissions trend for GHG emissions in Serbia.

Figure 56 : GHG emissions for methanol production (CRT 2B8a), for the period 1990-2023 (in kt CO_2e)



4.3.3.1.2 Methodological issues

The methodology used is Tier 1 and CO_2 emission estimates come from Equation 3.15 of petrochemical and carbon black production section in 2006 IPCC [I13]. The specific type of process used is not known. Activity data used for the calculation are national methanol productions and come from SORS [I2] from 2004 onwards. For 1994-2002 period, activity data values come from industrial statistics [I14].

Default emission factors for CO_2 and CH_4 are constant on the time series and come from 2006 IPCC Guidelines. Recommended applied values are respectively 0.67 t CO_2/ t methanol [I15] and 2.3 kg CH_4/ t methanol [I16].

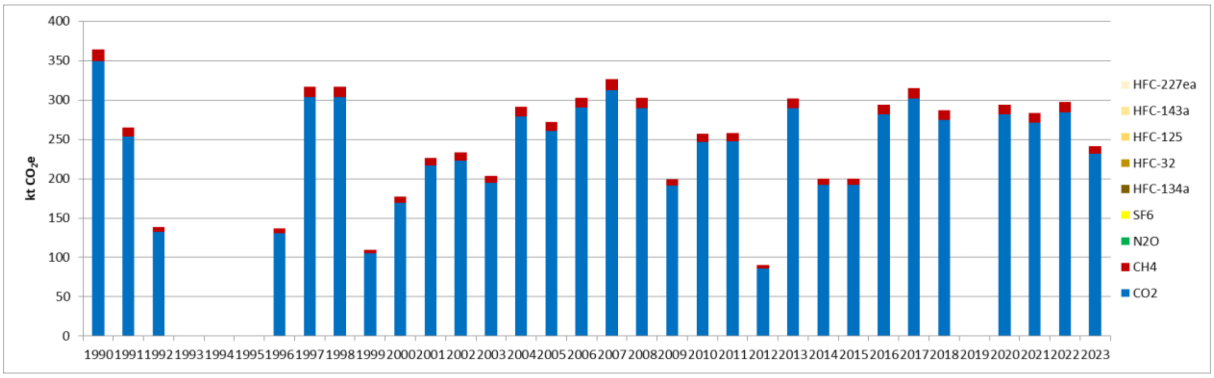
4.3.3.2 Ethylene production (2B8b)

4.3.3.2.1 Category description

In 2023, the ethylene production category is a key category for CO_2 emissions in terms of emission levels in Serbia. This sector contributes to 0.4% in terms of emissions level (rank 32).

Many variations in the sector's activity can be observed over the whole timeseries. Production has stopped between 1993 and 1995 following the hyperinflation and the war. After recovering, until 1998, production dropped significantly in 1999 during the NATO bombing. Then, the activity progressively recovered and increased until 2007, before dropping in 2009 due to the global economic crisis. Since 2016, the activity has been rather stable, except in 2019 where it momentarily stopped.

Figure 57 : GHG emissions for ethylene production (CRT 2B8b), for the period 1990-2023 (in kt CO_2e)



4.3.3.2.2 Methodological issues

The methodology used is Tier 1. CO_2 and CH_4 emission estimates respectively come from Equation 3.15 and Equation 3.23 to 3.25 of petrochemical and carbon black production section in 2006 IPCC [I13].

Activity data used for the calculation are the national ethylene productions and come from SORS [I2] for the time series.

Default emission factor for CO_2 and CH_4 are constant on the time series and come from 2006 IPCC Guidelines for steam cracking of naphtha. Recommended applied values are respectively 1.73 t CO_2/ t ethylene [I17] and 3 kg CH_4/ t ethylene [I18].

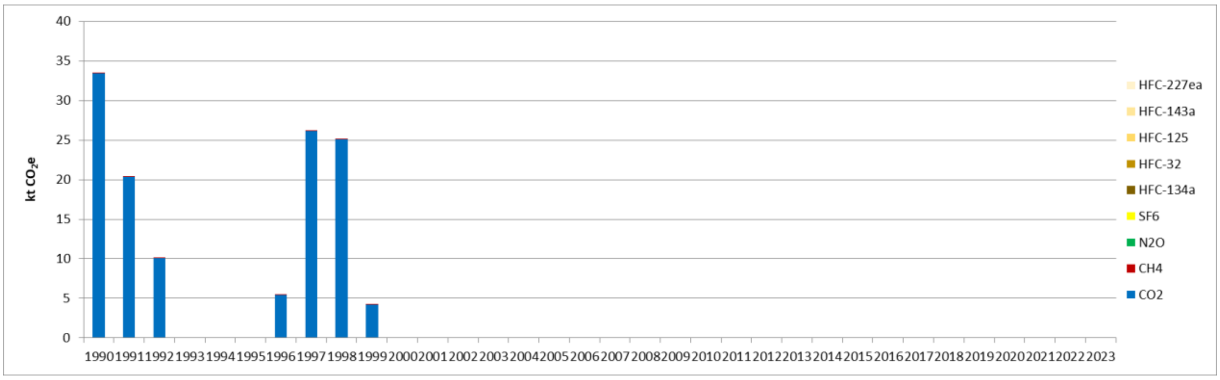
Default geographic adjustment factor for CO_2 emissions provided in 2006 IPCC Guidelines for Eastern Europe is 110% [I19] and is applied to Serbia CO_2 emissions for ethylene production.

4.3.3.3 Ethylene dichloride and vinyl chloride monomer production (2B8c)

4.3.3.3.1 Category description

In 2023, the category ethylene dichloride and vinyl chloride monomer production is neither a key category in terms of emission levels nor in terms of emission trend in Serbia. There is only VCM production in Serbia and the activity was stopped in 1999. It should be noted that the plant did not operate because of the war from 1993 to 1995 and was bombed in 1999.

Figure 58 : GHG emissions for ethylene dichloride and vinyl chloride monomer production (kt CO_2e)



4.3.3.3.2 Methodological issues

The methodology used is Tier 1. CO_2 and CH_4 emission estimates respectively come from Equation 3.15 and Equation 3.23 to 3.25 of petrochemical and carbon black production section in 2006 IPCC [I13].

Activity data used for the calculation are the national vinyl chloride monomer productions and come from SORS [I2] for the time series.

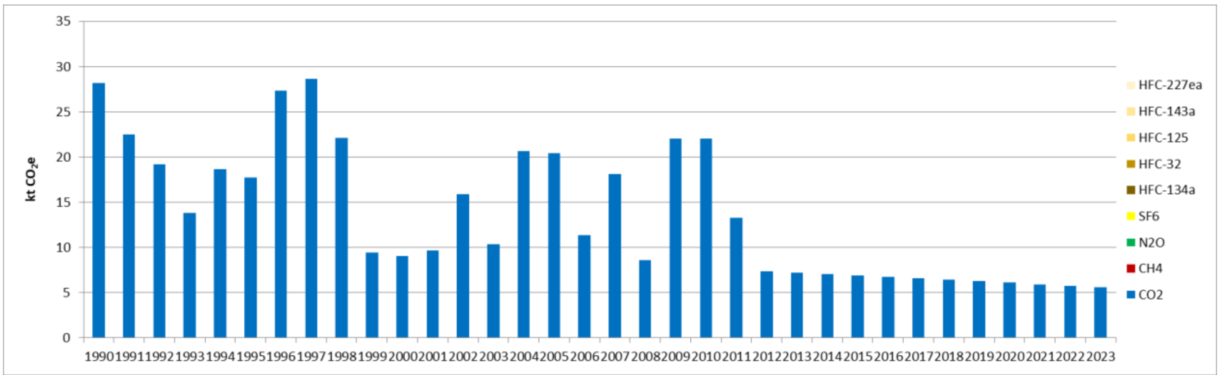
Default emission factor for CO_2 [I20] and CH_4 [I21] are constant on the time series and come from 2006 IPCC Guidelines for ethylene dichloride and vinyl chloride monomer production.

4.3.4 Other (2B10)

4.3.4.1 Category description

This category includes any other chemical production not considered in specific categories. In 2023, the category other chemical production is neither a key category in terms of emissions level nor in terms of emissions trend for GHG emissions in the Republic of Serbia. Emissions occurring in this category for Serbia are CO_2 emissions due to decolorization of HNO_3 and KAN.

Figure 59 : GHG emissions for other chemical production (CRT 2B10) for the period 1990-2023 (in kt CO_2e)



4.3.4.2 Methodological issues

A Tier 1 methodology is applied to CO_2 emission estimates for decolorization of HNO_3 and KAN. Activity data for this category are the consumptions of natural gas needed for this process. The data came in the following way:

Ammonia production data are from Statistical yearbooks and are available for the period 1990-2013. By using the default IPCC 2006 fuel consumption ratio for producing ammonia, it is possible to calculate the consumption of natural gas. Nitric acid production data are also from Statistical yearbooks and are available for the same period. There is no default IPCC 2006 fuel consumption ratio for the production of nitric acid, and no natural gas consumption for this purpose can be calculated. Resolving this problem: Reliable data on natural gas consumption has been available for the period 2009-2014 from the PRTR report. On this basis, it is possible to calculate the actual fuel consumption for each individual production (NH_3 and HNO_3). Having a ratio for the years mentioned above, the average value of natural gas consumption can be calculated in previous years. In this case, the assumption is that the structure and efficiency of these industrial sectors have been constant throughout the whole period. For the period 2015-2022, the activity data are extrapolated based on the previous linear evolution.

Emission factor used come from the 2006 IPCC guidelines for natural gas use, the default value of 56.1 t CO_2/TJ is used.

4.3.5 Uncertainties and time-series consistency

CO_2

Uncertainty estimate associated with activity data amounts to 5%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 3.2.3.2).

Uncertainty estimate associated with default emission factor amounts to 6%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 3 Table 3.1).

Combined uncertainty for emissions is 0.03% in the total national levels of emission in 2023, excluding LULUCF contribution.

CH_4

Uncertainty estimate associated with activity data amounts to 2%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 3 Table 3.27).

Uncertainty estimate associated with default emission factor amounts to 2%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 3 Table 3.27).

Combined uncertainty for emissions is 0.0005% in the total national levels of emission in 2023, excluding LULUCF contribution.

N_2O

Uncertainty estimate associated with activity data amounts to 2%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 3.2.3.2).

Uncertainty estimate associated with default emission factor amounts to 40%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 3 Table 3.3).

Combined uncertainty for emissions in the total national levels of emission in 2022 is null as there is no emission of N_2O occurring.

4.3.6 Category-specific QA/QC and verification

During the preparation of the inventory submission, activities related to quality control were mainly focused on proper use of notation keys in the CRT tables according to QA/QC plan.

4.3.7 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission of November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	1 371	628	504	1 050	894	1 007	867	1 178	731	611	593	825	576	6	300	290	303	0
Nouveau	kt CO2e	1 371	628	504	1 050	894	1 007	867	1 178	731	611	593	825	576	6	300	378	303	247
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+89	+0,0007	+247
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	+30,7%	+0,0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 2.B

2B8a - Methanol production:

Emissions were revised and corrected for 2021 and 2022.

4.3.8 Category-specific planned improvements

Main planned improvements for chemical category concern petrochemical activities and improvement of the completeness of activity data sets.

It is planned to ask methanol activity data (2B8a) to the statistics office to have a production for the complete timeseries and compare with current reference data.

It is planned to check with plants that no ethylene production (2B8b) occurred between 1993 and 1995 due to war.

4.4 Metal industry (CRT 2C)

In Serbia, the metal industry covers the following four sub-sectors:

- The production of iron and steel (CRT 2C1), disaggregated between the steel (2C1a), sinter (2C1d) and pellet (2C1e) productions,
- The production of magnesium (CRT 2C4),
- The production of lead (CRT 2C5),
- The production of zinc (CRT 2C6).

In the Republic of Serbia, the sector of the metal production has always been among the highest contributor to the industry GHG emissions (its share was of 34% in 1990). Due to its significant and progressive growth, in particular in the most recent years, the metal industry is now the highest contributor to the GHG emissions of the CRT 2 with 56% in 2023. Metal industry (CRT 2C) contributes to 4.2% of the total GHG emissions without considering LULUCF.

As for the other industrial subsectors, metal industries have been impacted negatively by the periods of hyperinflation and war (1990-1993) and of the NATO bombing (1999). After a recovery, the emissions stagnated between 2000 and 2003, before increasing importantly with the development of the steel industry and the new development of sintering and pelletizing installations in 2004. The global economic crisis in 2009 implied a sudden production decrease but the most abrupt reduction in emissions is observed in 2012, following the sale of the site Železara Smederevo by US Steel company. Since then and till 2022, metal industry emissions have been in a constant increase, except in 2020 due to the pandemic, in relation with the steel industry activity (increase of 63% in 2022, compared with the 1990 level). In 2023, there is a 14% decrease compared with the previous year.

Only almost CO_2 contributes to the total GHG emissions of the metal industries over the whole timeseries, representing 99% in 2023, the remainder being SF_6 and CH_4.

The predominant subsector in terms of GHG emissions is the Iron and steel industry (CRT 2C1), which represented 89% of the sector emissions in 1990, and constitutes the total emissions in 2023. Among the iron and steel industry, the main activity is the steel production throughout the timeseries, but the sinter and pellet productions which started in 2004 have gained importance and now represent respectively 10% and 2.2% in 2023. The other subsector that used to contribute in a non-negligible way was the magnesium production, which has seen its share decreased from 9% in 1990 to 2% in 2022 and stopping its activities in 2023. The lead and zinc industries, which were representing 0.2% and 2.2% in 1990, respectively, stopped their activities in 2014 and 2005, respectively.

Figure 60: GHG emissions trends for the metal industries (CRT 2C), for the period 1990-2023, per subcategory (in kt CO_2e)

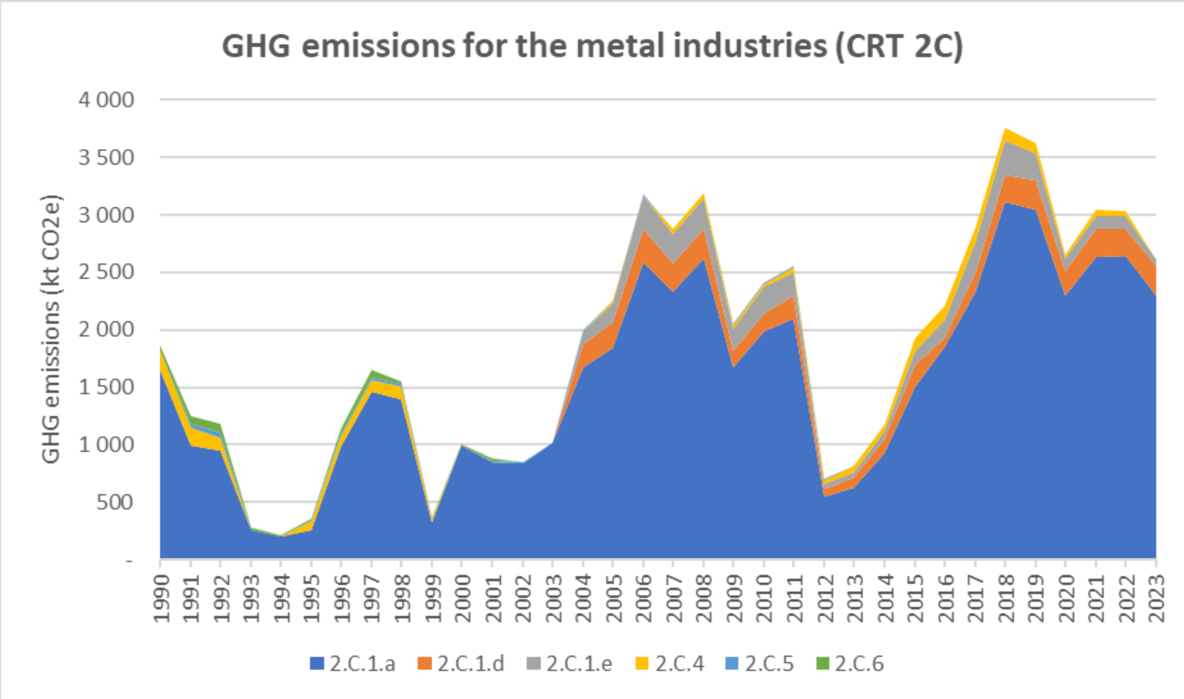
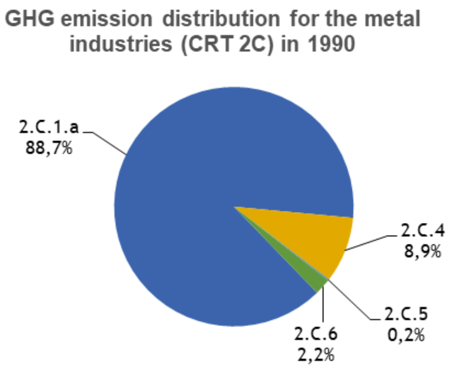
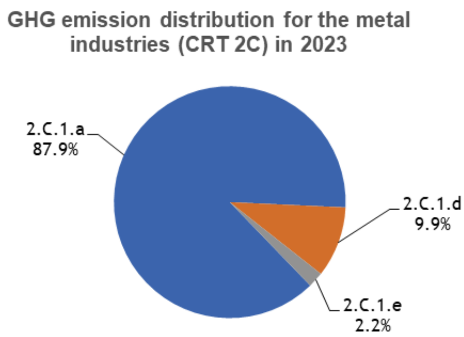


Figure 61: GHG emission distribution for metal industries (CRT 2C), for the years 1990 and 2022, per subcategory (in %)





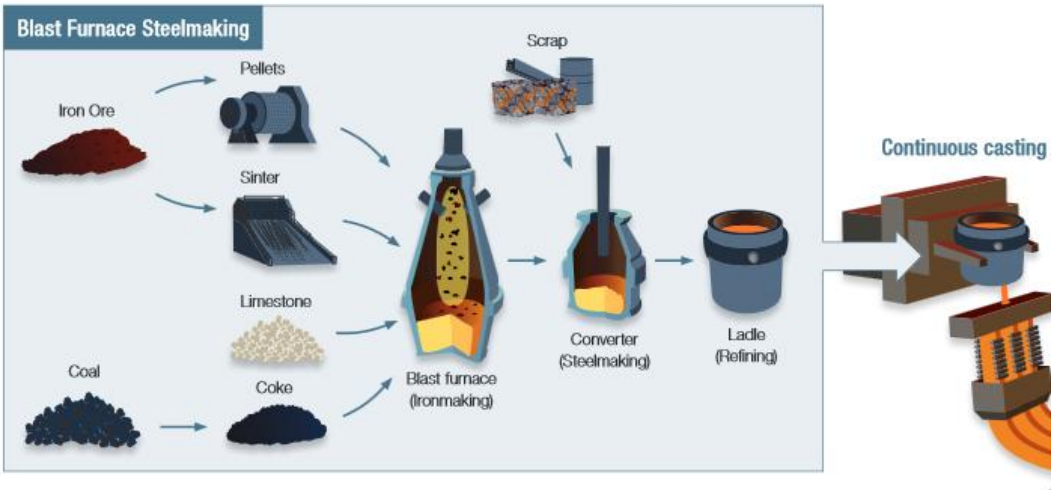
4.4.1 Iron and steel (CRT 2C1)

4.4.1.1 Category description

In the Republic of Serbia, there is one integrated iron and steel plant, which operates with a basic oxygen furnace (BOF, or "oxygen converter").

The pig iron produced in the blast furnaces is converted into steel via the BOF. Sinter and pellet productions began in 2004.

Figure 62: Overview of the integrated steel production



In Serbia, the iron and steel sector include the following sub-sectors:

- Production of steel (CRT 2C1a),
- Production of sinter (CRT 2C1d),
- Production of pellets (CRT 2C1e).

It should be noted that the production of coke (which is consumed in the blast furnace) is dealt within the 1A1c section. For the purpose of GHG emission calculations, the production of pig iron (occurring in the blast furnace) is included in the CRT 2C1a.

The use of raw materials as coke, coal, and carbonates, which contain carbon, lead to the emissions of CO_2 at all the steps of the iron and steel production process. Moreover, sinter production leads to CH_4 emissions. Other GHG emissions are not expected for this sector.

In 2023, the sub-category *Production of steel (CRT 2C1a)* is a key category for CO_2 emissions in the Republic of Serbia, both in terms of emission levels and trend. This sub-sector contributes 3.7% in terms of emissions level (rank 4) and 4.1% in terms of emissions trend (rank 5).

In 2023, the sub-category *Production of sinter (CRT 2C1d)* is a key category for CO_2 emissions in Serbia, both in terms of emission levels and trend. This sub-sector contributes to 0.4% in terms of emissions level (rank 30) and 1.0% in terms of emissions trend (rank 24).

In 2023, the sub-category *Production of pellets (CRT 2C1e)* is neither a key category in terms of emission level nor trend.

Figure 63: GHG emissions for steel production, for the period 1990-2023 (in kt CO_2e)

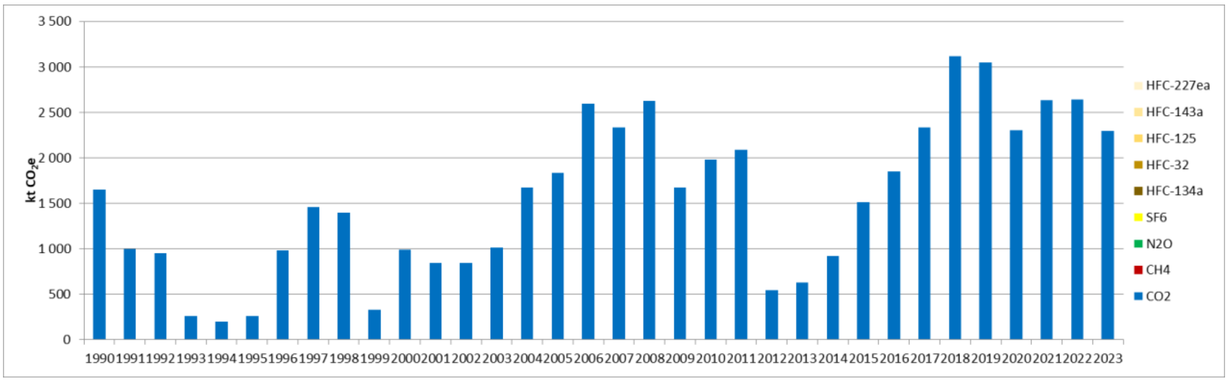


Figure 64: GHG emissions for sinter production, for the period 1990-2023 (in kt CO_2e)

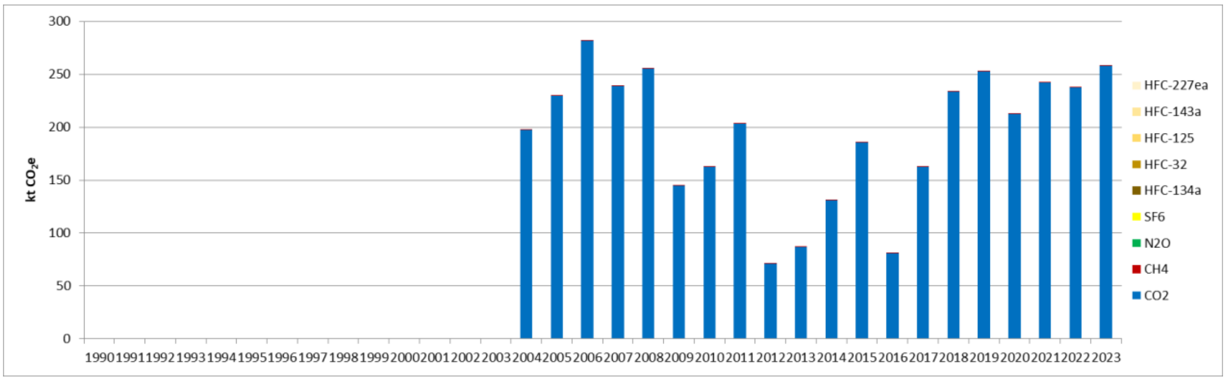
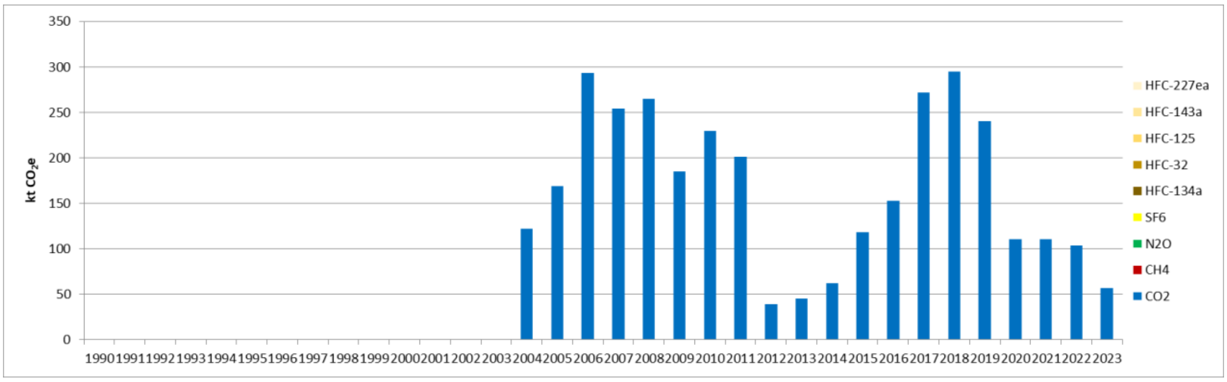


Figure 65: GHG emissions for pellet production, for the period 1990-2023 (in kt CO_2e)



CO_2 emissions from the iron and steel sector declined from 1990 to 1994 due to the decrease in industrial activities, caused by the war in Serbia. In addition, sudden declines in activities are observed in 1999, due to the NATO bombing, in 2009 due to the global economic crisis, and in 2012 due to reduced market demand for iron and steel, which consequently led to a lower utilization of production capacities in these industries. Between 2012 and 2018, the steel production has significantly and progressively increased, by 470%, before slightly decreasing in 2020 due to the pandemic and being stable since then. Similar observations, to different extents, can be made for the other subsectors of the pellet and sinter productions.

The steel industry has significant production capacities, which have been renewed, and has significantly raised their production after privatization (since 2001).

4.4.1.2 Methodological issues

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate the CO_2 and CH_4 emissions (equations 4.4, 4.7, 4.8 and 4.12 of the 2006 IPCC Guidelines [I22]). Tier 1 methodology provides equations for the calculation of:

- CO_2 and CH_4 emissions for sinter production,
- CO_2 emissions for pellets production,
- CO_2 emissions for iron and steel production (the equation includes pig iron production process and BOF steel production process).

The pig iron and crude steel productions come from the WorldSteel statistical yearbook [I23]. It is assumed that all pig iron is converted into steel.

The sinter and pellet productions come from SEPA questionnaires with the only operator [I24].

Default CO_2 emission factors from the 2006 IPCC Guidelines [I22] are used for steel production (1.46 t CO_2/t steel produced), sinter production (0.2 t CO_2/t sinter produced) and pellets production (0.03 t CO_2/t pellet produced).

Default CH_4 emission factor from the 2006 IPCC Guidelines [I22] is used for the sinter production (0.07 kg CO_2/t sinter produced).

4.4.2 Magnesium production (CRT 2C4)

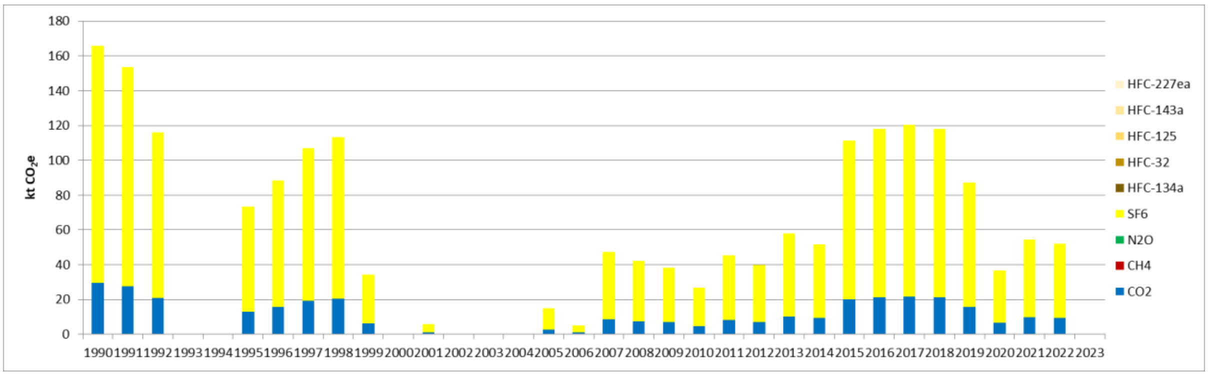
4.4.2.1 Category description

This category refers to process emissions occurring in both primary and secondary magnesium productions. During the primary production manufacturing, carbonated raw materials such as dolomite or magnesite are used and release CO_2 during the calcination process. The secondary production includes recovery and recycling of magnesium. Magnesium casting process may involve primary and secondary magnesium. As molten magnesium burns in presence of oxygen, high GWP gaseous components such as SF_6 or HFC are used in required protection systems to prevent burning.

In the Republic of Serbia, primary magnesium is produced from dolomite casting. CO_2 and F-gases emissions are expected.

In the following graph, the GHG emissions from this source are displayed. Many variations are observed since 1990, with the highest emission level occurring in 1990 during the studied period. After a rapid decline between 1990 and 1993, where the activity stopped for two years (1993-1994) during the war, the emissions recovered until 1999 where a plunge is observed due to the NATO bombing. GHG emissions are marginal or even null between 2000 and 2006 and remained relatively stable between 2007 and 2014, but at rather low levels compared with the pre-crisis levels (ranging from between half and a quarter). After a recovery of the GHG emission from this subsector between 2015 and 2019, a drop is observed in 2020 related to the pandemic. Since then, the activity, and hence emissions, from this subsector, remained rather low to stop completely in 2023.

Figure 66 : GHG emissions for magnesium production, for the period 1990-2023 (in kt CO_2e)



In 2023, the subsector magnesium production is not a key category in terms of emissions level but is ranked 49 (0.4%) in terms of emissions trend for GHG emissions, in Serbia.

4.4.2.2 Methodological issues

The methodology used is Tier 1. CO_2 and SF_6 emission estimates come respectively from Equation 4.28 and 4.30 of magnesium production section in 2006 IPCC Guidelines [I25]. HFC emissions are not estimated since 2006 IPCC Guidelines do not provide Tier 1 or Tier 2 methodologies nor default emission factors, unless emissions can occur.

Activity data used for the calculation are national magnesium productions and come from SORS [I2] for the time series.

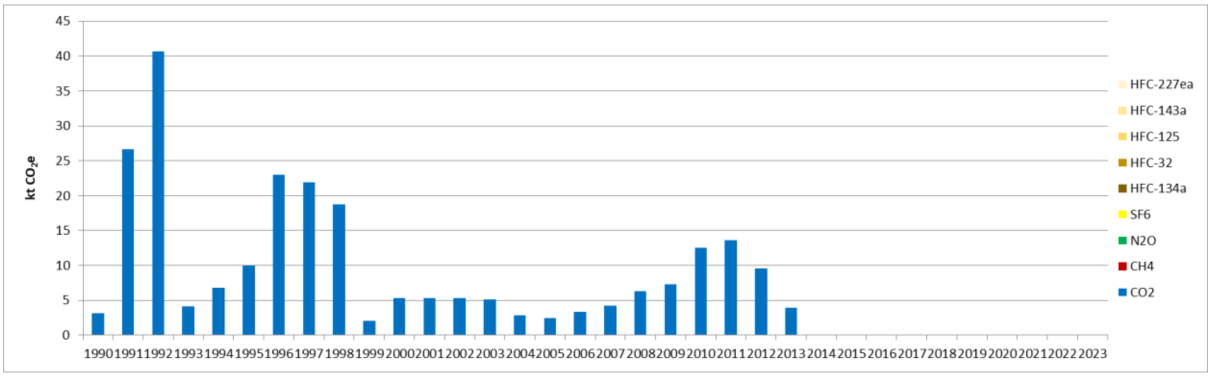
Default emission factors for CO_2 and SF_6 are constant on the time series and come from 2006 IPCC Guidelines. Recommended applied values are respectively 5.13 t CO_2/ t primary Mg [26] and 1 kg SF_6/ t Mg casting [I27].

4.4.3 Lead production (CRT 2C5)

4.4.3.1 Category description

This category refers to process emissions occurring in both primary and secondary lead productions. GHG emissions expected are CO_2 released from the use of carbonated reductants in the process.

Figure 67 : GHG emissions for lead production, for the period 1990-2023 (in kt CO_2e)



Since 2014, the primary and secondary lead production stopped and is now considering as not occurring (NO).

In 2023, the category lead production is neither a key category in terms of emission level nor in terms of emission trend for GHG emissions in Serbia.

4.4.3.2 Methodological issues

The methodology used is Tier 1. CO_2 emissions estimate come from Equation 4.32 of lead production section in 2006 IPCC Guidelines [I28].

Activity data used for the calculation are national primary and secondary lead productions. The primary lead production does not occur in Serbia after 2003. The source of activity data for lead production is direct communication with the operator [I29]. There were no data for secondary lead before 2000. As the process is not known, it is assumed that activity data are splitted between Direct Smelting process (20%) and Imperial Smelting Furnace process (80%), accordingly to default ratios provided in 2006 IPCC Guidelines [I28].

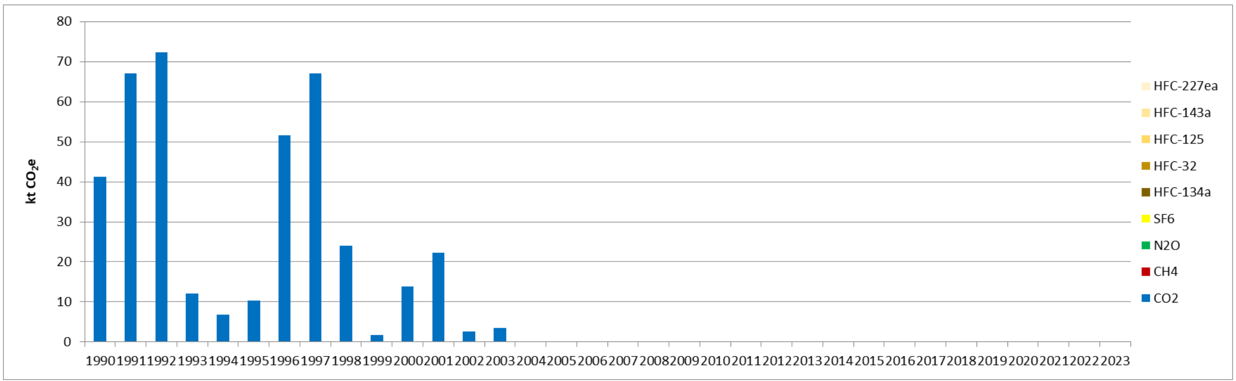
For primary production, default emission factor for CO_2 is constant by process on the time series and comes from 2006 IPCC Guidelines. Recommended applied values are 0.59 t CO_2/ t lead for ISF process and 0.25 t CO_2/ t lead for DS process [I30]. For secondary production, default emissions factor for CO_2 is constant on the time series. The value provided by 2006 IPCC Guidelines is 0.2 t CO_2/ t secondary lead [I30].

4.4.4 Zinc production (CRT 2C6)

4.4.4.1 Category description

This category refers to process emissions occurring in both primary and secondary zinc productions. GHG emissions expected are CO_2 released from the use of carbonates and reductants in the process. There is no more zinc production in the Republic of Serbia since 2004.

Figure 68 : GHG emissions for zinc production, for the period 1990-2023 (in kt CO_2e)



In 2023, the category zinc production is neither a key category in terms of emissions level nor in terms of emissions trend for GHG emissions in Serbia.

4.4.4.2 Methodological issues

The methodology used is Tier 1. CO_2 emission estimates come from Equation 4.33 of zinc production section in 2006 IPCC Guidelines [I31].

Activity data used for the calculation are the national zinc productions. The source for activity data concerning this category is SORS [I2]. From 2004, zinc production does not occur.

As the process is not known, default emission factor for CO_2 of 2006 IPCC Guidelines is used and considered constant on the time series and come. Recommended applied value is 1.72 t CO_2/ t zinc [I33].

4.4.5 Uncertainties and time-series consistency

CO_2

Uncertainty estimate associated with activity data for CRT 2C amounts to 10%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 4 – Table 4.4).

Uncertainty estimate associated with default emission factor amounts to 25%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 4 – Table 4.4).

Combined uncertainty for emissions is 1.2% in the total national levels of emission in 2023, excluding LULUCF contribution.

CH_4

Uncertainty estimate associated with activity data for CRT 2C amounts to 10%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 4 – Table 4.4).

Uncertainty estimate associated with default emission factor amounts to 25%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 4 – Table 4.4).

Combined uncertainty for emissions is 0.000001% in the total national levels of emission in 2023, excluding LULUCF contribution.

SF_6

Uncertainty estimate associated with activity data for CRT 2C amounts to 20% based on expert judgment.

Uncertainty estimate associated with default emission factor amounts to 5% based on expert judgment.

Combined uncertainty for emissions is null in the total national levels of emission in 2023, excluding LULUCF contribution.

4.4.6 Category-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 keys in the CRT tables.

Operators’ questionnaires are checked by the competent authorities.

4.4.7 Category-specific recalculations

No recalculations were made since previous NID submission (November 2024).

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	1 733	295	1 009	2 242	2 392	2 519	675	774	1 125	1 837	2 112	2 794	3 671	3 560	2 631	2 998	2 997	0
Nouveau	kt CO2e	1 733	295	1 009	2 242	2 392	2 519	675	774	1 125	1 837	2 112	2 794	3 671	3 560	2 631	2 998	2 997	2 612
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+2 612
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 2.C

4.4.8 Category-specific planned improvements

For the metal industry, especially for the iron and steel industry, the magnesium production and the lead production, the completeness and the consistency of the activity data set have to be improved.

4.5 Non-energy products from fuels and solvent use (CRT 2D)

This CRT 2D category covers the following emission sources:

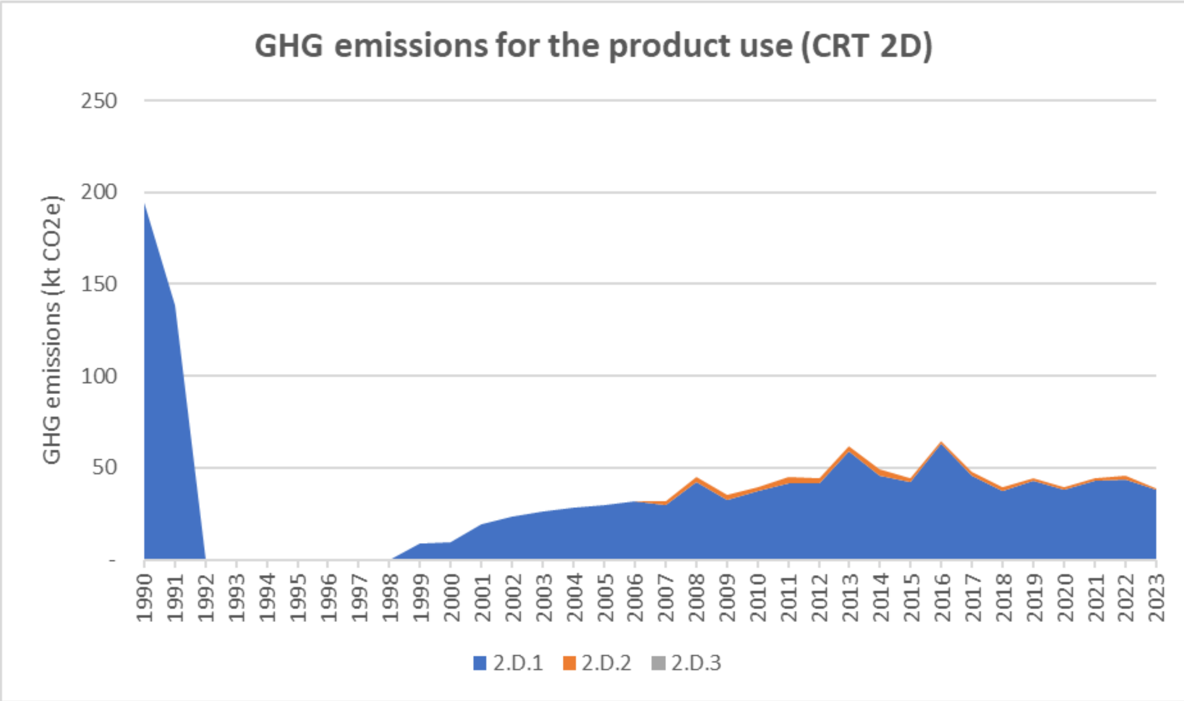
- The use of lubricant (CRT 2D1),
- The use of paraffin wax (CRT 2D2),
- The use of solvents (CRT 2D3).

All these emission sources are responsible of CO_2 emissions.

In 2023, in the Republic of Serbia, the CRT 2D is responsible of 0.1% of the national GHG emissions, excluding LULUCF contribution, and of 1% of the GHG emissions of CRT 2.

The following graph presents the GHG emission trend of the CRT 2D. After having undergone a significant reduction between 1990 and 1992, due to the war, and a relatively stable period from 1992 to 1998, the GHG emissions are in a slow and constant increase since then. This evolution is particularly related to the increase in the use of lubricant, related to the traffic growth. In 2023, the emissions from this sector are almost entirely due CRT 2D1 (99% of the category), the remainder being the paraffin wax use (CRT 2D2). It should be noted that the solvent use category (2D3) produces only NMVOC emissions which then react in the atmosphere and form indirect CO_2, and as such does not appear in the graph below.

Figure 69: GHG emissions trends for the non-energy product uses (CRT 2D), for the period 1990-2023, per subcategory (in kt CO_2e)



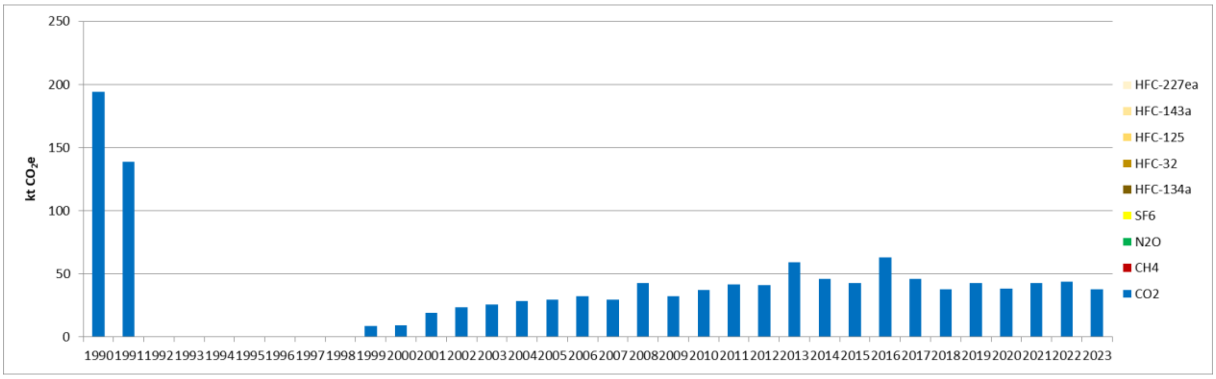
4.5.1 Lubricant use (CRT 2D1)

4.5.1.1 Category description

CO_2 emissions are implied by the use of lubricant in industrial and road applications. In this sector, only emissions related to non-energy use of lubricants are considered. The use of lubricant in mixtures with fuel such as gasoline, where it is burned in engines, is not considered in this section but in the CRT 1A3b or the non-road mobile sectors.

In 2023, the category Lubricant use is a key category in terms of emissions trend, in the Republic of Serbia. This sector contributes to 0.4% in terms of emission trend (rank 47).

Figure 70: CO_2 emissions for lubricant use, for the period 1990-2023 (in kt CO_2e)



CO_2 emissions from lubricant use declined rapidly between 1990 and 1992, in relation with the war. Emissions related to lubricant use increased progressively until 2008, before being relatively stable and slightly oscillating up to 2023. The lubricant consumption varies partly in consequence of the road traffic.

4.5.1.2 Methodological issues

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate the CO_2 emissions (equation 5.2 of the 2006 IPCC Guidelines [I34]).

The national non-energy lubricant consumption comes from the energy balance of Serbia [E2].

The default CO_2 emission factor from the 2006 IPCC Guidelines [I35] is used and its value is 20 t C/TJ. It is considered constant for the entire time-series. The default oxidation fraction parameter for lubricants is taken as default value from the 2006 IPCC Guidelines and is of 0.2 [I34].

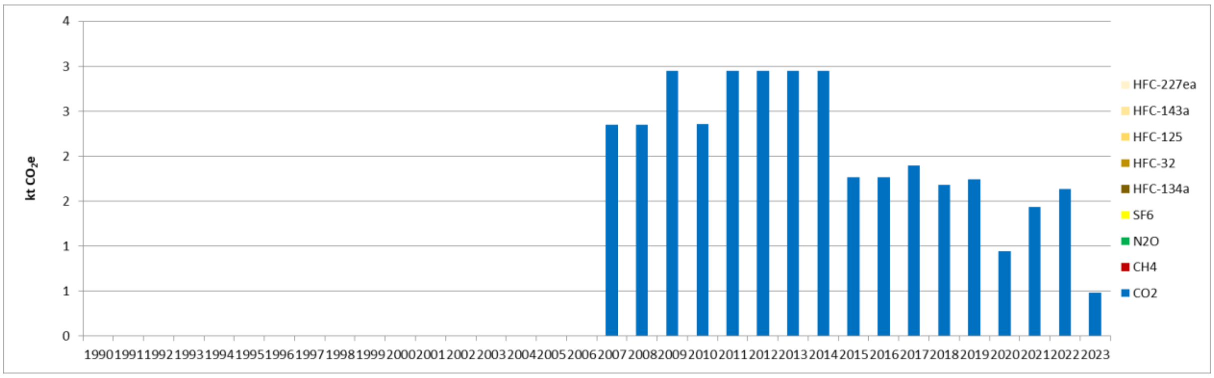
4.5.2 Paraffin wax use (CRT 2D2)

4.5.2.1 Category description

CO_2 emissions are implied by the use of products such as paraffin wax, petroleum jelly, and other waxes, including ozokerite. Paraffin waxes are used in various types of product such as candles, paper coating, food production, surfactants, etc. Emissions arise when these products are either burned or incinerated. However, when paraffin wax products are incinerated, emissions should be considered in Energy or Waste sector depending whether or not there is heat recovery.

In 2023, the category Paraffin wax use is neither a key category in terms of emission level nor in emission trend, in the Republic of Serbia.

Figure 71: CO_2 emissions for paraffin wax use, for the period 1990-2023 (in kt CO_2e)



Paraffin wax use started in 2007 and remained relatively low, fluctuating between 2 to almost 3 kt CO_2e until 2022. In 2023, emissions registered a 70% decrease.

4.5.2.2 Methodological issues

The Tier 1 method from the 2006 IPCC Guidelines is used to calculate the CO_2 emissions (equation 5.4 of the 2006 IPCC Guidelines [I36]).

The national non-energy paraffin wax consumption comes from the energy balance of Serbia [E2].

The default CO_2 carbon content from the 2006 IPCC Guidelines is applied and is of 20 t C/TJ [I36]. It is considered constant for the entire time-series. The default oxidation fraction parameter for lubricants is taken as default value from the 2006 IPCC Guidelines and is of 0.2 [I36].

4.5.3 Solvent use (CRT 2D3)

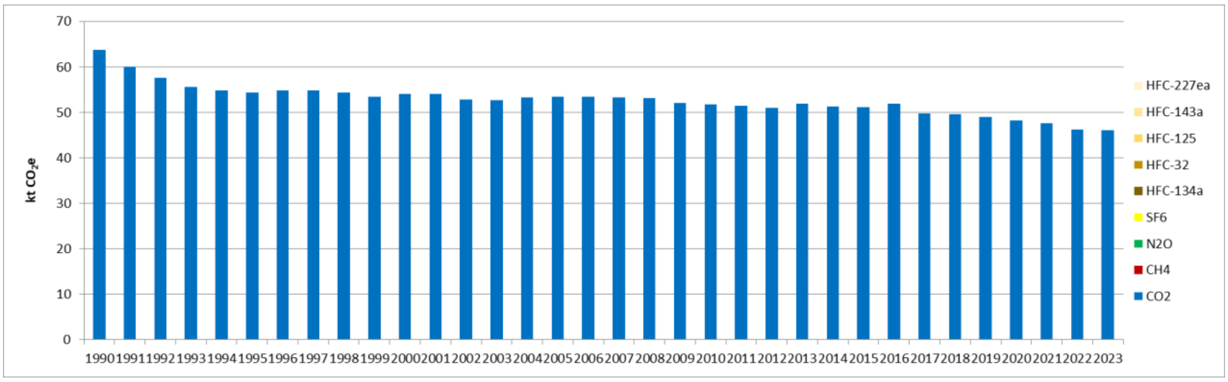
4.5.3.1 Category description

The use of solvents is responsible for evaporative emissions of NMVOC, which is further oxidised in the atmosphere and induce CO_2 emissions. If the solvents are made from fossil fuels, the oxidised carbon needs to be accounted in the national totals, but as indirect CO_2 emissions. Fossil fuels used as solvents are principally white spirit and kerosene.

Since the submission in 2025, the CO_2 emissions from this category are now reported as indirect CO_2 emissions.

In 2023, the indirect CO_2 emissions from Solvent use is neither a key category in terms of emission levels nor in emission trend, in the Republic of Serbia.

Figure 72: Indirect CO_2 emissions for solvent use, for the period 1990-2023 (in kt CO_2e)



The indirect CO_2 emissions related to the use of solvent are slightly and continuously declining through the timeseries. The achieved emission reduction for the period 1990-2023 is of 28%.

4.5.3.2 Methodological issues

A mix of Tier 1 ad Tier 2 methods from the EMEP/EEA Guidelines is used to calculate the NMVOC emissions related to the solvent use, depending on the subsector. Hence, the associated CO_2 emissions are estimated based on the 2006 IPCC Guidelines [I37].

The activity data vary depending on the emission source and can be either population, the solvent-containing product consumptions such as paint or the production of specific products such as rubber. The activity data come from the Statistical yearbook [I2].

The default fossil carbon content fraction of NMVOC applied comes from the 2006 IPCC Guidelines and its value is of 60% [I37].

Emissions related to the use of urea are not estimated as there is a lack of data accessibility concerning the imports and exports of this product.

4.5.4 Uncertainties and time-series consistency

CO_2

Uncertainty estimate associated with activity data for CRT 2D amounts to 15%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 5.2.3.2).

Uncertainty estimate associated with default emission factor amounts to 50%, accordingly to values reported in 2006 IPCC Guidelines (Volume 3 Chapter 5.2.3.1).

Combined uncertainty for emissions is 0.08% in the total national level of emission in 2023, excluding LULUCF contribution.

4.5.5 Category-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 keys in the CRT tables.

4.5.6 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	258	54	63	83	91	96	95	114	100	95	117	98	89	93	87	92	92	0
Nouveau	kt CO2e	194	0	9	30	39	45	44	62	49	44	65	48	39	45	39	44	46	39
Différence	kt CO2e	-64	-54	-54	-53	-52	-51	-51	-52	-51	-51	-52	-50	-50	-49	-48	-48	-46	+39
	%	-24,7%	-100,0%	-85,4%	-64,4%	-56,7%	-53,5%	-53,6%	-45,6%	-51,2%	-53,7%	-44,4%	-50,9%	-55,8%	-52,4%	-55,1%	-51,9%	-50,4%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 2.D

<u>2D3 – Other:</u>

- The emissions from the CRT 2D3 have been transferred to "indirect CO_2 emissions" category.
- The **rubber production (2D3g)** category was recalculated for 2022, incorporating new data for "Other foam (cellular) rubber products, not elsewhere specified."
- A correction was made in 2022 for **solvent use (2D3i)**, specifically adjusting the figures related to shoe production.

4.5.7 Category-specific planned improvements

For the use of non-energy products, the completeness and the consistency of the activity data set could be improved, in particular for lubricant, paraffin wax, as well as data about the imports and exports of urea. Discussion with the Statistical office, which provide these data, will be engaged.

4.6 Product uses as substitutes for ODS (CRT 2F)

The CRT 2F category covers the following subsectors:

- Refrigeration and air conditioning (2F1),
- Foam blowing agents (2F2),
- Fire protection (2F3),
- Aerosols (2F4).

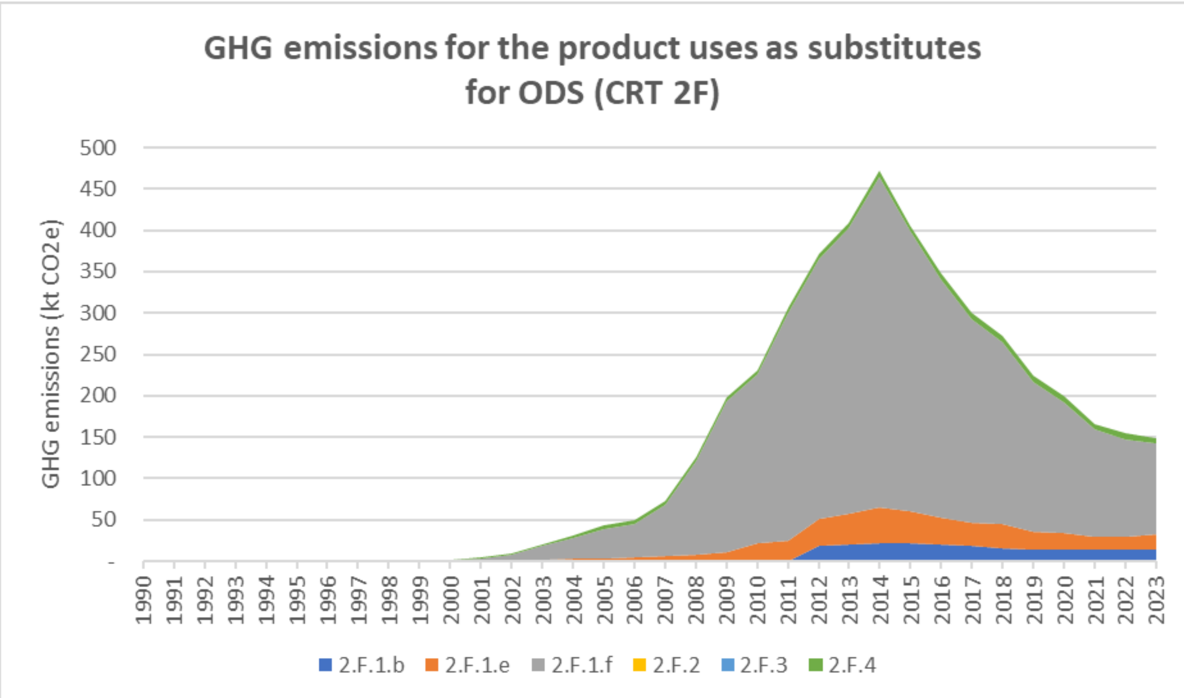
The Solvent sector (2F5) does not occur in the Republic of Serbia.

The category CRT 2F is the only contributor to HFC emissions in the Serbian inventory. In 2023, HFCs emissions contributed to 3.1% of the CRT 2 sectoral GHG emissions, as well as 0.24% to the total GHG emissions, excluding LULUCF contribution.

It can be observed that GHG emissions related to this activity appeared in 1997, increased slowly until 2007, and much faster between 2007 and 2014 (+542%), before decreasing progressively until the latest year 2023. The growth is related to the development of the use of fluorinated gases, whereas the decline corresponds to the impact of the regulation on the use of such substances (Regulation on the treatment of fluorinated gases with a greenhouse effect, as well as on the conditions for issuing permits for the import and export of these gases (OJ No 120/13)). Between 2014 and 2023, the achieved emission reduction is of 68%.

The main emission source of the sector is the stationary air conditioning, commercial and industrial refrigeration (CRT 2F1f), which represents most of the emissions throughout the timeseries. In 2023, this subsector contributes to 74% of the sector GHG emissions.

Figure 73: GHG emissions trends for the product uses as substitutes for ODS (CRT 2F), for the period 1990-2023, per subcategory (in kt CO_2e)



4.6.1 Refrigeration and air-conditioning (2F1)

4.6.1.1 Category description

Refrigeration and air conditioning accounts for most of the emissions in CRT 2F sector (95% in 2023). Emissions are released by the consumption of synthetic greenhouse gases (HFC-32, HFC-125, HFC-134a and HFC-143a), which are used as substitutes for cooling gases in refrigerating and air-conditioning systems that deplete the ozone layer (CFCs and HCFCs). This category includes the use of these substances in Commercial Refrigeration, Domestic Refrigeration, Industrial Refrigeration, Mobile Air-Conditioning and Stationary Air-Conditioning.

The 2F1 sector is split between 2F1b (domestic refrigeration), 2F1e (mobile air conditioning) and 2F1f (aggregated emission for stationary air conditioning, commercial and industrial refrigeration).

In 2023, the 2F1f subsector is a key category for HFCs emissions, in terms of emission trend, in the Republic of Serbia. This sector contributes to 0.4% in terms of emissions trend (rank 45). However, in 2023, the 2F1b and 2F1e subsectors are neither key categories in terms of emission levels and emission trend for GHG emissions in Serbia.

Refrigerants used in Serbia are R-134a, R-404A, R-407C and R-410A. The emissions by subsectors are summarized below:

Figure 74: GHG emissions for domestic refrigeration, for the period 1990-2023 (in kt CO_2e)

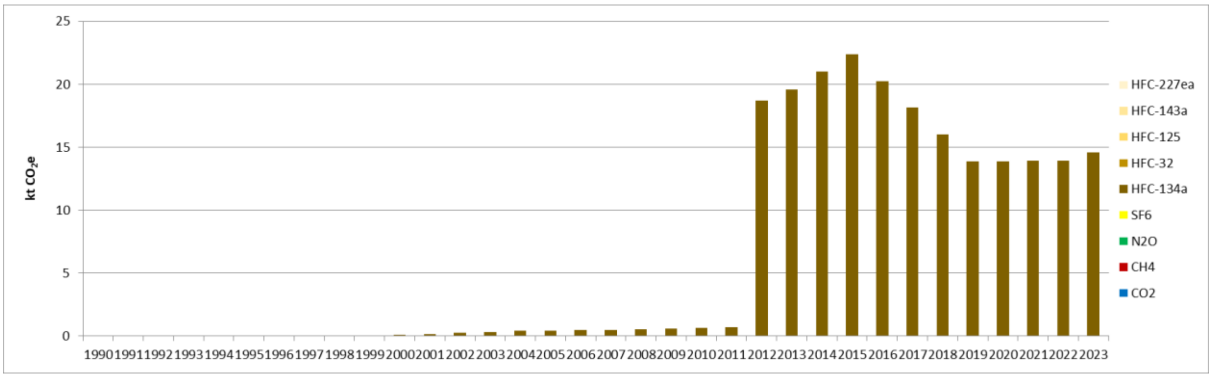


Figure 75: GHG emissions for mobile air-conditioning, for the period 1990-2023 (in kt CO_2e)

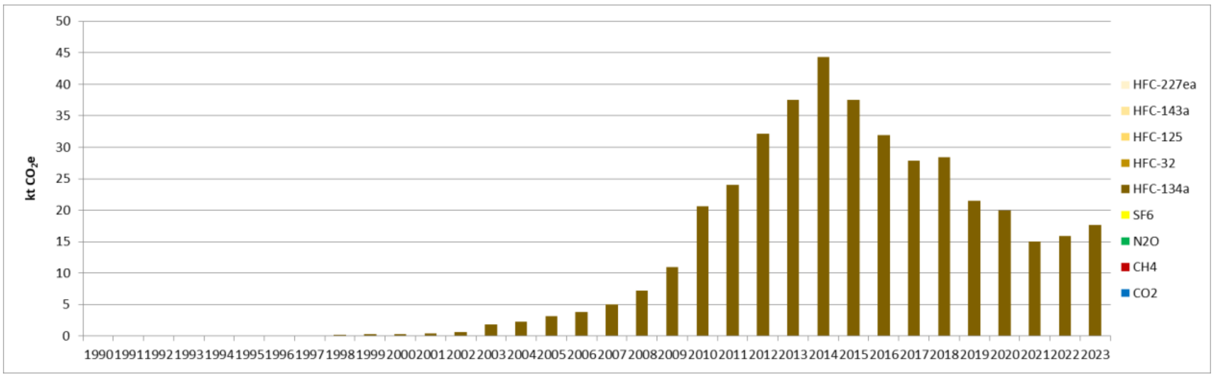
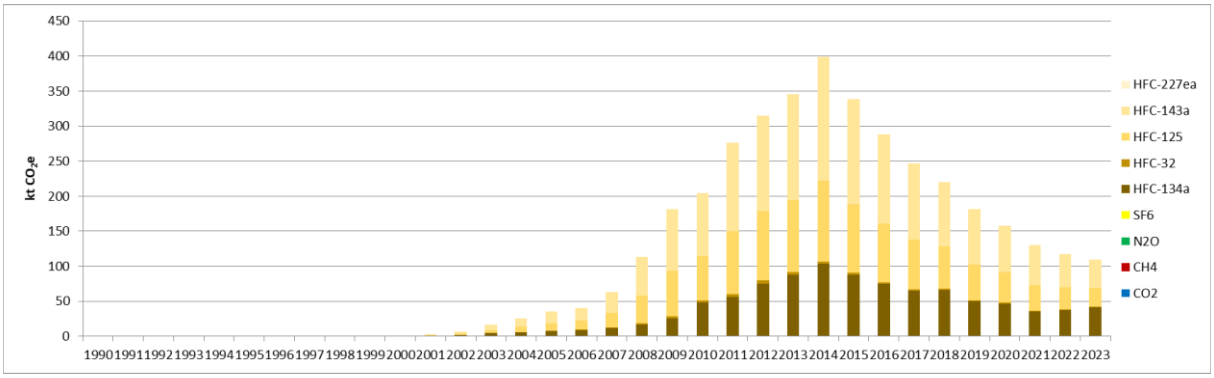


Figure 76: GHG emissions for commercial refrigeration, industrial refrigeration and stationary air-conditioning, for the period 1990-2023 (in kt CO_2e)



HFCs began to be used to a greater extent in the mid-2000s, but due to the increase of the average annual stock of refrigerant, emissions began to be high in early 2010s. Concerning HFC-134a domestic emissions, the high increase from 2012 was caused by emissions at the freezers' end of life. Indeed, it is assumed that there is no recovery of HFC at the decommissioning.

The implementation of the regulation on treatment and transfers of fluorinated gases implemented in 2013 enabled to achieve important emission reductions in CRT 2F1e and 2F1f since 2014.

4.6.1.2 Methodological issues

On one hand, Tier 1 methodology is used for 2F1e and 2F1f sectors due to missing data on average annual stocks. On the other hand, Tier 2a methodology is used for 2F1b sector.

4.6.1.2.1 Domestic refrigeration (2F1b)

The amount of HFC-134a contained in freezers in the Republic of Serbia is estimated with the following parameters:

- number of households in Serbia each year,
- share of households equipped with a freezer each year,
- repartition of gases introduced in new freezers,
- gas amount per appliance.

The number of households in Serbia and the share of households equipped with a freezer are collected each year in the statistical book [I2].

The repartition of the types of gas introduced in the new freezers (CFC-12, HFC-134a, HC-600a) is provided by a UNEP report [I38] and the knowledge of Serbian situation. UNEP report notices that 100% of the refrigerants used in 1992 are CFC-12 for Eastern Europe region, then 53% of refrigerant used in new equipment are HFC-134a in 1996, 66% in 2000, 40% in 2004 and 2008. Serbian information enables to know that the year of HFC introduction was 1997.

The gas amount per appliance comes from 2006 IPCC Guidelines [I39].

The emissions are calculated with Equation 7.10 of the 2006 IPCC Guidelines [I44]. The annual emission rate comes from 2006 IPCC Guidelines [I39] and it is assumed that there is no recovery of HFC during decommissioning appliances.

4.6.1.2.2 Mobile air conditioning (2F1e)

The Serbian Ministry of Environmental protection yearly collects data on quantities of HFCs imported and exported. The share of HFC-134a imported and exported used for mobile air conditioning is distinguished. The IPCC tool [I45] is used for the calculation of HFC-134a emissions. The different parameters used in this tool are presented below:

- The year of introduction is 1997,
- The assumed equipment lifetime is 15 years,
- The emission factor from installed base is 15%,
- The percentage destroyed at end of life is 0% (no recovery).

4.6.1.2.3 Stationary air conditioning, commercial and industrial refrigeration (2F1f)

The Serbian Ministry of Environmental protection yearly collects data on quantities of HFCs imported and exported. The share of refrigerant by sub-application (stationary air conditioning, commercial, industrial refrigeration) is not available. Consequently, emissions are aggregated in the same CRT code. As for 2F1e subsector, IPCC tool [I45] is used for the calculation of HFCs emissions. The different parameters used in this tool are presented below:

- The year of introduction is 1997 for HFC-134a and 2001 for HFC-32, HFC-125 and HFC-143a,
- The assumed equipment lifetime is 15 years,
- The emission factor from installed base is 15%,
- The percentage destroyed at end of life is 0% (no recovery).

4.6.2 Foam blowing agents (2F2)

4.6.2.1 Category description

This sector is currently not estimated due to a lack of available activity data. A questionnaire has been sent to determine whether HFCs are effectively used in Serbia foam manufacturer (Cf. chapter on planned improvements).

4.6.2.2 Methodological issues

Not estimated.

4.6.3 Fire protection (2F3)

4.6.3.1 Category description

This sector is currently not estimated because of the lack of activity data available. Questionnaire has been sent in order to know if HFCs are used in Serbia fire protection operators (Cf. chapter on planned improvements).

4.6.3.2 Methodological issues

Not estimated.

4.6.4 Aerosols (2F4)

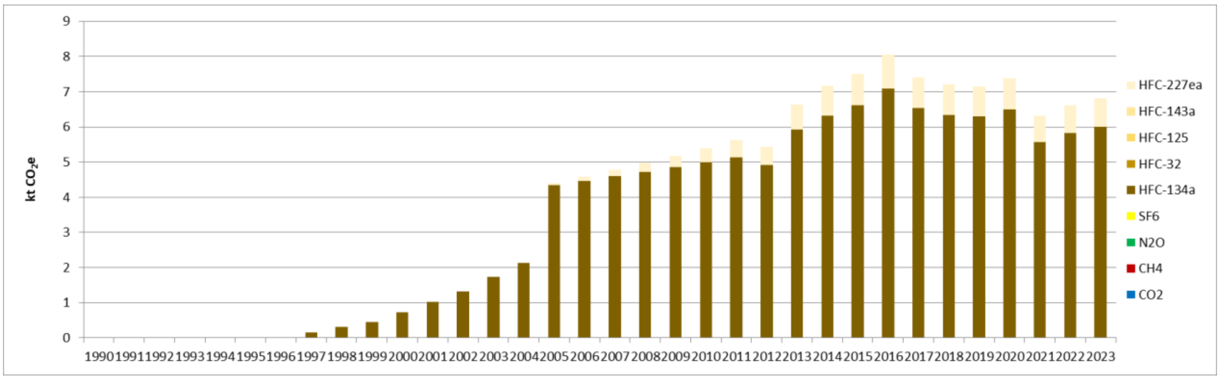
4.6.4.1 Category description

Metered dose inhalers (MDIs) are used to deliver certain pharmaceutical products as aerosols. For patients with respiratory illnesses, such as asthma and chronic obstructive pulmonary disease (COPD), medication needs to be delivered directly to the lungs. MDIs are one of the preferred means of delivering inhaled medication to patients with these illnesses. MDIs originally used CFC propellants but, as with industrial aerosols, concern over ozone destruction led to attempts to replace CFCs with HFCs.

In 2023, the category 2F4 aerosol is neither a key category in terms on emission level nor emission trend for GHG emissions in the Republic of Serbia.

The type of HFCs used are HFC-134a and HFC-227a. The emissions are summarized below:

Figure 77: GHG emissions for pharmaceutical aerosols, for the period 1990-2023 (in kt CO_2e)



The number of MDIs sales which contained HFCs increase with the substitution of propellant gas (CFC to HFC) and the growth of respiratory illnesses.

4.6.4.2 Methodological issues

The methodology used to estimate HFCs emissions corresponds to an IPCC Tier 2 method. Indeed, specific data for pharmaceutical aerosols have been collected. The amount of HFC is estimated with the following parameters:

- quantity of MDIs sales (number of doses) in Serbia each year,
- number of asthma patients,
- amount of HFC in one dose,
- share of type of propellant (CFC, HFCs).

The quantity of MDI sales is provided by Medicines and Medical Devices Agency of Serbia from 2004.

The number of asthma patients is used in order to estimate the MDIs sales before 2016. Indeed, the ratio of number of asthma patients and MDI sales of 2016 is used to calculate MDI sales for years before 2004. The number of asthma patients is provided in the health statistical yearbook of Republic of Serbia [I40].

The average amount of HFC contained in one dose come from the big manufacturer of MDI (GSK) [I41]. This quantity used is 12 g of HFC per dose.

The type of propellant used comes from a UNEP report and French information. Thus, it is assumed that 95% of HFC-134a and 5% of HFC-227ea are used in 2014 [I42]. The year of HFC-134a introduction to replace CFC is 1997 (approximately 4%) [I43]. The share of HFC-134a increase over time until 2005 (100%). From 2005 to 2014, the share of HFC-227ea gradually increased until 2014.

The emissions are calculated with Equation 7.6 of the 2006 IPCC Guidelines [I46]. It is assumed that all the HFC contained in the MDI is emitted in one year. Consequently, the emission factor used is 100%.

4.6.5 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 20%, based on expert judgment.

Uncertainty estimate associated with HFC emission factor amounts to 20%, also based on expert judgment.

Combined uncertainty for emissions is 0.07% in the total national levels of emission in 2023, excluding LULUCF contribution.

4.6.6 Category-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 keys in the CRT tables. Especially, new sectors have been estimated (domestic refrigeration and pharmaceutical aerosols).

4.6.7 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission of November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	0	0	2	43	231	306	371	409	472	406	348	300	272	224	199	165	161	0
Nouveau	kt CO2e	0	0	2	43	231	306	371	409	472	406	348	300	272	224	199	165	154	149
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-7,4	+149
	%	-	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-4,6%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 2.F

2F1 - Refrigeration emissions

Data for HFC-134a were corrected for 2022, with erroneous data removed from the **Domestic refrigeration** subcategory.

4.6.8 Category-specific planned improvements

4.6.8.1 Refrigeration and air conditioning (2F1)

- In the methodology used for 2F1e and 2F1f, estimated emissions based on the import/export data do not take into account the amounts of F-gases which are contained in the imported equipment in Serbia (example: stationary air conditioning or mobiles air conditioning). Consequently, one improvement would be to develop the Tier 2 methodology from 2006 IPCC guidelines to consider these quantities and to distinguish the different sub-applications (stationary air conditioning, commercial refrigeration and industrial refrigeration).

4.6.8.2 Foam blowing agents (2F2)

- This sector has been identified as a source of HFC emissions. This sector is currently not included in the inventory because no activity data is available. Survey was sent to concerned manufacturers/operators. Consequently, the improvement will be to estimate emission for foam blowing agents.

4.6.8.3 Fire protection (2F3)

- This sector has been identified as a source of HFC emissions. This sector is currently not included in the inventory because no activity data is available. Survey was sent to concerned manufacturers/operators. Consequently, the improvement will be to estimate emission for fire protection.

4.6.8.4 Aerosols (2F4)

- For the CRT 2F4 (pharmaceutical aerosol), the quantities of pharmaceutical aerosols sold in Serbia are only available for the years 2004 - 2023 by type of MDI. Consequently, the improvement would be to collect the amount of HFC contained in each product and to collect data MDI sales for the years before 2004.

4.7 Other product manufacture and use (CRT 2G)

4.7.1 Electrical equipment (2G1)

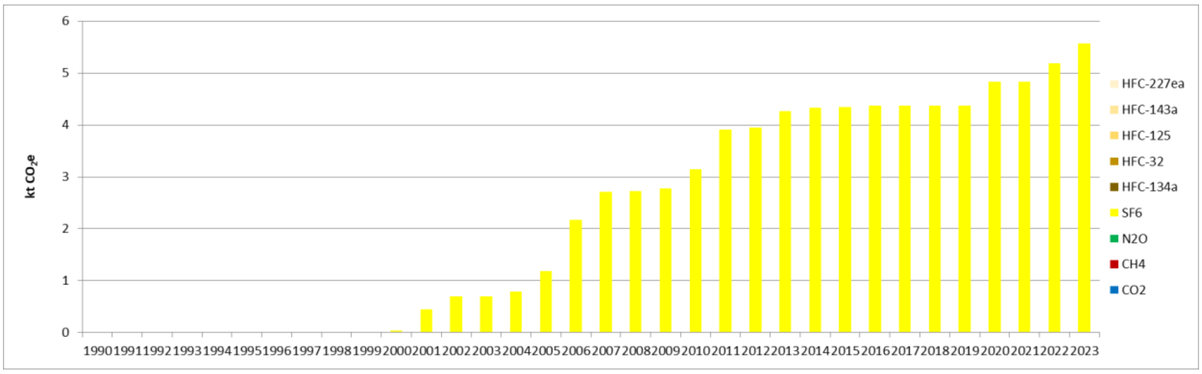
4.7.1.1 Category description

Sulphur hexafluoride (SF_6) is used in electrical equipment in order to insulate them and prevent current transmission. At each phase of the life cycle of the equipment, some emissions occur. The different phases of the life cycle include the manufacturing, installation, use, servicing and disposal. Two types of equipment need to be considered, the category “Sealed pressure systems” which do not require refilling, and the other “Closed pressure systems” which require refilling during its lifetime and contain much more gas (between 5 and several hundred kilograms).

In 2023, the category 2G1 electrical equipment is neither a key category in terms on emission level nor emission trend for GHG emissions in the Republic of Serbia.

SF_6 emissions related to electrical equipment started occurring in 2000 and increased progressively until 2013, before being rather stable until 2019. Since then, it appears to be on an upward trend.

Figure 78: GHG emissions for electrical equipment, for the period 1990-2023 (in kt CO_2e)



4.7.1.2 Methodological issues

The methodology used is Tier 1. SF_6 emission estimates come from Equation 8.1 of emissions of SF_6 and PFCs from electrical equipment section in 2006 IPCC Guidelines [I32].

Activity data used for the calculation are the nameplate capacity of installed equipment given for different values of voltage (110, 220 and 400 kV), for the 2000-2023 period, sourced from the electricity supplier Elektromreža Srbije (EMS). No activity data are considered for medium voltage in the Republic of Serbia.

Default Tier 1 emission factors for SF_6 of 2006 IPCC Guidelines are applied and considered constant on the time series. The values for the SF_6 fractions in high voltage equipment considered are as follows, depending on the phase: manufacturing 8.5%, use 2.6%, disposal 95%.

Only emissions related to the use of high voltage equipment are estimated. There is a lack of activity data for the other emission sources.

4.7.2 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission of November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nouveau	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0,14	+0,24
	%	-	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-39,2%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 2.G

<u>2G1 – Other product use</u>

A recalculation was completed in 2022, correcting previously inaccurate data.

4.7.3 Category-specific planned improvements

In the upcoming emission inventories, activity data about the SF_6 consumption by equipment manufacturers and the nameplate capacity of retiring equipment will need to be collected to estimate emissions related to manufacturing and disposal, for high voltage equipment.

For medium voltage equipment, all activity data necessary to estimate associated emissions need to be collected.

Chapter 5: Agriculture (CRT sector 3)

Note: Unless stated otherwise, all results discussed in the sectorial chapters consider national totals, excluding indirect CO_2 emissions.

5.1 Overview of sector

The Agriculture sector gathers all emissions related to agricultural activities other than the fuel combustion for the mobile engines, the heating of the buildings, the heating of greenhouses, etc., which are included in the CRT category 1A4c. In addition, the CO_2 emissions related to the carbon from soils and biomass related with agricultural activities are included in the LULUCF sector (CRT 4). This CRT 3 category covers the following sectors:

- Enteric fermentation (3A),
- Manure management (3B),
- Agricultural soils (3D),
- Field burning of agricultural residues (3F),
- Lime application (3G),
- Urea application (3H).

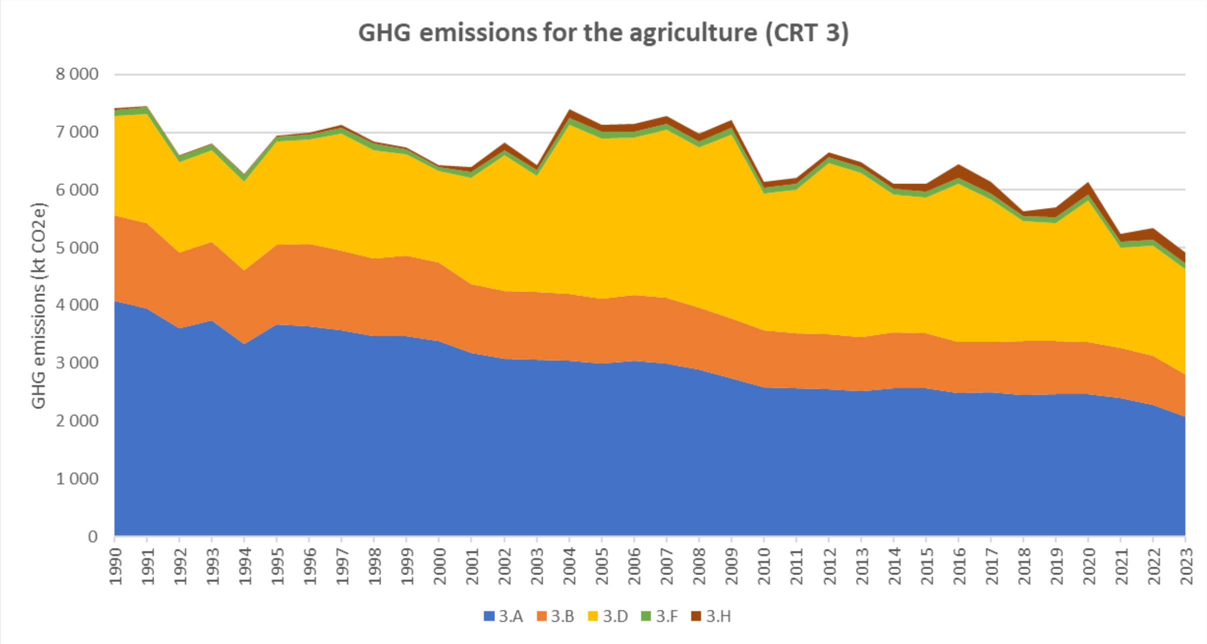
The activities of Rice cultivation (3C), Prescribed burning of savannas (3E) and Other Carbon-containing fertilizers (3I) do not occur in the Republic of Serbia. The emissions of the liming category (3G) are not estimated (NE), due to a lack of available activity data.

In 1990, without considering the LULUCF contribution, the CRT 3 category contributed to the national total emissions of each gas by: 0.05% for CO_2, 40.7% for CH_4, 70.9% for N_2O, and null for the other GHGs, which represented around 8.9% in terms of GHG emissions. In 2023, the same contributions evolved as follows: 0.4% for CO_2, 30.9% for CH_4, 84.1% for N_2O, none for the other GHGs, leading to a rather similar overall contribution in terms of GHG with 7.9% of the national emissions.

Hence, the agriculture sector is an important emissions source of methane and nitrous oxide in the Republic of Serbia, however it is almost negligible in terms of carbon dioxide, with only the application of urea (CRT 3G) being an emission source of this GHG.

The following graph presents the overall GHG emission trend for the agriculture in the Republic of Serbia, for the period 1990-2023, detailed by subsector.

Figure 79: GHG emission trends for agriculture (CRT 3), for the period 1990-2023, per subcategory (in kt CO_2e)



Contrary to the CRT 1 or CRT 2, the trend of emissions of the CRT 3 is rather stable and the different events which occurred in the Republic of Serbia over the studied period did not have as much impact on the emissions as it is the case for the two other sectors. Over the whole studied period, it can be observed that the emissions of both the enteric fermentation (3A) and manure management (3B) progressively decrease, to achieve respectively - 49% and -51% in 2023, compared with 1990, in relation with the decline of the livestock, especially of cattle and swine. The emissions related to the agricultural soils (3D) are more varying over the studied period, increased a lot between 2003 and 2004 and reached its peak, due to the increasing use of inorganic N-fertilisers (3D1a), and decreased significatively between 2016 and 2023 (-33%) in relation with the evolution of this same activity. In addition, the amounts of animal manure applied to soils have been reduced significantly over the timeseries, in relation with the decline of the grazing livestock, hence the N_2O emissions from CRT 3D1bi have decreased by 52% between 1990 and 2023. In overall, the emissions of N_2O of this subsector increased by 7% for the period 1990-2023. Finally, the emissions related to the field burning (3F) are rather stable over the timeseries (-5%) and the emissions of urea application (3H) are varying but overall increasing significantly (+489%). Both these subsectors are rather marginal in the agriculture total emissions, contributing to 2% and 4%, respectively, in 2023. The main subsector contributing to the sector emissions is the category CRT 3A, which represented 55% in 1990 but has a share of 42% in 2023. The subsector of the agricultural soils (3D) was the second highest contributing sector in 1990 with 23%, but close to the manure management (CRT 3B) which had a share of 20% of the sectoral emissions, is in 2023 way more preponderant with 37%, compared with CRT 3B which contributes in 2023 to 15% due to its significant reduction.

In overall, in 2023, GHG emissions from CRT 3 amounted to 4.9 Mt CO_2e, compared with 7.4 Mt CO_2e in 1990, which correspond to a 34% reduction for the whole period. GHG emissions have decreased over the reporting period, mainly as a result of the decrease in the total cattle population (-53% from 1990 to 2023), which has not been compensated in emission totals by the increase in the use of inorganic N-fertilisers or the application of urea (+489%).

5.2 Enteric fermentation (3A)

The enteric fermentation category covers the emissions of methane (CH_4) from the different animal species: cattle (3A1), sheep (3A2), swine (3A3) and others (3A4), including goats and horses.

Among the enteric fermentation (3A), the cattle category (CRT 3A1) is the main source of emissions over the whole studied period, representing 81% of the sector emissions in 1990 and 73% in 2023. Among the cattle category, the subcategory of the dairy cattle (CRT 3A1a) is the most dominant in terms of emissions over the period, with 59% of the CRT 3A1 category in 2023. The other most predominant subsector is the sheep livestock (CRT 3A2), which has an increasing contribution from 12% in 1990 to 21%, compensating the fall from the cattle subsector although the emissions are also in decline (-12%). Finally, the other contributing subsectors are the swine (3A3) and other (3A4) livestock, which have rather stable contributions between 1990 and 2022, about 5% and 2%, respectively, although their emissions decrease.

In overall, for the studied period 1990-2023, the emissions of the CRT 3A category are in continuous and progressive decline, achieving a total reduction of -49%.

Figure 80: GHG emission trends for the enteric fermentation (CRT 3A), for the period 1990-2023, per subcategory (in kt CO_2e)

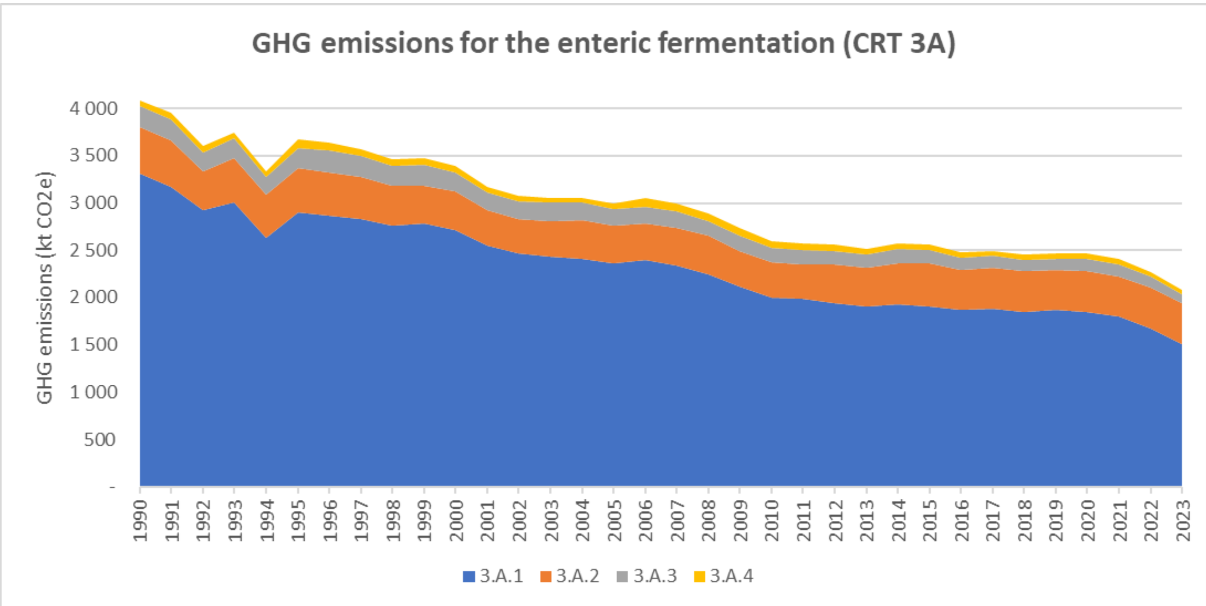
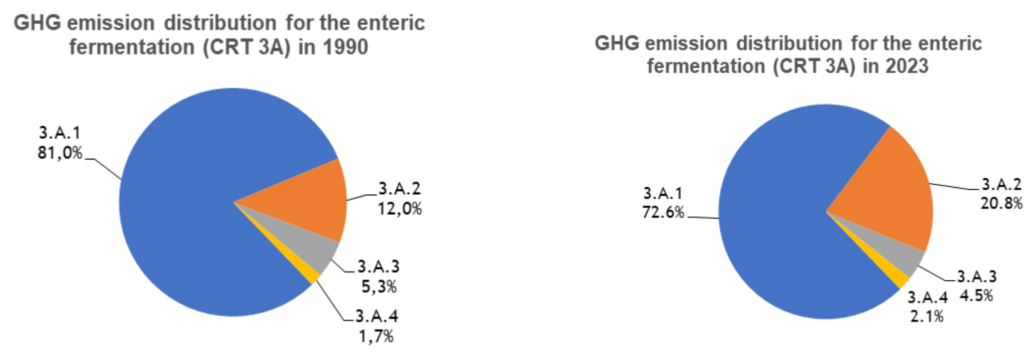


Figure 81: GHG emission distribution for enteric fermentation (CRT 3A), for the period 1990-2023, per subcategory (in %)



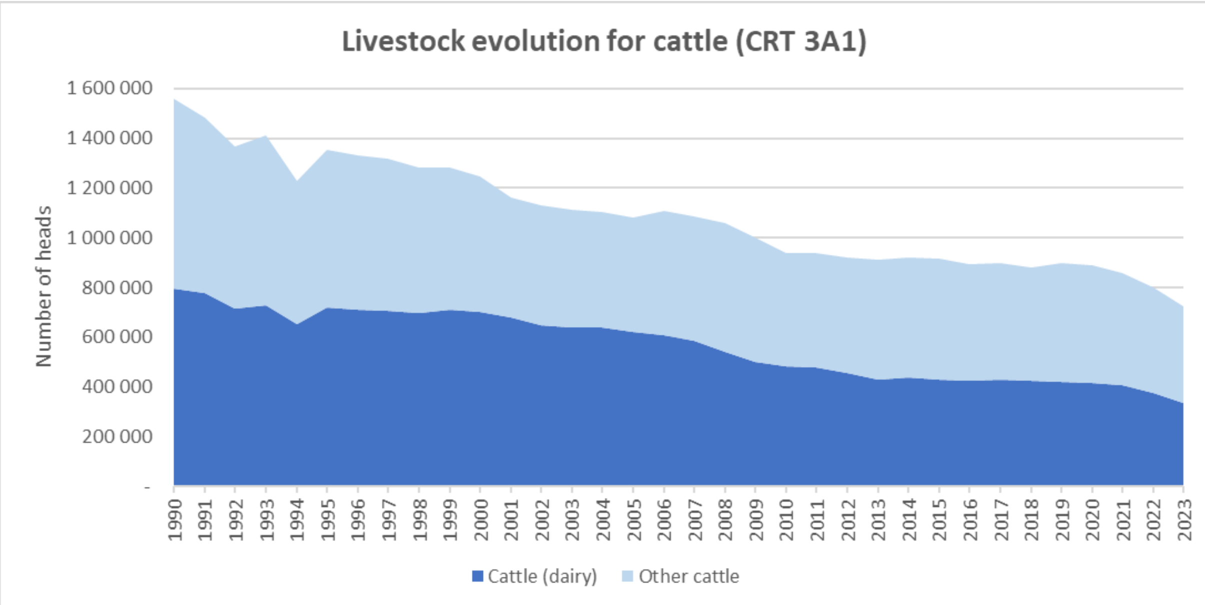
The Enteric fermentation (CRT 3A) has decreased its contributions to the total and sectoral GHG emissions. This category contributes to 3.3% of the total GHG emissions excluding LULUCF, in 2023, whereas it represented 4.9% of the national share in 1990. Concerning its part in the Agriculture (CRT 3) sector, in the Republic of Serbia, it is of 42% in 2023, and it was of 55% in 1990.

5.2.1 Cattle (3A1)

5.2.1.1 Category description

The enteric fermentation for cattle is subdivided in two subcategories: dairy cattle (CRT 3A1a) and non-dairy cattle (CRT 3A1b). The following graph gives the evolution of the livestock (by number of heads) of these two subcategories. It can be observed that both categories follow a progressive decreasing trend since 1990. The number of dairy cattle has been reduced by 58% over the studied period, and the number of other cattle by 49%.

Figure 82 : Livestock evolution for cattle, in number of heads, for the period 1990-2023



The evolution of CH_4 emissions for the CRT 3A1a and 3A1b are proportional to the evolution of the livestock presented in the previous figure as constant default EF are applied over the timeseries.

Figure 83 : GHG emissions for enteric fermentation of dairy cattle (CRT 3A1a) (kt CO_2e)

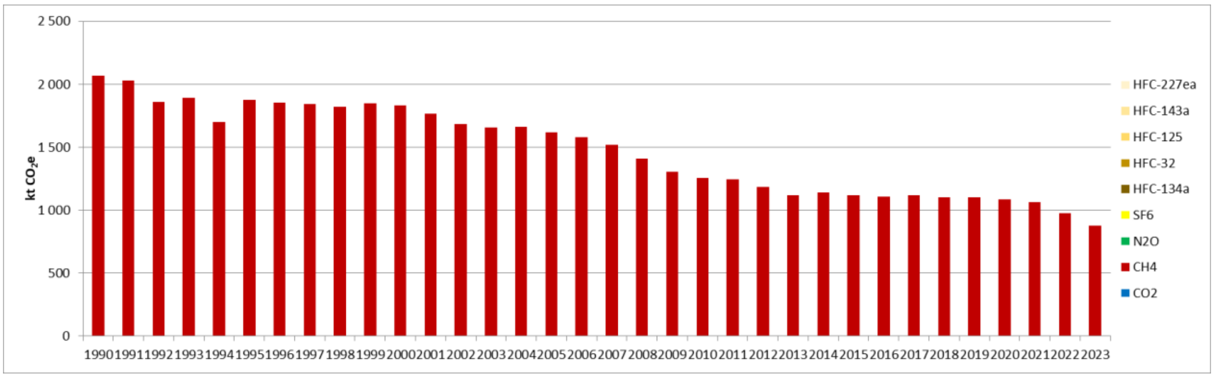
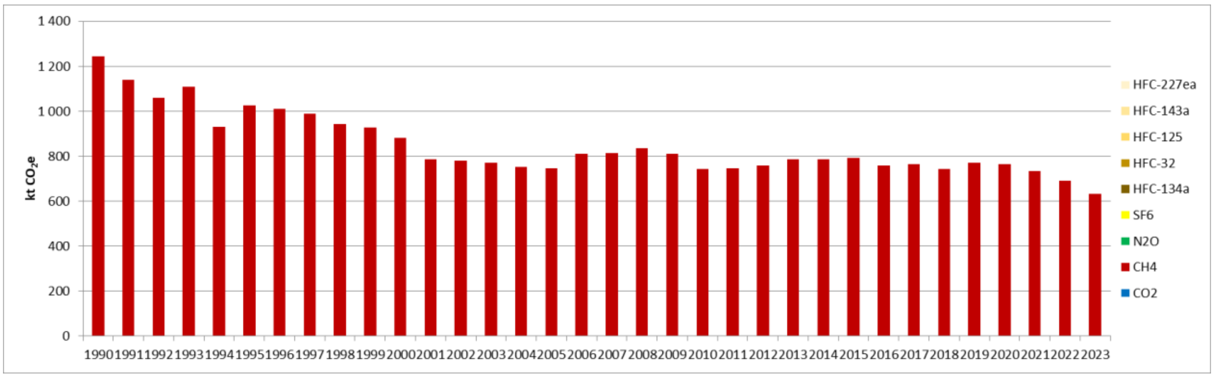


Figure 84 : GHG emissions for enteric fermentation of non-dairy cattle (CRT 3A1b) (kt CO_2e)



In 2023, the 3A1a (dairy cattle) sector is a key category for CH_4 emissions in the Republic of Serbia, both in terms of emission levels and trend. This sector contributes to 1.4% in terms of emissions level (rank 9) and 2.6% in terms of emissions trend (rank 10).

In 2023, the 3A1b (non-dairy cattle) sector is a key category both in emission level (1.0% of total emissions, rank 13) and in emission trend (1.1% of contribution, rank 21).

5.2.1.2 Methodological issues

Emissions of CH_4 from enteric fermentation are calculated with a Tier 1 approach which is in line with the 2006 IPCC Guidelines [A1].

Activity data used are the annual livestock (average population in heads), for each subcategory. These activity data for the entire time series are taken from the Serbian Statistical Yearbook [A2].

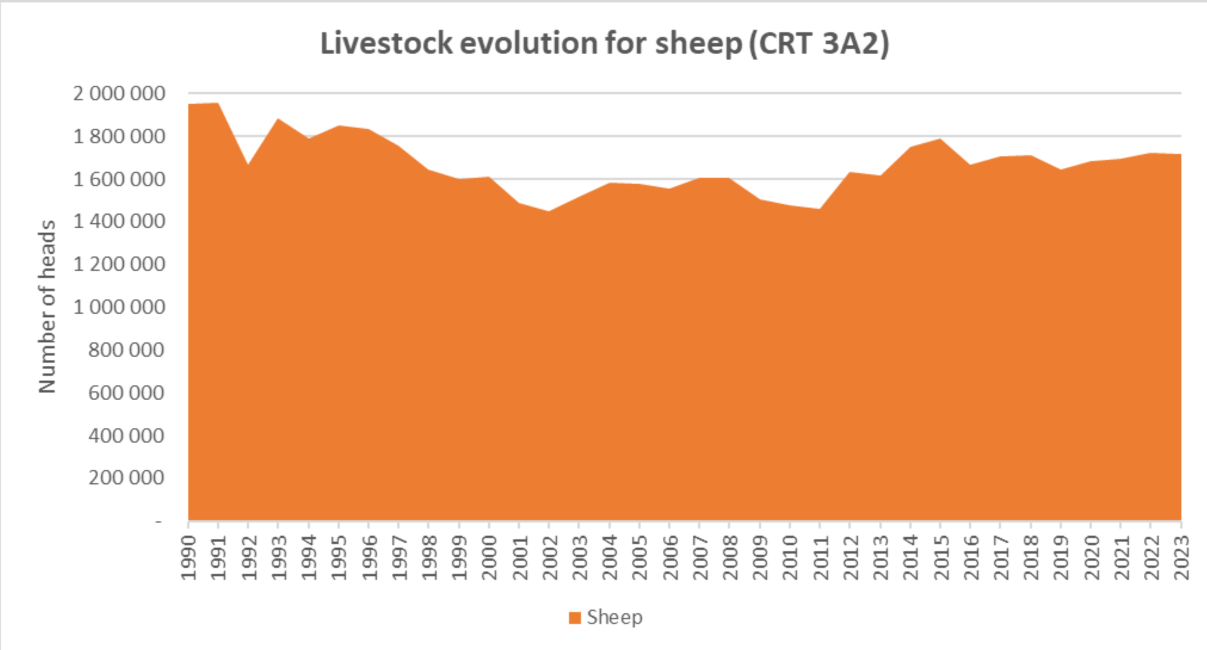
Emission factors used for calculating CH_4 emissions come from 2006 IPCC guidelines [A3]. They are of 93 kg CH_4/head/year for dairy cattle and 58 kg CH_4/head/year for other cattle.

5.2.2 Sheep (3A2)

5.2.2.1 Category description

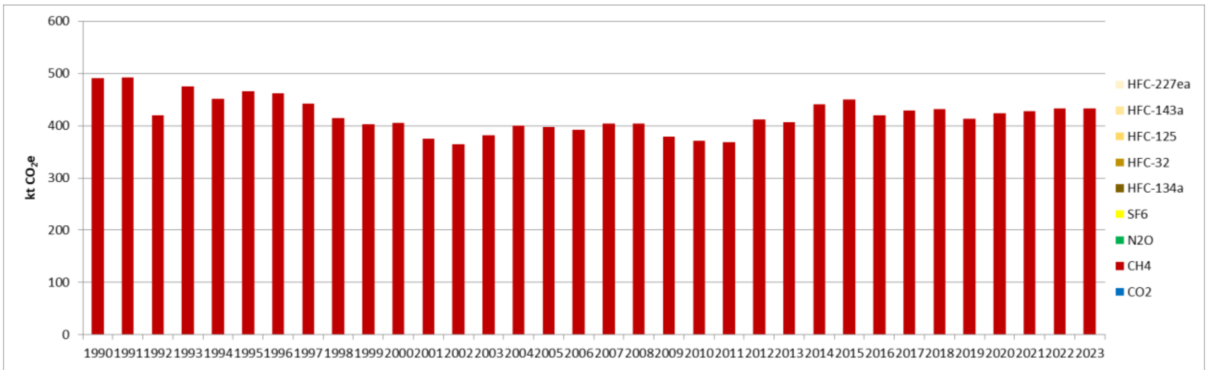
The enteric fermentation for CRT 3A2 is based only on the population of sheep, without further distinction. The population of sheep can be observed to be varying over the timeseries, being rather stable overall although a slight decline of 12% is recorded between 1990 and 2023. The total number of sheep in 2023 is around 1,717,000 heads. Except the sudden decline observed in 1992, a slow progressive reduction is observed until 2002, and some variations between 2002 and 2011. Then, a slight increase is observed for the period 2011-2023.

Figure 85 : Livestock evolution for sheep, in number of heads, for the period 1990-2023



The evolutions of CH_4 emissions for the CRT 3A2 are directly proportional to the evolution of the livestock presented in the previous figure.

Figure 86 : GHG emissions for enteric fermentation of sheep (CRT 3A2) (kt CO_2e)



In 2023, the 3A2 sector is a key category for CH_4 emissions in the Republic of Serbia, in emission level and in emission trend. This sector contributes to 0.7% in terms of emissions level (rank 20), and 0.3% (rank 59).

5.2.2.2 Methodological issues

Emissions of CH_4 from enteric fermentation are calculated with a Tier 1 approach which is in line with the 2006 IPCC Guidelines [A1].

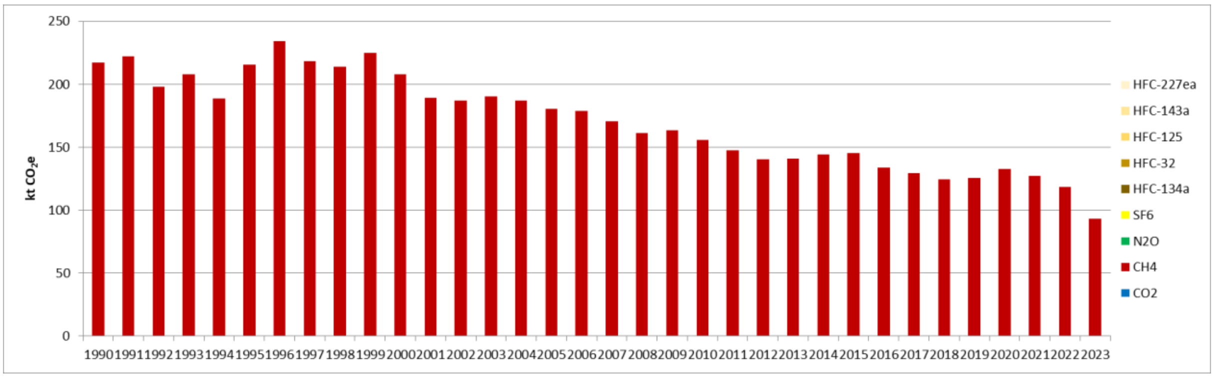
Activity data used are the annual livestock (average population in heads). These activity data for the entire time series come from the Serbian Statistical Yearbook [A2].

Emission factor used for calculating CH_4 emissions is taken from 2006 IPCC guidelines [A3], is constant over the timeseries and the value is 9 kg CH_4/head/year.

5.2.3 Swine (3A3)

5.2.3.1 Category description

Figure 87 : GHG emissions for enteric fermentation of swine (CRT 3A3) (kt CO_2e)



In 2023, the category 3A3 is a key category in terms of emission trend, for GHG emissions, in the Republic of Serbia, with a contribution of 0.3% (rank 58).

5.2.3.2 Methodological issues

Emissions of CH_4 from enteric fermentation are calculated with a Tier 1 approach which is in line with the 2006 IPCC Guidelines [A1].

Activity data used are the annual livestock (average population in heads). These activity data for the entire time series are taken from the Serbian Statistical Yearbook [A2].

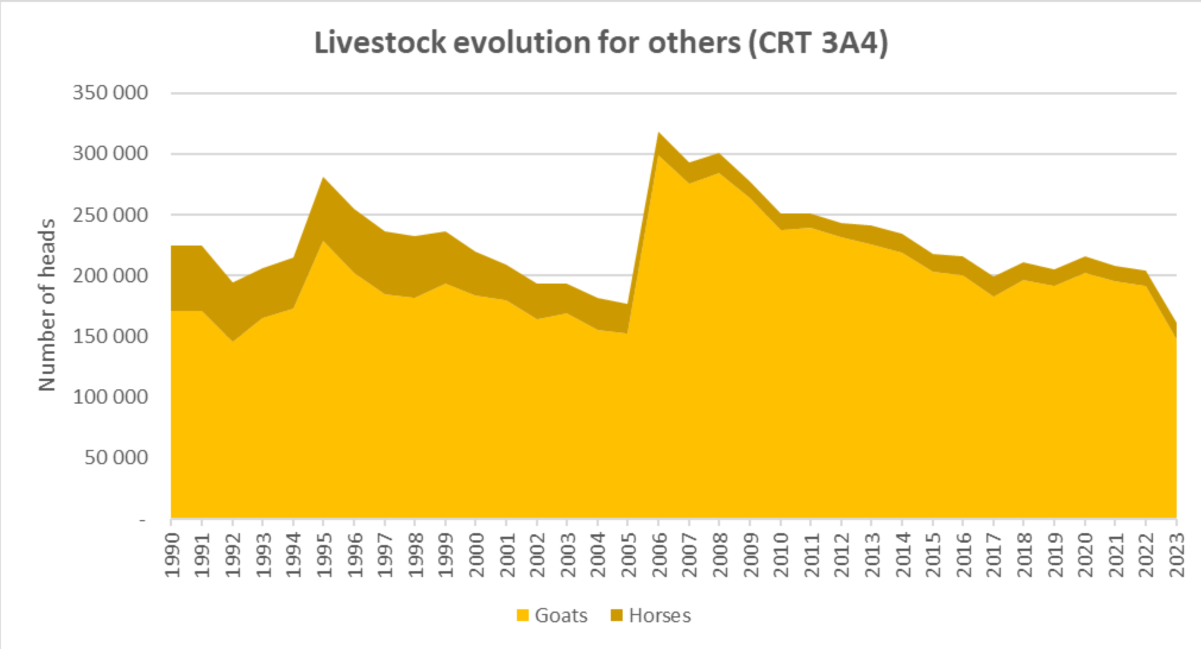
Emission factors used for calculating CH_4 emissions come from 2006 IPCC guidelines [A3], are equal for fattening pigs and sows, and the value is 1.5 kg CH_4/head/year.

5.2.4 Other livestock (3A4)

5.2.4.1 Category description

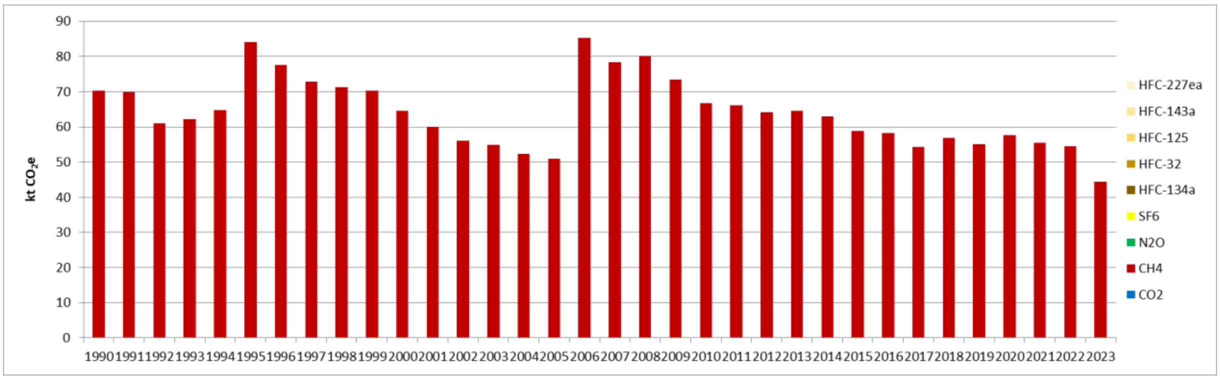
The enteric fermentation for other livestock is subdivided in two subcategories: horses and goats. The following graph gives the evolution of the livestock (by number of heads) of these two species. The number of horses has reduced significantly for the period 1990-2023, by 73%, and is rather marginal in the total livestock of this category, in number, with 24% of the share in 1990 and only 9% in 2023. On contrary, the number of goats has increased by 12% between 1990 and 2022 however it should be noted that the goats livestock experienced a 23% decrease in 2023 compared with 2022.

Figure 88 : Livestock evolution for other livestock, in number of heads, for the period 1990-2023



The evolutions of CH_4 emissions for this sector are proportional to the evolution of the livestock presented in the previous figure, as constant default EFs are applied over the timeseries. The emissions related to the enteric formation of horses are twice as much important by head than for goats. As a consequence, the sectoral emissions decrease faster (-37%) than the total livestock (-28%), over the studied period, but follow a similar trend.

Figure 89 : GHG emissions for enteric fermentation of other livestock (CRT 3A4) (kt CO_2e)



In 2023, the category 3A4 is neither a key category in terms of emission level nor in trend for GHG emissions in the Republic of Serbia.

To be noted: there is no CH_4 emissions from enteric fermentation from poultry.

5.2.4.2 Methodological issues

Emissions of GHG from enteric fermentation are calculated with a Tier 1 approach which is in line with the 2006 IPCC Guidelines [A1].

Activity data used are the annual livestock (average population in heads), for goats and horses. These activity data for the entire time series are taken from the Serbian Statistical Yearbook [A2].

Emission factors used for calculating CH_4 emissions come from 2006 IPCC guidelines [A3], are constant over the timeseries and equal to 18 kg CH_4/head/year for horses and 9 kg CH_4/head/year for goats.

5.2.5 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 20%, based on 2006 IPCC Guidelines (Volume 4, Chapter 10, Section 10.2.3).

Uncertainty estimate associated with CH_4 emission factor amounts to 40%, also based on 2006 IPCC Guidelines (Volume 4, Chapter 10, Section 10.3.4).

The uncertainty combined for CH_4 emissions is 1.6% in the total national levels of emission in 2023, excluding LULUCF contribution. This makes it the 2nd highest sector contributing to the overall national uncertainty in GHG emissions, after the methane emissions from solid waste disposal on land (CRT 5A).

5.2.6 Category-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 keys in the CRT tables.

5.2.7 Category-specific recalculations

No recalculations were made since last NID submission (November 2024).

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	4 090	3 671	3 391	2 991	2 593	2 569	2 560	2 516	2 572	2 565	2 481	2 496	2 456	2 467	2 466	2 405	2 272	0
Nouveau	kt CO2e	4 090	3 671	3 391	2 991	2 593	2 569	2 560	2 516	2 572	2 565	2 481	2 496	2 456	2 467	2 466	2 405	2 272	2 078
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+2 078
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 3.A

5.2.8 Category-specific planned improvements

For enteric fermentation, in the current inventory, the methodology used is the Tier 1. An improvement could be to launch a research project, look for publications to implement a Tier 2 method. A Tier 2 method involves the use of a lot of new parameters, among other the average gross energy intake, the average CH_4 conversion rate. This is a consequent improvement regarding the efforts, time, and research required.

Another significant improvement will be to move the emission estimation to the 2019 IPCC refinement.

5.3 Manure management (3B)

The manure management category covers the emissions of CH_4 (CRT 3B1) and N_2O (CRT 3B2) from the different livestock: cattle (3.B.1.1 and 3.B.2.1), sheep (3.B.1.2 and 3.B.2.2), swine (3.B.1.3 and 3.B.2.3) and others (3.B.1.4 and 3.B.2.4), including goats, horses and poultry. For the categories related to cattle, a distinction is made between dairy cattle and other cattle. The swine category is separated between fattening pigs and sows. Finally, among the other category, the poultry are distinguished among several animal species: layers, broilers, turkeys and others. The emissions related to poultry are estimated in the manure management, and are not negligible.

The following graph describes the evolution of the emissions of GHG, in equivalent CO_2, with details given by animal categories. In general, it can be observed that the GHG emissions from the manure management decrease progressively throughout the timeseries. In 2023, the achieved reduction for the sector is of 51%, compared with the emission levels from 1990. Both the emissions of CH_4 and N_2O have been reduced, at different rates, by 47% and 55%, respectively, over the same period. The share between the CH_4 and N_2O emissions is rather constant over the timeseries and, in 2023, methane represents 60% of the sector emissions. In the light of the fall in livestock, all emissions from the subcategories of the CRT 3B are in decline between 1990 and 2023.

The GHG emissions of the manure management are well distributed among several categories. The CH_4 emissions from manure management of swine (CRT 3.B.1.3) are the main source of emissions, representing about 30% of the sector emissions in 2023, and was at 31% in 1990, although a 53% drop for the period. Among the swine category, the manure management of fattening pigs is more important than the one for sows, representing 78% of the emissions of this subcategory in 2023. This is in particular due to the fact that the number of fattening pigs is much bigger and represents 85% of the swine livestock in 2023. In addition, the second most contributing sector in 2023 is the CH_4 emissions from manure management of cattle (CRT 3.B.1.1), which contributes to 23% of the sector emissions. Then, the N_2O emissions from manure management of cattle (CRT 3.B.2.1) and swine (CRT 3.B.2.3) are respectively the 3rd and 4th biggest contributing categories, with respective shares of 18% and 17%. In 1990, the shares of the N_2O emissions from swine and cattle and of the CH_4 emissions from cattle were slightly more equal with about 20% each, but the N_2O emissions have been reduced at a faster rate than the CH_4 emissions for both these two animal categories. The emissions from the sheep and other livestock are not negligible and represent about 11% of the sector totals in 2023, which is in slight progression compared with 1990, in particular related to manure management from poultry.

Figure 90: GHG emission trends for manure management (CRT 3B), for the period 1990-2023, per subcategory (in kt CO_2e)

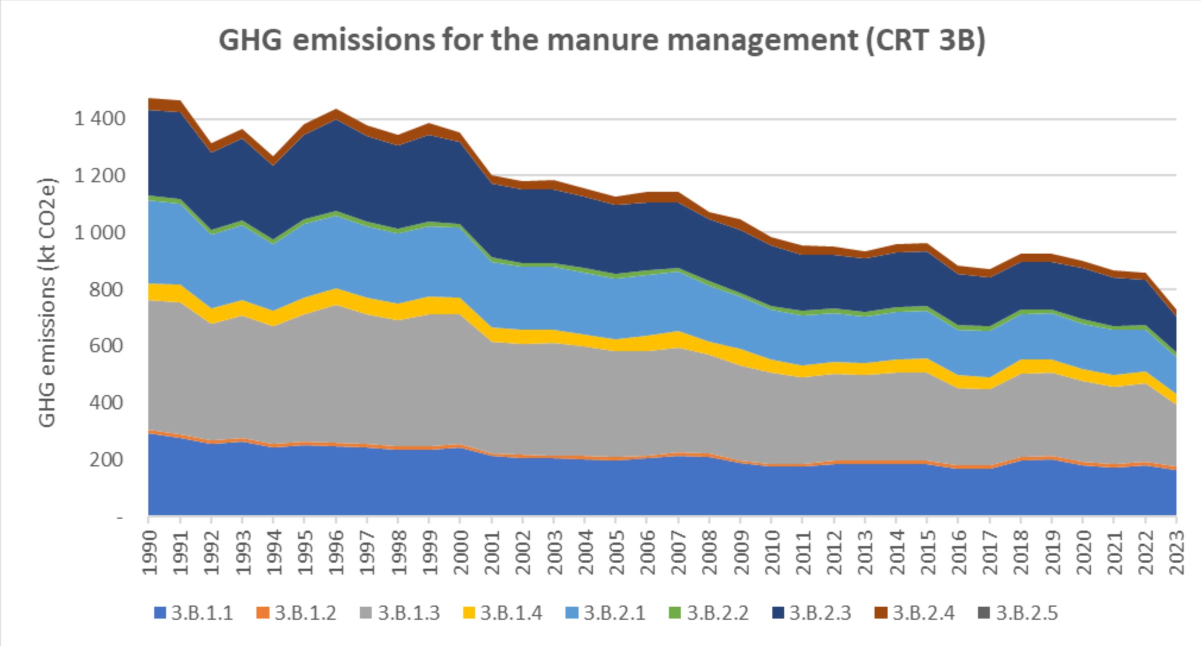
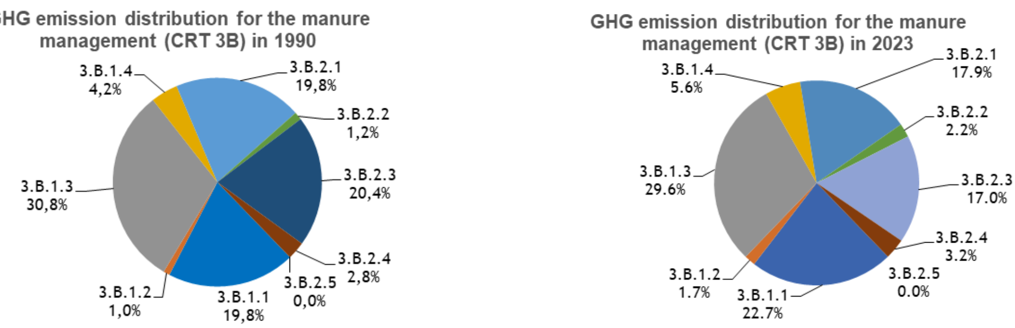


Figure 91: GHG emission distribution for manure management (CRT 3B), for the period 1990-2023, per subcategory (in %)



The emissions from Manure management (CRT 3B) have a slightly decreasing but rather constant share of the total and sectoral GHG emissions in 2023, compared with 1990. This category contributes to 1.2% of the total GHG emissions excluding LULUCF, in 2023, whereas it represented 1.8% of the national share in 1990. Concerning its share in the Agriculture (CRT 3) sector, in the Republic of Serbia, it went from 20% in 1990 to 15% in 2023.

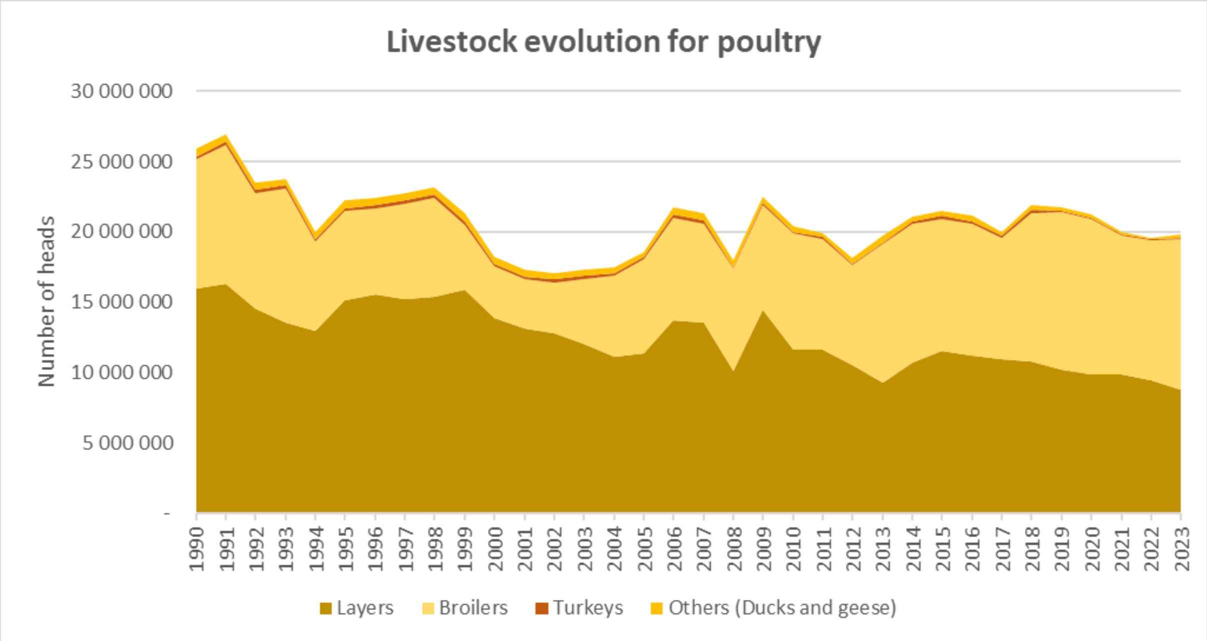
5.3.1 CH_4 emissions from Manure management (3B1)

5.3.1.1 Category description

Methane emissions from Manure management are subdivided among the different livestock (cattle, sheep, swine, and others).

In addition of the graphs of the evolution of the different livestock categories already presented throughout chapters 5.2.1 to 5.2.4, the evolution of the livestock of poultry, which impacts the CRT 3.B.1.4 emissions, is presented in the following figure. The two main subcategories of poultry are layers and broilers, which represent 98% of the whole livestock of poultry in 2023. The population of broilers varies quite significantly throughout the timeseries, with an overall 16% increase between 1990 and 2023. However, the population of layers varies also for the studied period but a progressive decline is observed, with an overall reduction of 45% in 2023. Thus, although the important reductions of the population of turkeys (-68%) and others (-48%), the livestock of poultry globally decreases by only 24% over the period 1990-2023.

Figure 92 : Livestock evolution for poultry, in number of heads, for the period 1990-2023, per different animal specie



The methane emissions associated with the manure management of dairy cattle, other cattle and sheep evolve in direct relation with the evolution of their respective livestock population presented in the previous section. In addition, the EF from dairy cattle increases by 7% between 1990 and 2023, whereas the one from other cattle increases by 28% (see Table 27 and

Table 28). The evolution of the CH_4 EF is due to the evolution in the methane conversion factors (MCFs), in relation with the evolution of the average annual temperature, which varies but has globally increased, and by 21% between 1990 and 2023. Thus, the methane emissions from these two categories are being reduced at a slightly slower rate than the livestock, respectively by 55% (versus 58% for the dairy cattle population) and by 35% (versus 49% for the population of other cattle). For sheep, the EF considered for the manure management is constant over the timeseries and therefore the emission evolution is directly proportional to the livestock evolution (-12% for the same period).

Figure 93 : CH4 emissions for manure management of dairy cattle (CRT 3B11a) (kt CO_2e)

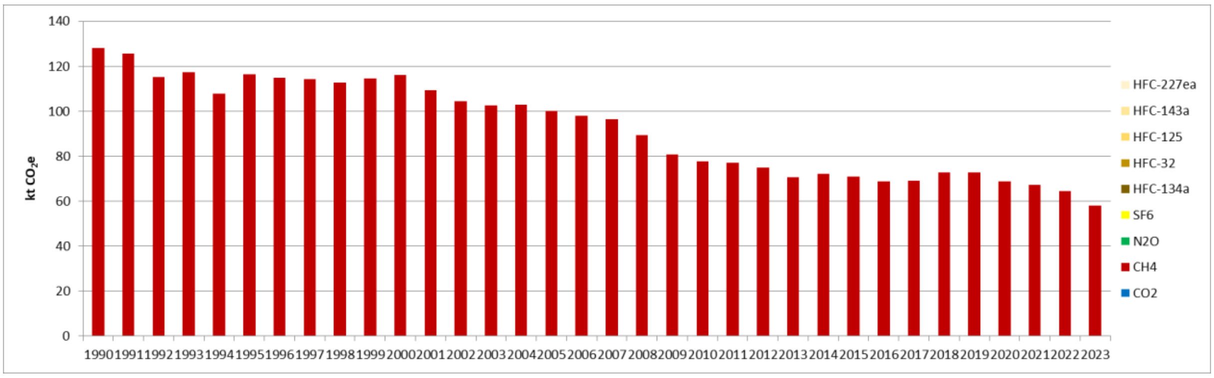


Figure 94 : CH4 emissions for manure management of non-dairy cattle (CRT 3B11b) (kt CO_2e)

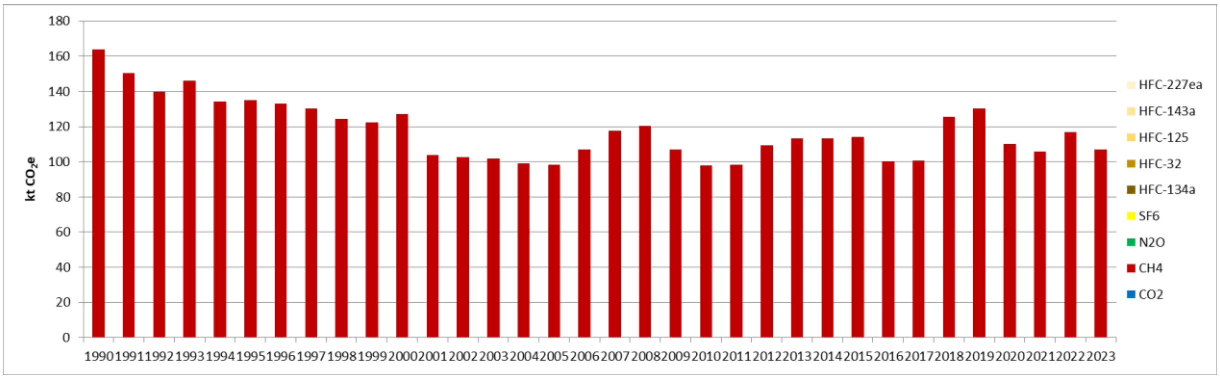
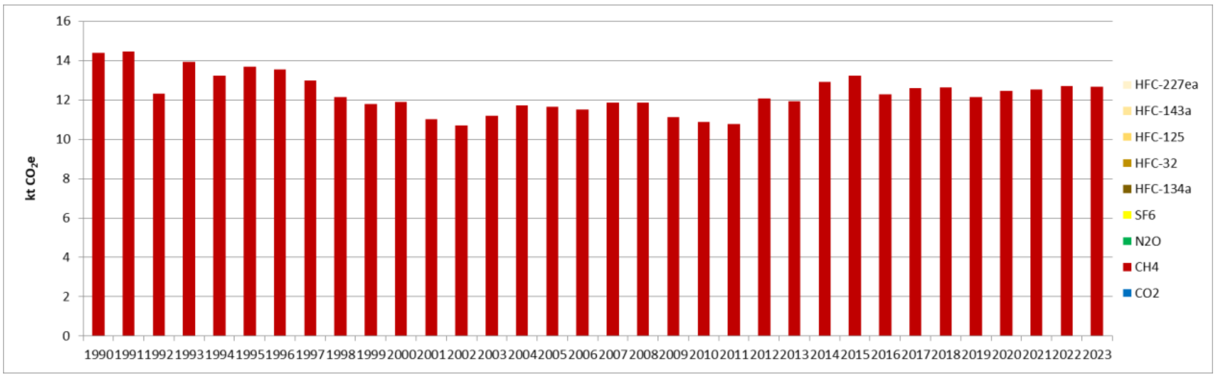


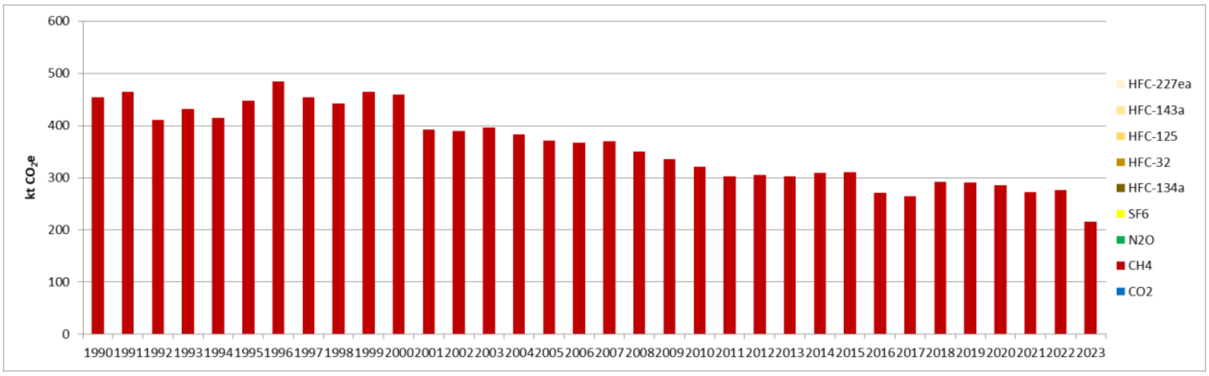
Figure 95 : CH4 emissions for manure management of sheep (CRT 3B12) (kt CO_2e)



The methane emissions from the swine manure management evolve according to the evolution of the livestock of fattening pigs and sows, as well as the evolution of the EF. The later varies depending on the MCFs, and hence on the annual average temperature, which increased by 21% for the period 1990-2023. Overall, both EF from fattening pigs and sows increased by 15% for the studied period (see Table 27 and

Table 28). All things combined, the methane emissions from these two categories have been reduced by 46% for fattening pigs (versus 53% for their population) and by 67% for sows (versus 71% for their population). In total, considering the fact that the fattening pigs are more predominant in the swine livestock and represent 85% of the overall population in 2023, but the emission factor is 67% higher for sows than for fattening pigs, the emissions from the CRT 3.B.1.3 have been reduced by 53% over the timeseries.

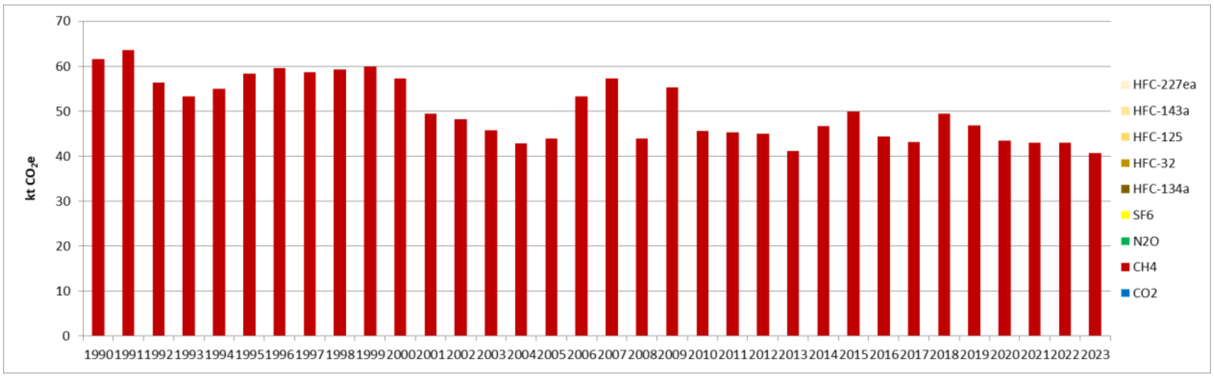
Figure 96 : CH4 emissions for manure management of swine (CRT 3B13) (kt CO_2e)



The methane emissions for the manure management of other livestock evolve depending on the evolution of the different livestock (goats, horses and poultry) and of the EF. The emissions related to manure management of horses and goats are rather marginal in the total of the category and represent less than 3% over the timeseries (and less than 0.5% in 2023). Among the poultry livestock, the layers represent the most important share of emissions with 89% of poultry emissions in 2023. The EF from the layers varies depending on the MCFs over the timeseries, which evolves according to the average annual temperature, and increases by 16% for the period 1990-2023 (see Table 27 and

Table 28). The EF from the other poultry species (broilers, turkeys and others) are all constant over the timeseries. In total, the emissions from the CRT 3.B.1.4 have been reduced by 34% between 1990 and 2023.

Figure 97 : CH4 emissions for manure management of other livestock (CRT 3B14) (kt CO_2e)



In 2023, only the subcategory 3.B.1.3 is a key .category in terms of emission level and trend, in the Republic of Serbia, with a contribution of 0.3% (rank 36) and 0.5% (rank 42), respectively.

5.3.1.2 Methodological issues

Emissions of CH_4 from manure management are calculated with a Tier 2 approach, which is in line with the 2006 IPCC Guidelines [A4].

Activity data used are the annual livestock (average population in heads), for all different subcategories presented above. These activity data for the entire time series come from the Serbian Statistical Yearbook [A2]. The activity data are then split by manure management system based on the 2019 IPCC Guidelines default values [A20]. Emissions factors used for calculating CH_4 emissions are taken from the Tier 2 from 2006 IPCC guidelines [A6]. The methane conversion factors (MCFs) vary depending on the average annual temperature, which is taken from the Copernicus website, and evolves as presented in the following figure. Considering the range of temperatures, the climate is considered to be cool. All other parameters are taken as default from the IPCC guidelines and are recalled in the following tables (the Bo values, the excretion rates VS, and the fractions of manure management system used per livestock category).

Figure 98 : Evolution of the average annual temperature, in the Republic of Serbia, for the period 1990-2023 (in °C)

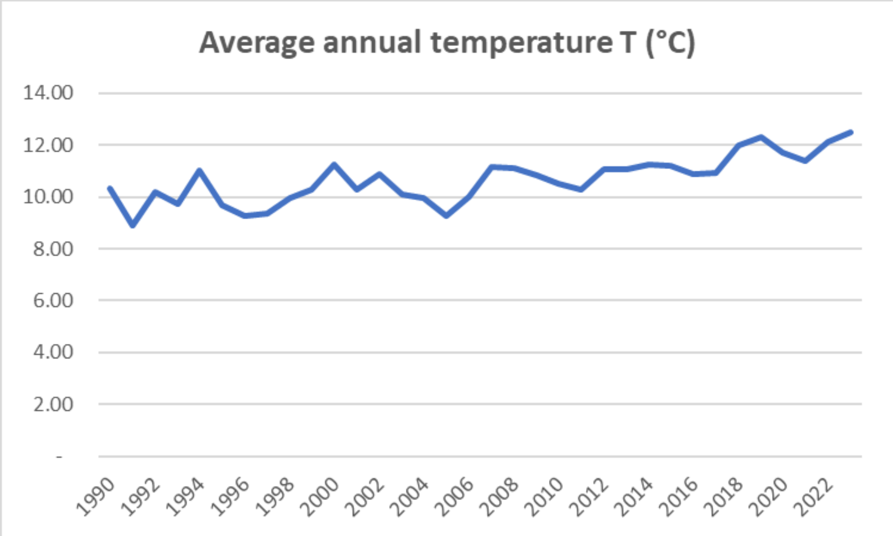


Table 23: Fraction of livestock category's manure handled by each manure management system (in %), from 2019 IPCC Guidelines, used in Serbian inventory

Livestock category	MS lagoon (%)	MS liquid/ slurry (%)	MS solid storage (%)	MS dry lot (%)	MS pasture range (%)
Dairy cattle	-	5%	74%	-	20%
Other cattle	-	64%	5%	-	31%
Sheep	-	-	42%	-	58%
Fattening pigs	5%	31%	55%	1%	-
Sows	5%	31%	55%	1%	-
Goats	-	-	9%	-	91%
Horses	-	-	-	-	50%
Layers	-	-	-	47%	-
Broilers	-	-	-	-	-
Turkeys	-	-	-	-	-
Other poultry	-	-	-	-	-

Livestock category	MS pit < 1 month (%)	MS pit > 1 month (%)	MS daily spread (%)	MS poultry with litter (%)	MS other (%)
Dairy cattle	-	-	1%	-	-
Other cattle	-	-	-	-	-
Sheep	-	-	-	-	-
Fattening pigs	4%	4%	-	-	-
Sows	4%	4%	-	-	-
Goats	-	-	-	-	-

Horses	-	-	50%	-	-
Layers	-	34%	-	19%	-
Broilers	-	-	-	100%	-
Turkeys	-	-	-	100%	-
Other poultry	-	-	-	100%	-

Table 24: Methane conversion factors per manure management system (in %), depending on the average annual temperature, from 2006 IPCC Guidelines, used in Serbian inventory

Manure management system	T=10°C	T=11°C	T=12°C	T=13°C	T=14°C
Lagoon	66%	68%	70%	71%	73%
Liquid/Slurry	10%	11%	13%	14%	15%
Solid storage	2%	2%	2%	2%	2%
Dry lot	1%	1%	1%	1%	1%
Pasture/range	1%	1%	1%	1%	1%
Pit < 1 month	3%	3%	3%	3%	3%
Pit > 1 month	17%	19%	20%	22%	25%
Daily spread	0.1%	0.1%	0.1%	0.1%	0.1%
Poultry manure with litter	1.5%	1.5%	1.5%	1.5%	1.5%

Table 25: Daily volatile solid excreted VS, for each livestock category (in kg dry matter/animal/day), from 2006 IPCC Guidelines, used in Serbian inventory

Livestock category	VS (kg/animal/day)
Dairy cattle	4.5
Other cattle	2.7
Sheep	0.4
Fattening pigs	0.3
Sows	0.5
Goats	0.3
Horses	2.13
Layers	0.02
Broilers	0.01
Turkeys	0.07
Other poultry	0.02

Table 26: Maximum methane producing capacities for manure produced by each livestock category ("Bo values") (in m^3 CH_4/kg of VS excreted), from 2006 IPCC Guidelines, used in Serbian inventory

Livestock category	Bo (m^3/kg of VS)
Dairy cattle	0.24
Other cattle	0.17
Sheep	0.19
Fattening pigs	0.45
Sows	0.45
Goats	0.18
Horses	0.3
Layers	0.39
Broilers	0.36
Turkeys	0.36
Other poultry	0.36

Consequently, the methane emission factors for manure management evolve as follows:

Table 27: Manure management CH_4 EF (in kg/head), per livestock category, for the period 1990-2015, every 5 years

Livestock category	1990	1995	2000	2005	2010	2015
Dairy cattle	5,76	5,76	5,89	5,76	5,76	5,89
Other cattle	7,64	7,64	8,36	7,64	7,64	8,36
Sheep	0,26	0,26	0,26	0,26	0,26	0,26
Fattening pigs	2,74	2,74	2,91	2,74	2,74	2,91
Sows	4,57	4,57	4,84	4,57	4,57	4,84
Goats	0,14	0,14	0,14	0,14	0,14	0,14
Horses	0,86	0,86	0,86	0,86	0,86	0,86
Layers	0,12	0,12	0,14	0,12	0,12	0,14
Broilers	0,01	0,01	0,01	0,01	0,01	0,01
Turkeys	0,09	0,09	0,09	0,09	0,09	0,09
Other poultry	0,03	0,03	0,03	0,03	0,03	0,03

Table 28: Manure management CH_4 EF (in kg/head), per livestock category, for the period 2016-2022

Livestock category	2016	2017	2018	2019	2020	2021	2022	2023
Dairy cattle	5.76	5.76	6.16	6.16	5.89	5.89	6.16	6.16
Other cattle	7.64	7.64	9.80	9.80	8.36	8.36	9.80	9.80
Sheep	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Fattening pigs	2.74	2.74	3.16	3.16	2.91	2.91	3.16	3.16
Sows	4.57	4.57	5.26	5.26	4.84	4.84	5.26	5.26
Goats	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Horses	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Layers	0.12	0.12	0.14	0.14	0.14	0.14	0.14	0.14
Broilers	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Turkeys	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Other poultry	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

5.3.2 N_2O emissions from manure management (3B2)

5.3.2.1 Category description

Nitrous dioxide emissions from Manure management are subdivided by type of livestock (cattle, sheep, swine, other livestock). There is an extra CRT category (3B2.5) in which indirect N_2O emissions from volatilisation and leaching are reported. However, in a Tier 1 methodology, as used in the Serbian inventory for this category, indirect N_2O emissions from leaching and run-off from manure management are not estimated, according to the IPCC guidelines.

The direct emissions of N_2O from manure management are estimated based on a Tier 1 methodology, and the EF applied for each livestock category are constant over the timeseries (see chapter 5.3.2.2). Hence, the emissions for the CRT 3.B.2.1.a, 3.B.2.1.b and 3.B.2.2 are all directly proportional to the livestock and vary based on their evolution, as presented in the various graphs about the livestock in chapter 5.2.

Figure 99 : N2O emissions for manure management of dairy cattle (CRT 3B21a) (kt CO_2e)

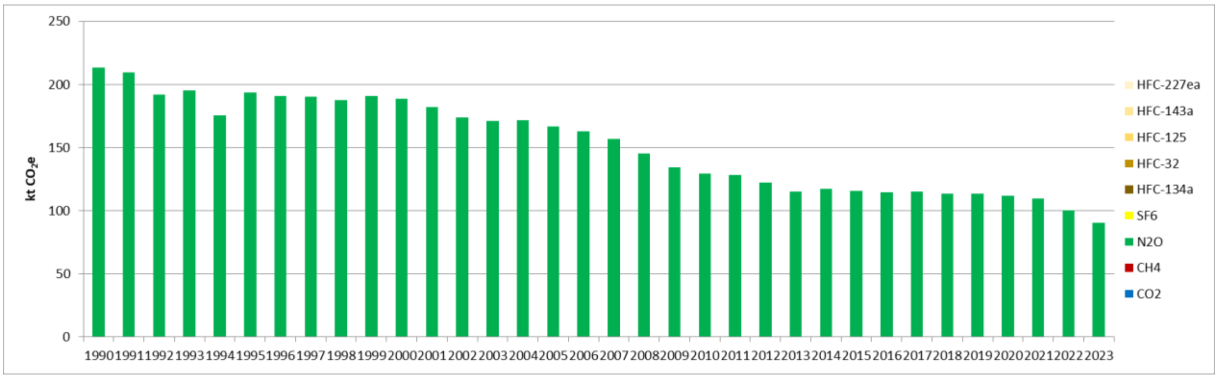


Figure 100 : N_2O emissions for manure management of non-dairy cattle (CRT 3B21b) (kt CO_2e)

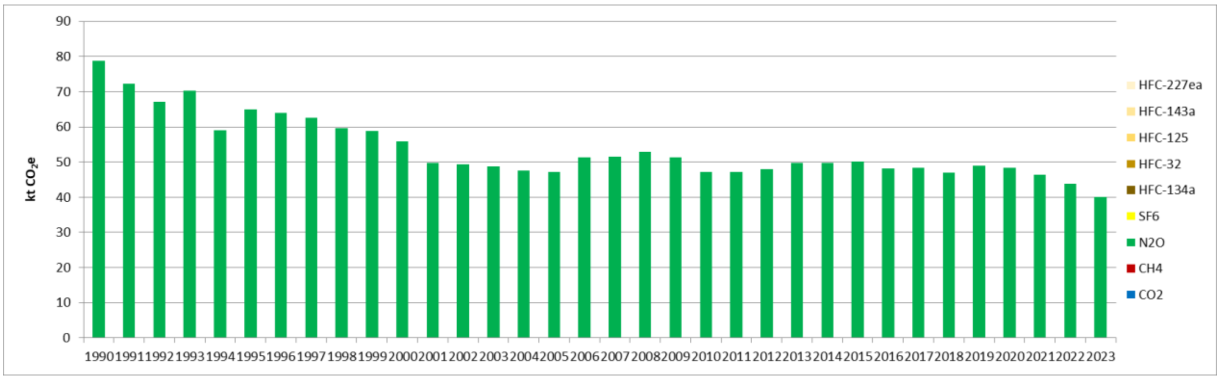
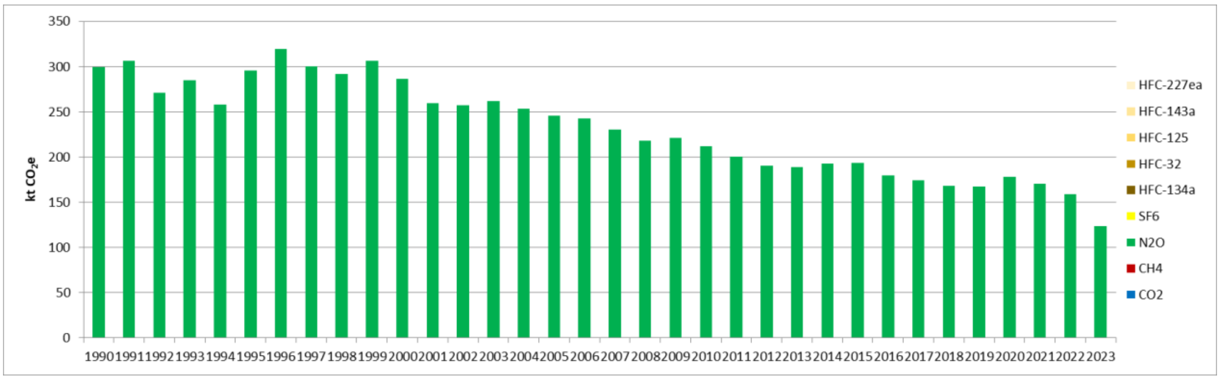


Figure 101 : N2O emissions for manure management of sheep (CRT 3B22) (kt CO_2e)

For manure management from swine, the emissions evolve according to the variation of the livestock, as well as the share of livestock between fattening pigs and sows, considering the fact that the EF for sows is 62% higher than for fattening pigs (see chapter 5.3.2.2). However, as the population of fattening pigs is larger, the emissions related to this livestock contribute to 69% of the share in 1990 and 78% in 2023. Overall, the emissions from this category have been reduced by 59% for the period 1990-2023.

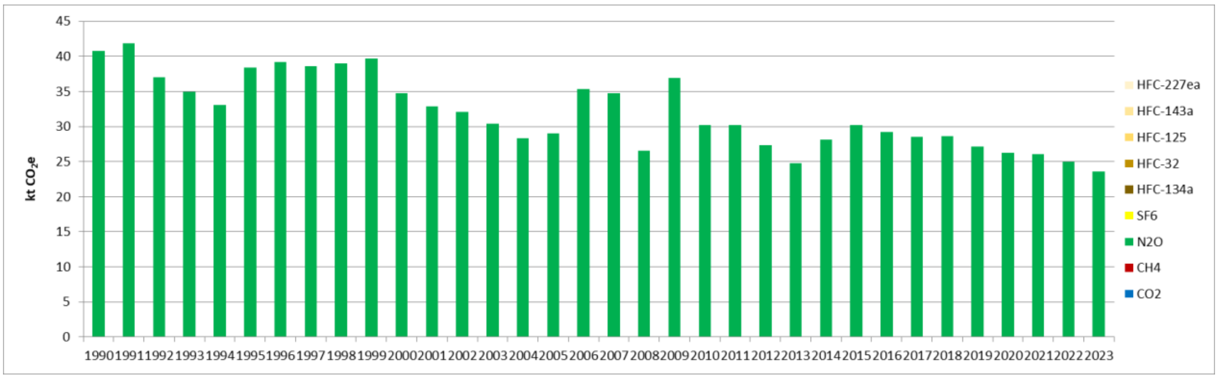
Figure 102 : N2O emissions for manure management of swine (CRT 3B23) (kt CO_2e)



For the other livestock (i.e., horses, goats, poultry), the emission evolve depending on the population evolution of each animal category, as well as the manure produced by each of them. And, for the emissions related to manure management of other livestock, layers are predominant with 94% of the share in 1990 and 91% in 2023.

Thus, the emissions from this category evolve principally in relation with the evolution of the population of layers, as presented in Figure 92.

Figure 103 : N2O emissions for manure management of other livestocks (CRT 3B24) (kt CO_2e)



The indirect N_2O emissions from volatilisation are mainly driven by cattle and pigs subcategories, as these animals produce around 83% of the N volatilised as NH_3 and NOx (building and storage) for the whole period.

Figure 104 : Indirect N2O emissions from volatilisation and leaching in manure management (CRT 3B25) (kt CO_2e)

In 2023, there is no key category in emission level in the Republic of Serbia. If the emissions from cattle were considered aggregating dairy and other cattle, it would also be a key category in emission level.

In terms of emission trend, in 2023, the N_2O emissions from manure management of swine (CRT 3.B.2.3) and dairy cattle (CRT 3.B.2.1.a) are key categories, contributing respectively 0.4% (rank 51) and 0.3% (rank 57) to the national totals.

5.3.2.2 Methodological issues

Emissions of N_2O from manure management are calculated with a Tier 1 approach which is in line with the 2006 IPCC Guidelines [A7].

Activity data used are annual livestock (average population in heads). These activity data for the entire time series come from the Serbian Statistical Yearbook [A2]. The activity data are then split by manure management system and also consider the typical mass of each type of livestock based on the 2019 IPCC Guidelines default values [A20].

Emissions factors and all parameters used for calculating N_2O emissions are based on the 2019 IPCC guidelines [A20]. The values used are presented in the following tables. The fraction of manure management system used per livestock category are the same as the ones used for the methane emissions, presented in Table 23.

Table 29: Typical animal mass per livestock category (in kg/animal), from 2019 IPCC Guidelines, used in Serbian inventory

Livestock category	TAM (kg/animal)
Dairy cattle	550
Other cattle	389
Sheep	40
Fattening pigs	59
Sows	204
Goats	36
Horses	377
Layers	1.9
Broilers	1.1
Turkeys	6.8
Other poultry	2.7

Table 30: Daily N excretion rate per animal (in kg N/t animal/day), from 2019 IPCC Guidelines, used in Serbian inventory

Livestock category	Nrate (kg N/t animal/day)
Dairy cattle	0.42
Other cattle	0.47
Sheep	0.36
Fattening pigs	0.77
Sows	0.36
Goats	0.44
Horses	0.30
Layers	0.81
Broilers	1.12
Turkeys	0.74
Other poultry	0.83

Table 31: N_2O EF per manure management system (in kg N_2O-N/kg Nex) from 2019 IPCC Guidelines, used in Serbian inventory

Manure management system	EF (kg N_2O-N/kg Nex)
Lagoon	0
Liquid/Slurry	0.005
Solid storage	0.01

Dry lot	0.02
Pasture/range	-
Pit < 1 month	0.002
Pit > 1 month	0.002
Daily spread	0
Poultry manure with litter	0.001

The resulting EF for direct emissions of N_2O are as follows, for each livestock category:

Table 32: N_2O Emission factor for direct emissions from manure management (CRT 3B2) used in Serbian inventory

Livestock category	EF N_2O (kg/animal)
Dairy cattle	1.01
Other cattle	0.39
Sheep	0.03
Fattening pigs	0.19
Sows	0.31
Goats	0.008
Horses	0
Layers	0.009
Broilers	0.0007
Turkeys	0.003
Other poultry	0.0013

Indirect emissions of N_2O from volatilization and leaching in manure management are calculated with a Tier 1 approach which is in line with the 2006 IPCC Guidelines [A4].

For indirect N_2O emission from volatilization, the activity data are the N volatilized as NH_3 and NOx. Relevant NH_3 and NOx emissions are taken from the pollutants inventory produced by Serbia for the CLRTAP. The emission factor applied comes from the 2006 IPCC guidelines [A9].

5.3.3 Uncertainties and time-series consistency

CH_4

Uncertainty estimate associated with activity data amounts to 20%, based on 2006 IPCC Guidelines (Volume 4, Chapter 10, Section 10.2.3).

Uncertainty estimate associated with CH_4 emission factor amounts to 30%, also based on 2006 IPCC Guidelines (Volume 4, Chapter 10, Section 10.4.4).

The uncertainty combined for emissions is 0.3% in the total national levels of emission in 2023, excluding LULUCF contribution.

N_2O

Uncertainty estimate associated with activity data amounts to 20%, based on 2006 IPCC Guidelines (Volume 4, Chapter 10, Section 10.2.3).

Uncertainty estimate associated with N_2O emission factor amounts to 50%, also based on 2006 IPCC Guidelines (Volume 4, Chapter 10, Section 10.5.5).

Combined uncertainty for emissions is 0.3% in the total national levels of emission in 2023, excluding LULUCF contribution.

5.3.4 Category-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 keys in the CRT tables.

5.3.5 Category-specific recalculations

No recalculations were made since the latest NID submission (November 2024).

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	1 473	1 381	1 352	1 128	985	954	949	933	959	964	884	872	926	925	901	869	857	0
Nouveau	kt CO2e	1 473	1 381	1 352	1 128	985	954	949	933	959	964	884	872	926	925	901	869	857	727
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+0,0000	+0,0000	-0,0000	+727
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	+0,0%	+0,0%	-0,0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm /3.B

5.3.6 Category-specific planned improvements

Currently, the estimation of CH_4 and N_2O emissions from manure management mobilize many default parameters from the IPCC. An important improvement would be to move to national specific parameters to better reflect national circumstances.

Another significant improvement will be to move the emission estimation to the 2019 IPCC refinement.

5.4 Agricultural soils (3D)

The agricultural soils category covers the direct (3D1) and indirect (3D2) emissions of N_2O. For direct emissions, the following emission sources are covered in the Serbian inventory:

- Application of inorganic N fertilisers (3.D.1.a),
- Application of animal manure (3.D.1.b.i),
- Urine and dung deposited by grazing animals (3.D.1.c),
- Crop residues (3.D.1.d),
- Cultivation of organic soils (3.D.1.f).

Emissions related to the application of sewage sludge (3.D.1.b.ii), other organic fertilisers (3.D.1.b.iii), mineralization/ immobilization associated with loss/gain of soil organic matter (3.D.1.e), are all considered as "not occurring" (NO).

For indirect emissions, the emissions are distinguished between the atmospheric deposition (3.D.2.a) and the nitrogen leaching and run-off (3.D.2.b).

For the period 1990-2023, the emissions of the CRT 3D category vary significantly and, after having peaked in 2009, followed a global decline since then. Nonetheless, overall, emissions have increased by 7% over the studied period. From 2000 onwards, the emissions vary in particular in relation with the abrupt changes in the amounts of inorganic fertilisers applied to the soils, meanwhile the other categories vary more progressively. Indeed, in 2023, the CRT 3.D.1.a is the most important emission source, contributing to 31% to the sectoral emissions, whereas it was way less predominant in 1990 with 5%. This is due to an important increase in the use of inorganic fertilisers, whereas other important emissions sources decreased, such as the application of animal manure (3.D.1.a.i) with -52% between 1990 and 2023, meanwhile it was contributing to 44% of the CRT 3D emissions in 1990, or remained rather stable such as nitrogen leaching and run-off (CRT 3.D.2.b, +7%). The two other important categories of this sector are the 3.D.1.d, which contributed to 16% in 1990 and 20% in 2023, and increased its emissions by 31% over the timeseries, and the indirect emissions from atmospheric deposition (3.D.2.a) went from a share of 12% to 8% of the sectoral emissions.

Figure 105: GHG emission trends for agricultural soils (CRT 3D), for the period 1990-2023, per subcategory (in kt CO_2e)

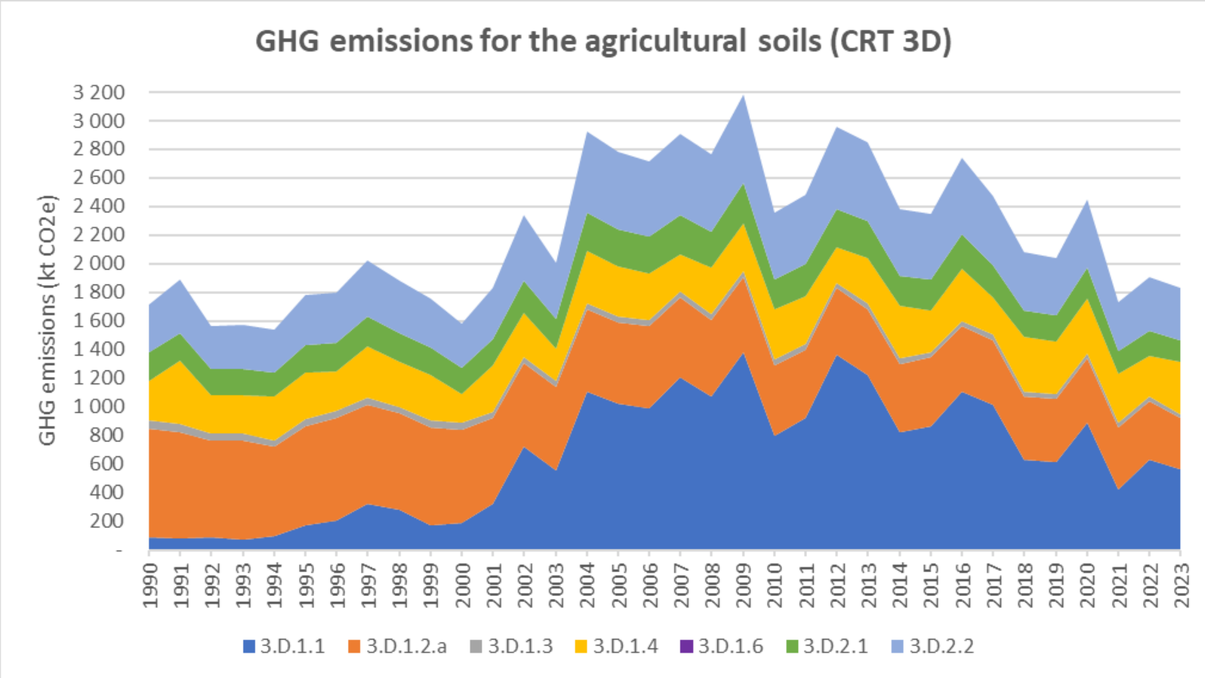
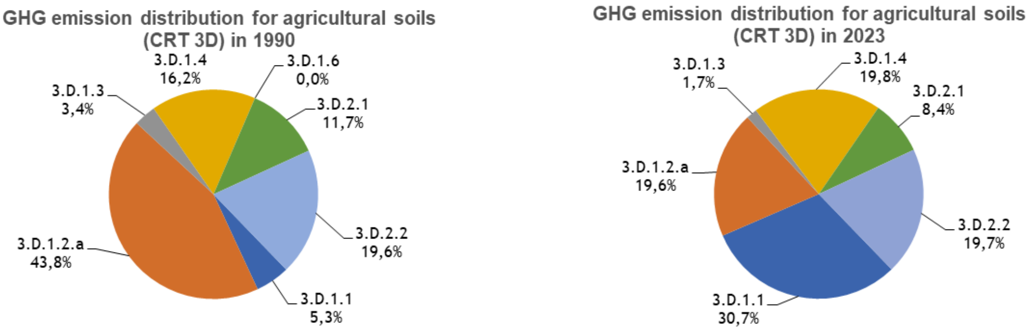


Figure 106: GHG emission distribution for agricultural soils (CRT 3D), for the period 1990-2023, per subcategory (in %)



The share of GHG emissions of the Agricultural soils (CRT 3D) category in the national totals, excluding LULUCF, has increased from 2.1% in 1990 to 2.9% in 2023. Concerning its contribution in the Agriculture (CRT 3) sector, in the Republic of Serbia, it increased from 23% in 1990 to 37% in 2023, due to its increase meanwhile other categories reduced their emissions. In terms of N_2O emissions, this sector represents around 72% of the national emissions in 2023, whereas its share was of 51% in 1990.

5.4.1 Direct N_2O emissions from managed soils (3D1)

5.4.1.1 Category description

The activity data considered for the direct N_2O emissions from agricultural soils evolve as follows:

Table 33: Activity data for direct N_2O emissions from agricultural soils (3D1), for the period 1990-2010, every 5 years

Management system	1990	1995	2000	2005	2010
Inorganic fertilisers (kg N)	21,781,776	40,740,000	45,101,000	245,487,662	191,248,900
Animal manure applied to soils (kg N)	180,614,714	167,130,639	156,132,342	135,739,332	119,194,846
Urine and dung deposited by cattle, poultry and pigs (kg N)	29,234,787	25,232,239	23,084,754	19,969,635	17,602,710
Urine and dung deposited by sheep and others (kg N)	7,955,138	7,939,311	6,631,246	6,120,134	6,032,054
Crop residues (kg N)	66,613,208	77,220,224	48,779,955	85,302,693	84,458,050
Managed/drained organic soils (ha)	88	88	88	88	88

Table 34: Activity data for direct N_2O emissions from agricultural soils (3D1), for 2015 and 2019-2023

Management system	2015	2019	2020	2021	2022	2023
Inorganic fertilisers (kg N)	208,354,610	147,451,663	213,373,773	101,021,198	151,994,841	134,872,180

Animal manure applied to soils (kg N)	114,608,614	106,182,703	108,217,206	104,554,670	98,435,219	85,899,984
Urine and dung deposited by cattle, poultry and pigs (kg N)	17,325,763	16,964,753	16,775,549	16,221,214	15,115,527	13,721,750
Urine and dung deposited by sheep and others (kg N)	6,835,493	6,294,662	6,470,201	6,457,211	6,509,044	6,307,171
Crop residues (kg N)	69,780,682	87,247,786	92,001,374	82,071,115	67,300,966	87,122,764
Managed/drained organic soils (ha)	88	88	88	88	88	88

In short, the noticeable change in activity data is accounted for the application of inorganic N-fertilisers where a drastic increase is observed, and the overall growth for the period 1990-2023 is of +519%. In the most recent years, the activity related to this emission source fluctuates quite significantly but follows a downward trend since 2012 (-58% in 2023, compared with 2012). This trend is also the consequence of relatively poor activity data recording, which only became available from SORS since 2013, where this category has been more stable.

The activity data related to the amounts of animal manure applied to soils and urine and dung deposited by the different livestock follow a similar trend and know a progressive and continuous decline, to achieve a reduction of 52% for animal manure and 46% for urine and dung deposited in 2023, compared with 1990 levels. This decreasing trend is explained by the declining livestock as described earlier. Finally, the amounts of nitrogen for crop residues vary also importantly over the timeseries, from -27% to +60% compared with the level of 1990, but the activity recorded for 2023 is rather stable with the level of 1990, after being among the highest levels in 2018-2020.

The estimation methodology for this sector is based on the Tier 1 from the IPCC, and therefore the EF applied to the activity data are constant over the timeseries (see chapter 5.4.1.2). Hence, the direct emissions of N_2O from agricultural soils for the following categories evolve directly proportional to the activity data presented previously.

Figure 107 : N2O emissions from inorganic N fertilisers (CRT 3D1.1) (kt CO_2e)

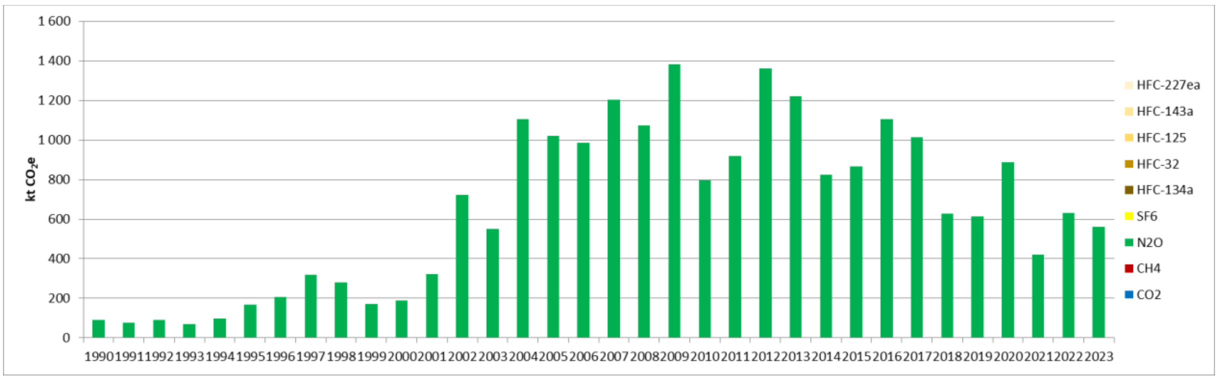


Figure 108 : N2O emissions from organic N fertilisers (CRT 3D1.2a) (kt CO_2e)

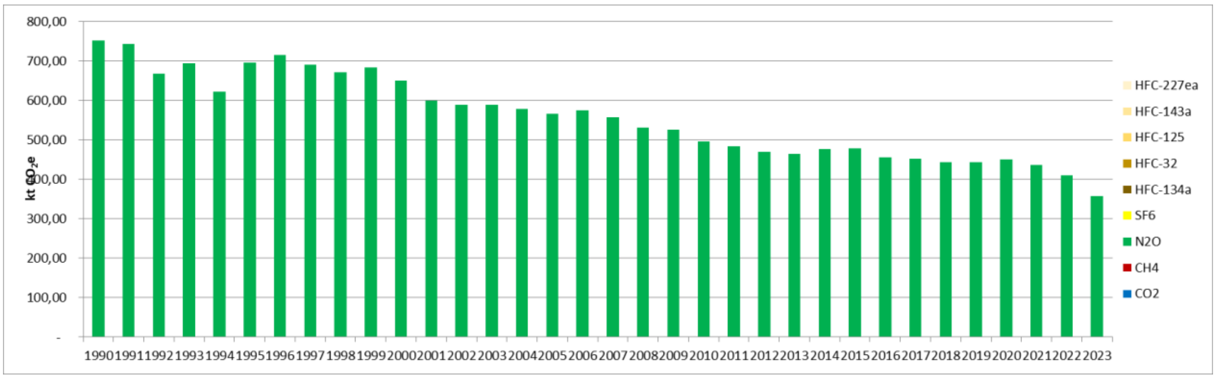


Figure 109 : N2O emissions from urine and dung deposited by grazing animals (CRT 3D1.3) (kt CO_2e)

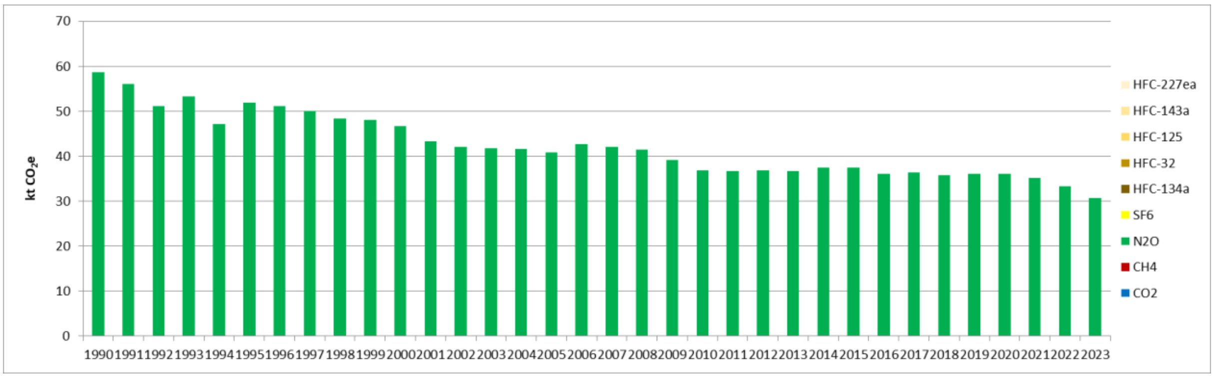


Figure 110 : N2O emissions from crop residues (CRT 3D1.4) (kt CO_2e)

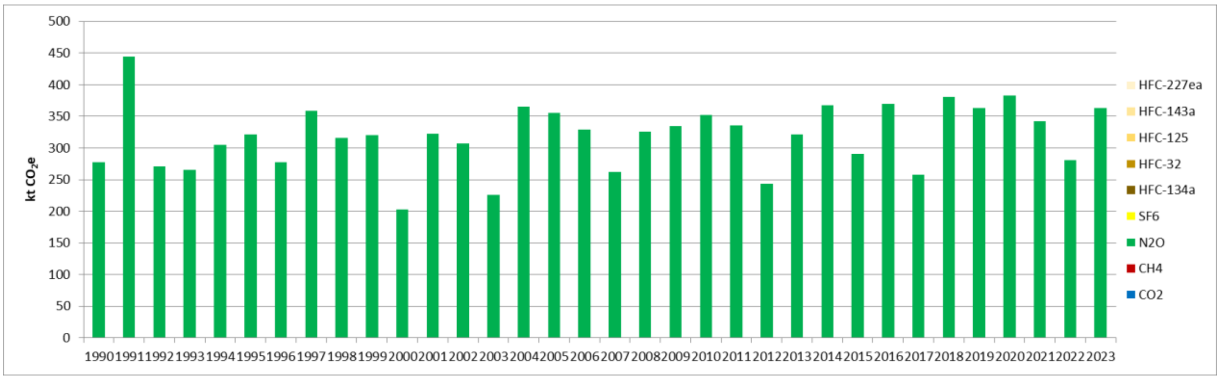
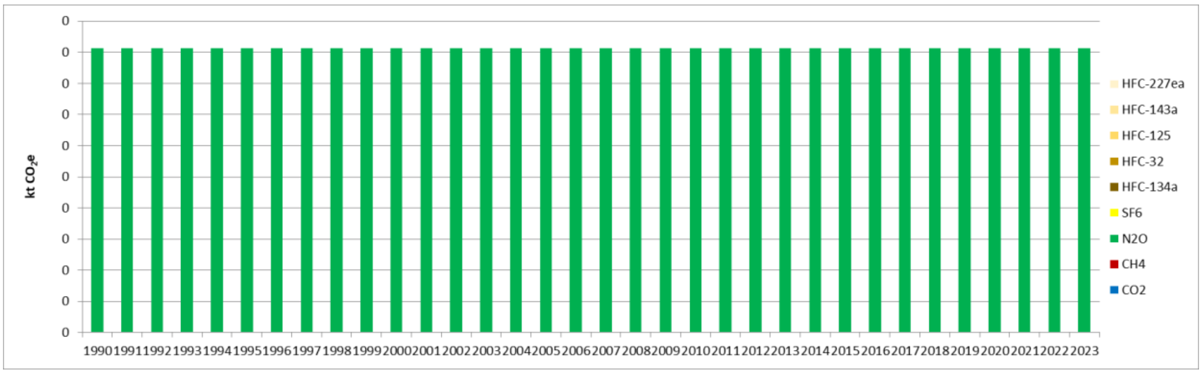


Figure 111 : N2O emissions from cultivation of organic soils (CRT 3D1.6) (kt CO_2e)



In 2023, the CRT categories 3.D.1.a (inorganic N fertilisers), 3.D.1.b.i (animal manure applied to soil) and 3.D.1.d (crop residues) are both key categories in terms of emission levels and trend.

The N_2O emissions from the subsector inorganic N fertilisers contribute to 0.9% in terms of emissions level (rank 17) and 1.9% in terms of emissions trend (rank 14).

The N_2O emissions from the subsector animal manure applied to soil contribute to 0.6% in terms of emissions level (rank 24) and 0.8% in terms of emissions trend (rank 31).

The N_2O emissions from subsector crop residues contribute to 0.6% in terms of emissions level (rank 22) and 0.6% in terms of emissions trend (rank 37).

5.4.1.2 Methodological issues

Direct emissions of N_2O from managed soils are calculated with a Tier 1 approach which is in line with the 2019 IPCC Guidelines [A21].

Activity data used are the quantities of inorganic fertiliser [A2], the amounts of animal manure and urine and dung deposited by animals, which are calculated through CRT 3B categories (livestock), the amounts of N from crop residues and the surface of managed/drained organic soils [A11].

For the crop residues, the estimations are based on calculations related to the total annual harvested crop areas [A2], the productions of crop [A2] and the amount of biomass burned in agriculture [A12], for each type of crop. Default parameters from the 2006 IPCC guidelines are used (dry matter content, N content of above and below ground residues, etc.).

Emissions factors used for calculating N_2O emissions come from the 2019 IPCC guidelines [A21][A13] and the 2013 Wetland supplement [A22]. Those factors are presented in the following table.

Table 35: N_2O emission factors for agricultural soils (3D1), per management system, from 2019 IPCC Guidelines and 2013 Wetland supplement, used in Serbian inventory

Management system	EF (kg N_2O-N/kg N)
Inorganic fertilisers	0.01
Animal manure applied to soils	0.01
Urine and dung deposited by cattle, poultry and pigs	0.004
Urine and dung deposited by sheep and others	0.003
Crop residues	0.01
Managed/drained organic soils	5

5.4.2 Indirect N_2O emissions from managed soils (3D2)

5.4.2.1 Category description

The indirect emissions of N_2O from managed soils are separated between two subcategories: atmospheric deposition, and leaching and run-off. The emission estimation methodology used is based on Tier 1 from 2006 IPCC guidelines. The activity data used are the same as in the previous chapter, the amounts of N applied to soils, recalculated to obtain the amounts of N volatilised and added to/mineralised in soils through leaching and run-off.

The indirect emissions from leaching and run-off are directly proportional to the evolution of the sum of all activities from Table 33 and Table 34, except for organic soils. The emissions are slightly varying but rather stable from 1990 to 2001, before increasing progressively until 2009, where they reached their peak (+121% compared with 2001). From 2009 onwards, the emissions vary significantly but an overall reduction is observed, and the emission levels achieved in 2023 are 43% below the one from 2009, but 61% higher than the one from 1990.

The indirect emissions related to volatilisation are lower in magnitude, and represent 25% of the total of the category 3D2 in 2023 (versus 30% in 1990). This is due to the fact the fractions of volatilised N are lower than the fraction of N leaching and running off (see chapter 5.4.2.2), in particular for synthetic fertiliser. Hence, the large variations of the amounts of inorganic N-fertilisers applied to soils have a more moderate impact on the emissions by atmospheric deposition. However, the observed trend is relatively similar, and the same observations made previously for the emissions from leaching and run-off can be adapted to this subsector, with a different order of magnitude. Overall, an increase of 29% has been observed in the indirect emissions from atmospheric deposition, for the period 1990-2023.

Figure 112 : Indirect N_2O emissions from atmospheric deposition (CRT 3D2.1) (kt CO_2e)

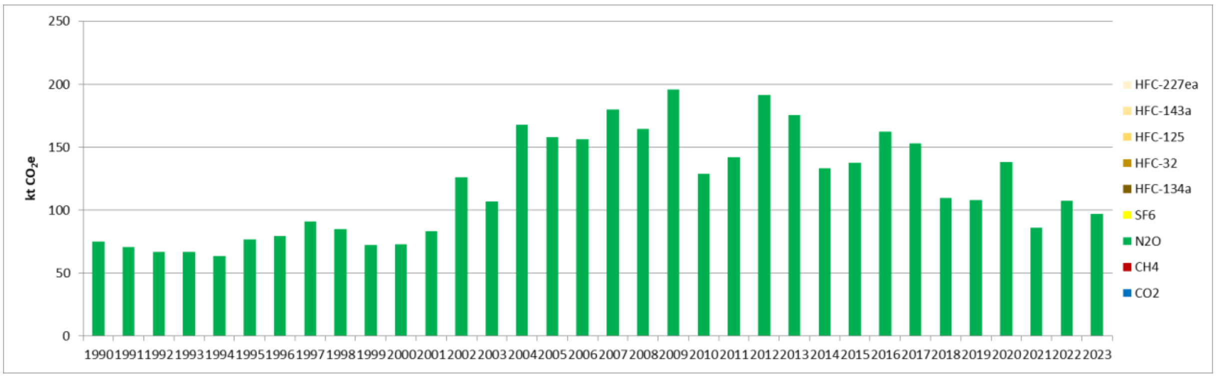
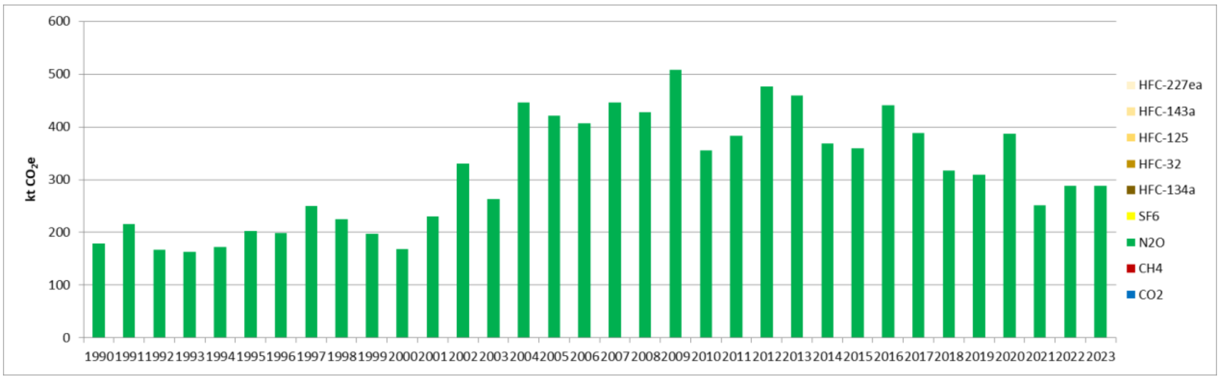


Figure 113 : Indirect N2O emissions from nitrogen leaching and run-off (CRT 3D2.2) (kt CO_2e)



In 2023, the N_2O emissions from the CRT 3.D.2.b (Nitrogen leaching and run-off) are a key category in the Republic of Serbia both in emission levels and trend. This sector contributes to 0.6% in terms of emissions level (rank 23), and 0.4% in terms of trend (rank 44).

The N_2O emissions from nitrogen atmospheric deposition (CRT 3.D.2.a) are a key category in emission levels with a contribution of 0.2% (rank 41).

5.4.2.2 Methodological issues

Direct emissions of N_2O from managed soils are calculated with a Tier 1 approach in line with the 2019 IPCC Guidelines [A21].

Activity data used are the same as the one given in chapter 5.4.1.25.4.1, with some additional calculations in order to calculate the amounts of volatilised N and N lost through leaching and run-off, according to IPCC 2019 guidelines. The parameters used to estimate the appropriate activity data are:

- Fraction of synthetic fertiliser N that volatilises as NH_3 and NOx: F_{GASF} = 0.11 kg N volatilised/kg N applied;
- Fraction of organic fertiliser N (including urine and dung deposited by grazing animals) that volatilises as NH_3 and NOx: F_{GASM} = 0.21 kg N volatilised/kg N applied or deposited;
- Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs: F_{GASF} = 0.24 kg N volatilised/kg N additions.

Emissions factors used for calculating N_2O emissions come from 2019 IPCC guidelines [A21] and are given in the following table:

Table 36: N_2O emission factors for indirect emissions from agricultural soils (3D1) from 2019 IPCC Guidelines, used in Serbian inventory

	EF
Atmospheric deposition (in kg N_2O-N/kg NH_3-N+Nox-N volatilised)	0.01
Leaching and run-off (in kg N_2O-N/kg N leaching/runoff)	0.011

5.4.3 Uncertainties and time-series consistency

3D1

Uncertainty estimate associated with activity data amounts to 5%, based on expert judgment.

Uncertainty estimate associated with N_2O emission factor amounts to 28%.

The uncertainty combined for N_2O emissions from this category is of 0.6% in the total national levels of emission in 2023, excluding LULUCF contribution.

3D2

Uncertainty estimate associated with activity data amounts to 5%, based on expert judgment.

Uncertainty estimate associated with N_2O emission factor amounts to 101%, also based on 2006 IPCC Guidelines (Volume 4, Chapter 11, Table 11.3).

The uncertainty combined for N_2O emissions is 0.8% in the total national levels of emission in 2023, excluding LULUCF contribution.

5.4.4 Category-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 keys in the CRT tables.

5.4.5 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	836	961	803	2 106	1 768	1 914	2 410	2 312	1 832	1 793	2 214	1 949	1 569	1 528	1 930	1 229	1 433	0
Nouveau	kt CO2e	1 716	1 783	1 579	2 779	2 354	2 482	2 956	2 851	2 385	2 348	2 742	2 470	2 080	2 037	2 451	1 732	1 904	1 828
Différence	kt CO2e	+880	+822	+776	+673	+587	+567	+546	+539	+553	+555	+528	+522	+511	+509	+522	+503	+471	+1 828
	%	+105,3%	+85,6%	+96,7%	+32,0%	+33,2%	+29,6%	+22,7%	+23,3%	+30,2%	+31,0%	+23,9%	+26,8%	+32,6%	+33,3%	+27,0%	+40,9%	+32,9%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 3.D

<u>3Da2a – Animal manure applied to soils:</u>

For the whole timeseries, the activity data have been corrected and constitute a significant increase compared to the previous submission where the amounts of urine and dung deposited by grazing animals were incorrectly considered for this category.

The impact is of approximately 880 kt CO_2e in 1990 and decrease progressively down to 470 kt CO_2e in 2022.

5.4.6 Category-specific planned improvements

For the CRT 3D1.4, not all crops have been taken into account in the calculation. Regarding the crop residues, progress can be made by adding other crops in the calculation.

For the CRT code 3D2, indirect N_2O emissions are estimated based on fractions that take the default values from the 2019 IPCC Guidelines. However, for atmospheric deposition, this can be improved by estimating the NH_3 and NOx emissions with the EMEP methodology. The work has been done for indirect N_2O from 3B. Consequently, an improvement would be to also implement this methodology for 3.D to develop more accurate fraction of volatilization for future N_2O deposition.

In addition, another improvement will be to use the disaggregated EF included in the 2019 IPCC refinement to estimate the emissions by climate region (wet/dry).

5.5 Field burning of agricultural residues (3F)

The field burning of agricultural residues category covers the emissions of CH_4 and N_2O from the burning of wheat (3.F.1.1) and maize (3.F.1.3). The field burning from cultures of other cereals (i.e., barley and others) is not occurring, as well as for the other cultures: pulses (3.F.2), tubers and roots (3.F.3), sugar cane (3.F.4) and others (3.F.5).

Overall, the GHG emissions from Field burning (CRT 3F) have slightly reduced, by 5%, between 1990 and 2023, but follow an oscillating but rather stable trend. For the whole studied period, this sector is marginal in the national totals as well as in the agriculture totals. In 2023, it represents 2% of the CRT 3 GHG emissions and 0.3% of the national totals, excluding LULUCF contribution.

As emissions are only related to the CRT 3.F.1 category, the emission trend description is given in the following chapter.

5.5.1 Cereals (3F1)

5.5.1.1 Category description

The following figures give the evolution of the GHG emissions from both subcategories from this sector (wheat and maize), distinguished between CH_4 and N_2O emissions. For both emission sources, the emissions from methane are predominant and represent about 80% of the GHG totals.

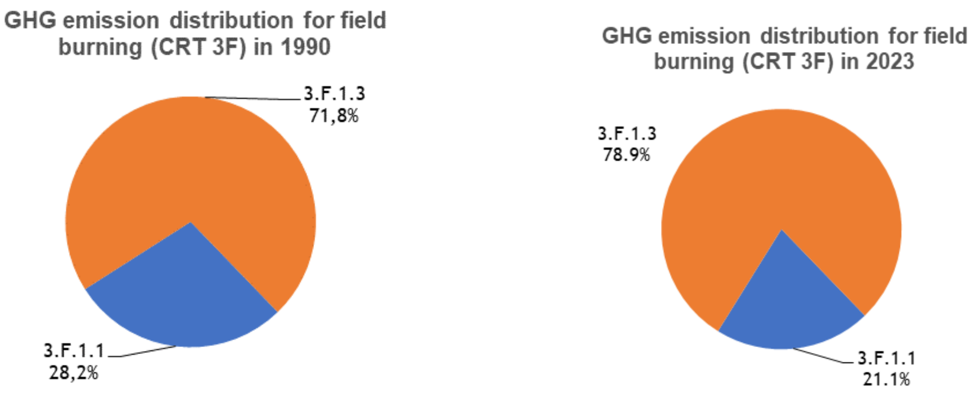
The emission estimation methodology is based on the Tier 1 from 2006 IPCC guidelines (see chapter 5.5.1.2), hence the emission evolution is directly proportional to the changes in the amounts of maize and wheat burned.

In short, the GHG emissions from wheat burning have varied significantly from 1990 to 2004, and are more stable since then, achieving an overall reduction of 329% between 1990 and 2023. The GHG emissions from maize burning are more stable over the timeseries and, in 2023, a small increase of 5% is observed compared with 1990. The emissions from maize burning are the main emission source and contribute to about 79% of the sector emissions in 2023, a slight increase from its 1990 contribution of 72%.

Figure 114 : GHG emissions from field/ burning of wheat (CRT 3F1.1) (kt CO_2e)

Figure 115 : GHG emissions from field burning of maize (CRT 3F1.3) (kt CO_2e)

Figure 116: GHG emission distribution for field burning of agriculture residues (CRT 3F), in 1990 and 2023 (in %)



In 2023, CRT 3F1 subcategories (3F1.1, 3F1.3) are neither key categories in terms of emission levels nor in emission trend, in the Republic of Serbia.

5.5.1.2 Methodological issues

GHG emissions from field burning of agricultural residues are calculated with a Tier 1 approach which is in line with the 2006 IPCC Guidelines [A16].

Activity data used are the quantities of wheat and maize burned and come from the FAO database [A12].

Emissions factors used for calculating GHG emissions come from 2006 IPCC guidelines [A16] and are given in the following table. They are given as the product of the combustion factor, which depends on the crop and is of 0.9 for wheat and 0.8 for maize, with the EF for agricultural residues which are of 2.7 g CH_4/kg and 0.07 g N_2O/kg.

Table 37: N_2O emission factors for field burning of agricultural residues (CRT 3F), from 2006 IPCC Guidelines, used in Serbian inventory

Burned crop	EF CH_4 (g/kg)	EF N_2O (g/kg)
Wheat	2.43	0.063
Maize	2.16	0.056

5.5.2 Uncertainties and time-series consistency

CH_4

Uncertainty estimate associated with activity data amounts to 30%, based on expert judgment.

Uncertainty estimate associated with CH_4 emission factor amounts to 100%, also based on expert judgment.

The uncertainty combined for emissions is 0.15% in the total national levels of emission in 2023, excluding LULUCF contribution.

N_2O

Uncertainty estimate associated with activity data amounts to 30%, based on expert judgment.

Uncertainty estimate associated with CH_4 emission factor amounts to 100%, also based on expert judgment.

The uncertainty combined for emissions is 0.03% in the total national levels of emission in 2023, excluding LULUCF contribution.

5.5.3 Category-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 keys in the CRT tables.

5.5.4 Category-specific recalculations

No recalculations were made compared with the latest NID submission (November 2024).

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	107	96	81	105	109	111	94	95	100	96	96	94	90	92	95	97	100	0
Nouveau	kt CO2e	107	96	81	105	109	111	94	95	100	96	96	94	90	92	95	97	100	102
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+102
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm /3.F

5.5.5 Category-specific planned improvements

For the CRT 3F, the assumption made is that there is no burning of crop residues in Serbia, except for maize and wheat because data were found in the FAO statistics for these crops regarding biomass burnt. An improvement can be to further explore this question in order not to miss any emission source and ensure the completeness of this category.

5.6 Urea application (3.H)

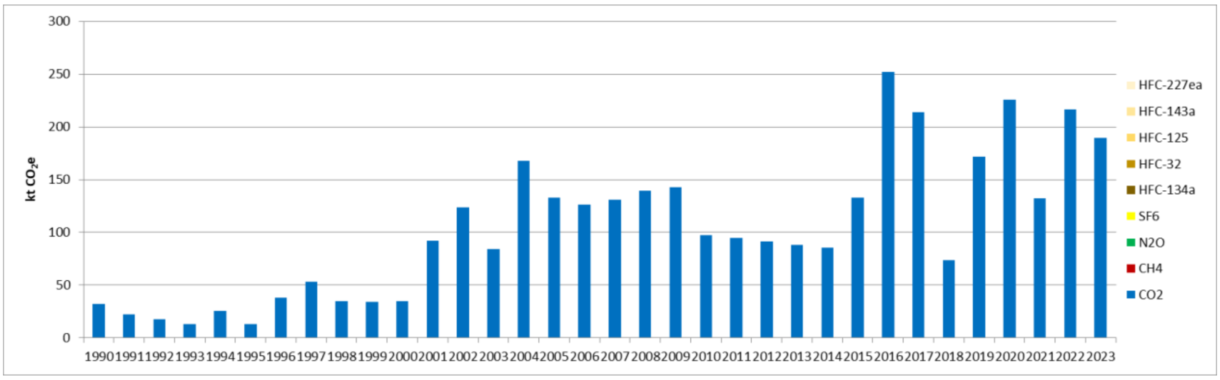
5.6.1 Category description

For this category, the emissions of CO_2 related to the application of urea onto agricultural fields are estimated. The emissions are calculated with a Tier 1 methodology, with a constant EF applied, hence the emissions are directly proportional to the evolution of the activity data. This sector represents the only emissions of CO_2 from the Agriculture sector (which are considered in the emission inventory scope, hence different from CO_2 related to biomass).

In the following figure, it can be observed that the emissions are rather stable from 1990 to 2000, before increasing rapidly between 2001 and 2004 (+379% compared with 2000 emission level). A slight reduction is then observed until 2014, before increasing again significantly and rapidly up to 2016. From 2016 onwards, the data vary significantly. In 2023, the emissions have increased by +489% compared with 1990.

This sector has an important growing share in the national and sectoral emission totals. In 2023, this category contributes to 3.9% of the Agriculture sector emissions, whereas it was only 0.3% in 1990. In addition, in the national emissions excluding LULUCF contribution, its share is of 0.3% in 2023 (while it was 10 times less in 1990).

Figure 117 : GHG emissions from urea application (CRT 3H) (kt CO_2e)



In 2023, the CRT 3H sector is a key category for CO_2 in the Republic of Serbia, both in terms of emission levels and trend. This sector contributes to 0.3% in terms of emission level (rank 39) and to 0.6% in emission trend (rank 36).

5.6.2 Methodological issues

GHG emissions from urea application are calculated with a Tier 1 approach which is in line with the 2006 IPCC Guidelines [A17].

Activity data used are the annual quantities of urea applied to agricultural soils, which are taken from SORS [A18].

Emission factor used for calculating GHG emissions comes from 2006 IPCC guidelines [A19] and the value is of 0.2 t C/t urea, which corresponds to about 733.3 kg/t.

5.6.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 5%, based on expert judgment.

Uncertainty estimate associated with CO_2 emission factor amounts to 50%, also based on 2006 IPCC Guidelines (Volume 4, Chapter 11, p.11.32).

The uncertainty combined for emissions is 0.2% in the total national levels of emission in 2023, excluding LULUCF contribution.

5.6.4 Category-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 keys in the CRT tables.

5.6.5 Category-specific recalculations

No recalculations were made compared with the latest NID submission (November 2024).

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	32	13	35	133	97	94	91	88	85	133	252	214	74	172	226	132	217	0
Nouveau	kt CO2e	32	13	35	133	97	94	91	88	85	133	252	214	74	172	226	132	217	190
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+190
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 3.H

5.6.6 Category-specific planned improvements

No improvement is planned for this specific category, for the moment.

Chapter 6: Land use, land-use change and forestry (CRT sector 4)

Note: Unless stated otherwise, all results discussed in the sectorial chapters consider national totals, excluding indirect CO_2 emissions.

6.1 Overview of sector

This category includes all GHG emissions and absorptions (or "removals", or "negative emissions") due to land use, land use change and forestry (LULUCF). Since the sector present both emissions and absorptions, the term "flux" is used to mention all figures.

The CRT 4 category covers the following sectors:

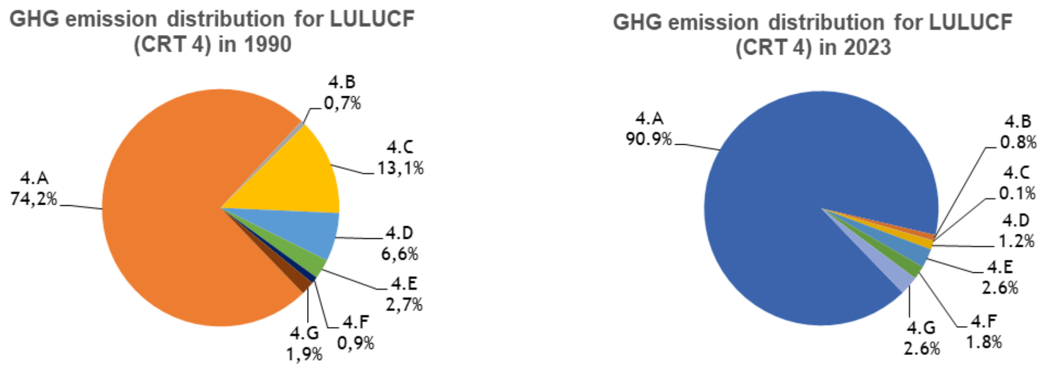
- Forest land (4A), including Forest lands remaining forest lands (4A1), and Lands converted to forest lands (4A2) with croplands (4.A.2.1), grasslands (4.A.2.2), wetlands (4.A.2.3), settlements (4.A.2.4) and other lands (4.A.2.5),
- Cropland (4B), including Lands converted croplands (4B2) with forest lands (4.B.2.1), grasslands (4.B.2.2), wetlands (4.B.2.3) and settlements (4.B.2.4)
- Grassland (4C), including Grasslands remaining grasslands (4C1), and Lands converted to forest lands (4C2) with forest lands (4.C.2.1), croplands (4.C.2.2), wetlands (4.A.2.3), settlements (4.A.2.4) and other lands (4.A.2.5),
- Wetlands (4D), including Lands converted to another type of wetlands (4.D.2.3),
- Settlements (4E), including Lands converted to settlements (4E2), with forest lands (4.E.2.1), croplands (4.E.2.2) and grasslands (4.E.2.3),
- Other land (4F), including Lands converted to other lands (4F2), with forest lands (4.F.2.1), croplands (4.F.2.2) and grasslands (4.F.2.3),
- Harvested wood products (4G).

The subcategories Croplands remaining croplands (4B1), Wetlands remaining wetlands (4D1) and Settlements remaining settlements (4E1), are considered as not estimated (NE), applying the default tier 1 approach of equilibrium assumption. In addition, the category Other (4H) and some other subcategories such as other lands converted to croplands (4.B.2.5), and Lands converted to peat extraction (4.D.2.1) are not occurring (NO) in the Republic of Serbia, for the reported period. Finally, the category Lands converted to flooded lands (4.D.2.2) is considered as included elsewhere (IE) in the emission inventory.

The LULUCF sector is a net sink, offsetting 1.7% of the GHG emissions in 1990 and 8.0% in 2023. CO_2 represents more than 97% of the sector fluxes in 1990 and more than 99% in 2023. The emissions of methane and nitrous oxide from LULUCF are rather negligible in the national totals, contributing to 0.07% and 0.6%, respectively, in 2023.

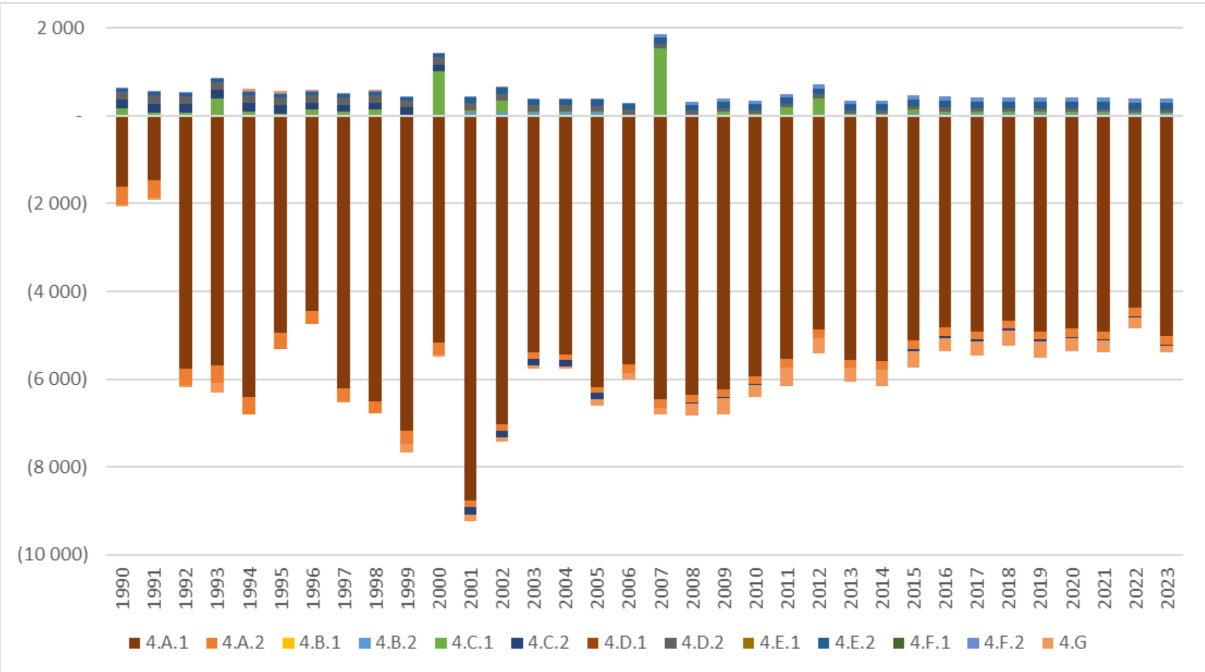
Considering all emissions and absorptions in absolute values, the main contributor subsector is the CRT 4A, in particular the CRT 4A1 which contributes to 94% of the fluxes of this subsector (74% of the LULUCF sector in 1990 more than 91% in 2023). The fluxes related to croplands (CRT 4C), which were quite significant in 1990 and contributed to 13% of the sector total, have decreased significantly, with a share of only 0.1% in 2023. Finally, to another extent, another significant contributor is the harvested wood product (HWP) category (CRT 4G), which has increased its share from 1.9% to 6.5%, between 1990 and 2019, due to an important increase of this net sink, before decreasing again to 2.6% in 2023.

Figure 118: GHG emission distribution for LULUCF (CRT 4), for the period 1990-2023, per subsector (in %)



In the Republic of Serbia, as for the majority of EU Member states, the LULUCF sector has been a net sink during the historical period (from 1990), mostly due to the forest land, and seems to show an increasing trend in the 1990s, and a slightly declining trend from the 2000's to the most recent years. The following graph presents the country's LULUCF net sink evolution and each of the LULUCF categories results.

Figure 119: GHG emissions trends for LULUCF (CRT 4), for the period 1990-2023, per subcategory (in kt CO_2e)



In overall, in 2023, GHG emissions from CRT 4 LULUCF are a net removal of -5.0 Mt CO_2e, compared with -1.4 Mt CO_2e in 1990, corresponding to a 253% increase for the studied period. GHG emissions vary significantly during the reporting period, in particular until 2003, due in part to a lower harvesting rate (increase of sink) and wildfires (sink reduction). From 2008 onwards, the emissions from LULUCF are more stable and follow an increasing trend (i.e., the sink of emissions is getting smaller), and an overall increase of 23% is observed for the period 2008-2023. The significant reduction of the sinks in the Forest land category, in the 2010-2012 period, is the result of a significant drop of forest mass increment due to a drought in 2012, which explains the 2012 emissions peak. In addition, the sinks are decreasing mainly due to the increased use in biomass and to natural disasters (e.g., fires, breakages due to storms, damage caused by insects and diseases).

Only Forest Land and Harvested Wood Products are categories that are net sinks, (Forest Land being approximately 15 times higher than HWP). HWP net sink increased from 1990 to 2019, and is now decreasing. All other categories are net sources of emissions, mostly due to land conversions or the burning of dry pastures, with small amounts. To summarize, during the last years, Forest Land represented approximately -5 Mt CO_2e of sink; HWP -0.1 Mt; and all other categories cumulated between 0.4 Mt.

6.2 Land-use definitions and the classification systems used and their correspondence to the land use, land-use change and forestry categories (e.g. land use and land-use change matrix)

The definition of forest is the one used by the Global Forest Resources Assessment 2015 (Country Report Serbia). The selected thresholds are:

- Minimum land area: 0.5 ha;
- Minimum canopy cover: 10% (in situ. i.e. potential of the standing stock to reach this threshold);
- Minimum height: 5 meters (in situ. i.e. potential of the standing stock to reach this threshold);

However, in the framework of the GHG inventory, all 6 land-use categories are directly connected with the definitions Corine Land Cover which is the main source used in the current Serbian inventory to determine areas. The nomenclature of Corine Land Cover was associated to 6 IPCC categories following this allocation table.

Table 38: Table of correspondence between CLC and IPCC classes

Code	CLC class	IPCC class
111	Continuous Urban Fabric	Settlement
112	Discontinuous Urban Fabric	Settlement
121	Industrial or Commercial	Settlement
122	Road and Rail networks	Settlement
123	Sea Ports	Settlement
124	Airports	Settlement
131	Mineral extraction sites	Settlement
132	Dump	Settlement
133	Construction sites	Settlement
141	Green Urban areas	Settlement
142	Sport and Leisure facilities	Settlement
211	Non-irrigated arable land	Cropland
221	Vineyards	Cropland
222	Fruit trees and berries plantations	Cropland
231	Pastures	Grassland
242	Complex cultivation	Cropland
243	Land principally occupied by agriculture with areas of natural vegetation	Grassland
311	Broad Leaved forest	Forest
312	Coniferous forest	Forest
313	Mixed forest	Forest
321	Natural grassland	Grassland
324	Transitional woodland shrub	Forest
331	Beaches, dunes, sand	Other land
332	Bare rocks	Other land
333	Sparsely vegetated	Other land
334	Burnt areas	Other land

411	Inland Marshes	Wetlands
511	Stream courses	Wetlands
512	Water bodies	Wetlands

6.3 Information on approaches used for representing land areas and on land-use database used for the inventory preparation

The methodology to estimates land use matrixes corresponds to an approach 3 because the land-use changes are spatially explicit and gross changes are known.

Land use and land use change areas are based on monitoring data from Corine Land Cover. Currently, four editions of the CLC dataset are used in the Serbian inventory : 1990, 2000, 2006 and 2012. The land use changes have been estimated for the periods 1990-2000, 2000-2006 and 2006-2012. The 2018 edition and the 2012-2018 change map are not yet used.

Table 39: Annual land use changes for the period 1990-2000 (ha/year)

↱	Forest	Cropland	Grassland	Wetland	Settlement	Other land
Forest		64	223	94	55	24
Cropland	283		953	105	403	0
Grassland	425	242		192	127	5
Wetland	34	24	40		8	38
Settlement	113	55	29	2		0
Other land	9	0	3	7	0	

Table 40: Annual land use changes for the period 2000-2006 (ha/year)

↱	**Forest**	**Cropland**	**Grassland**	**Wetland**	**Settlement**	**Other land**
Forest		53	12	65	178	3
Cropland	55		106	112	457	0
Grassland	74	918		109	80	0
Wetland	5	0	13		6	0
Settlement	101	3	13	4		0
Other land	125	0	0	4	0	

Table 41: Annual land use changes for the period 2006-2012 (ha/year)

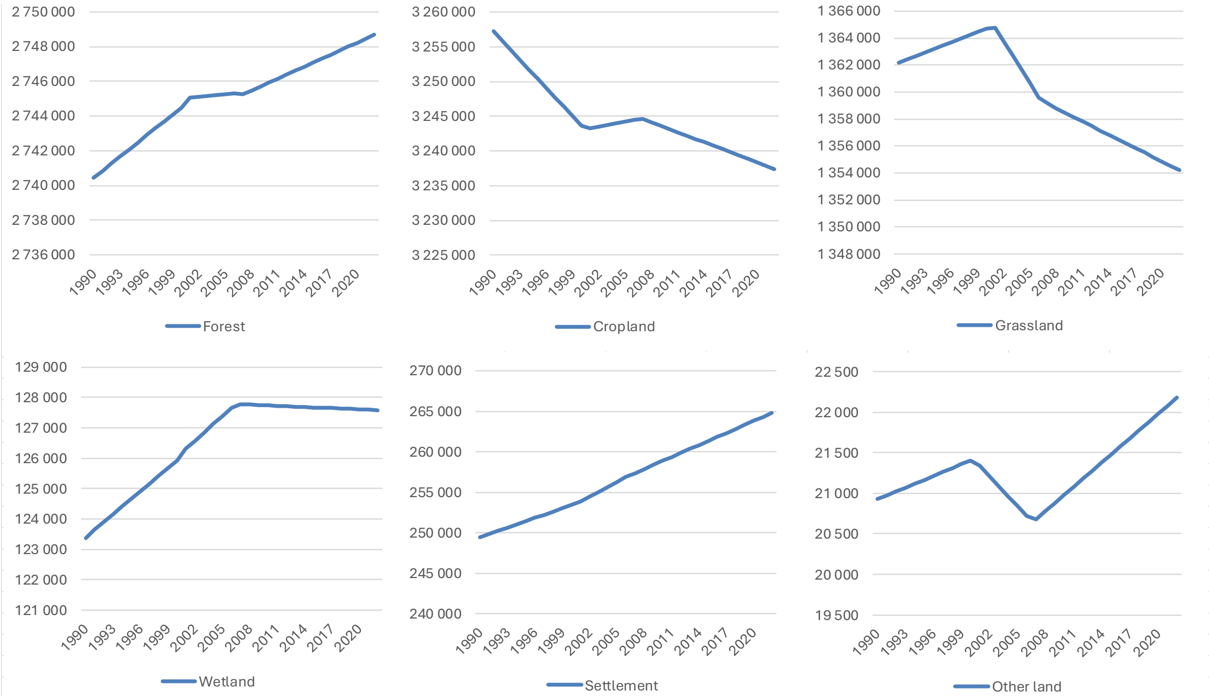
↱	Forest	Cropland	Grassland	Wetland	Settlement	Other land
Forest		24	5	27	211	139
Cropland	183		222	45	384	0
Grassland	134	287		83	111	0
Wetland	111	31	30		7	0
Settlement	171	8	30	8		0
Other land	35	0	0	4	0	

For the inventory it is necessary to estimate annual changes since 1970 to 2023, so the following treatments are implemented:

- During each monitoring period the changes are supposed to be constant, annual changes are thus estimated by dividing the changes of the period by the number of years of the period.
- Before 1990, land use changes are assumed to be equivalent to the period 1990-2000.
- After 2012, that land use changes are assumed to be equivalent to the period 2006-2012.

The year 2000 was chosen as the only reference for land use changes to avoid potential small discrepancies between maps. All the areas are calculated on the basis of 2000 areas combined with annual changes. The calculation of "area of land remaining land" is done by subtracting all the changes that become that land in that year from the area at the end of the year.

Figure 120: Evolution of the land use areas in the Republic of Serbia since 1990



This protocol allows building both annual and 20-year matrixes which are necessary for the calculation of carbon fluxes.

Table 42: Example of annual matrix for the year 2023 (ha)

↱	Forest	Cropland	Grassland	Wetland	Settlement	Other land	Initial Area
Forest	2 748 908	24	5	27	211	139	2 749 314
Cropland	183	3 236 898	222	45	384	0	3 237 732
Grassland	134	287	1 353 873	83	111	0	1 354 488
Wetland	111	31	30	127 573	7	0	127 752
Settlement	171	8	30	8	265 292	0	265 510
Other land	35	0	0	4	0	22 280	22 319
Final Area	2 749 543	3 237 248	1 354 161	127 740	266 005	22 419	7 757 115

Table 43: Example of 20-year matrix for the year 2023 (ha)

⮣	Forest	Cropland	Grassland	Wetland	Settlement	Other land	Initial Area
Forest	2 737 671	573	125	650	4 115	2 376	2 745 509
Cropland	3 270	3 228 380	4 083	1 105	7 907	0	3 244 744
Grassland	2 505	7 639	1 348 847	1 733	2 123	0	1 362 848
Wetland	1 908	520	551	124 020	141	0	127 140
Settlement	3 213	136	554	154	251 720	0	255 777
Other land	976	0	0	77	0	20 043	21 097
Final Area	2 749 543	3 237 248	1 354 161	127 740	266 005	22 419	7 757 115

6.4 Common elements to all land uses (CRT 4)

6.4.1 Carbon stock changes

- Living biomass

All fluxes related to living biomass are estimated by the stock-difference method on areas with land use changes (equation 2.5 of the IPCC 2006 guidelines) and by the gain-loss method on forest remaining forest (equation 2.4 of the IPCC 2006 guidelines). For all land uses but forest, on land remaining land, living biomass is assumed to be in equilibrium and gains and losses are reported as not estimated.

EQUATION 2.4
ANNUAL CARBON STOCK CHANGE IN A GIVEN POOL AS A FUNCTION OF GAINS AND LOSSES (GAIN-LOSS METHOD)

$$\Delta C = \Delta C_G - \Delta C_L$$

Where:

ΔC = annual carbon stock change in the pool, tonnes C yr^{-1}

ΔC_G = annual gain of carbon, tonnes C yr^{-1}

EQUATION 2.5
CARBON STOCK CHANGE IN A GIVEN POOL AS AN ANNUAL AVERAGE DIFFERENCE BETWEEN ESTIMATES AT TWO POINTS IN TIME (STOCK-DIFFERENCE METHOD)

$$\Delta C = \frac{(C_{t_2} - C_{t_1})}{(t_2 - t_1)}$$

Where:

ΔC = annual carbon stock change in the pool, tonnes C yr^{-1}

C_{t_1} = carbon stock in the pool at time t_1, tonnes C

C_{t_2} = carbon stock in the pool at time t_2, tonnes C

Default carbon stocks from IPCC guidelines are used in the current inventory for living biomass.

	Aboveground Biomass (t d.m/ha)	Root to shoot ratio	Carbon content (tC/t d.m)
Forest	120	0.3	0.47
Cropland	10	0	0.47
Grassland	6.5	0	0.47
Wetland	0	0	0.47
Settlement	0	0	0.47
Other land	0	0	0.47

- Dead organic matter (dead wood, litter)

Data for deadwood carbon stocks are not available in the IPCC guidelines (Table 2.2).

The information regarding litter carbon stocks is extracted from the IPCC guidelines (Table 2.2), it is assumed that only forest areas have litter carbon stocks. This stock is assumed to be 16tC/ha.

All fluxes related to litter are estimated by the stock-difference method on areas with land use changes.

- Soils (mineral and organic soils)

In the Republic of Serbia, it is assumed that all soils are mineral soils. All fluxes related to organic soils are reported as not occurring.

IPCC default carbon stocks are not used, instead country-specific values from a study "Project on determining Soil organic carbon in Serbia" are applied and as follows:

Table 44: Carbon stock parameters used in the Serbian emission inventory, per type of land (in t C/ha)

	SOC (tC/ha)
Forest	132.3
Cropland	77.4
Grassland	61.6
Settlement	0
Other land	0
Wetland	0

6.4.2 Direct N_2O Emissions from N Inputs to Managed Soils

It is assumed that no other land but agricultural land is fertilized in Serbia, thus direct N_2O emissions are reported as not occurring in LULUCF.

6.4.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.4.4 Direct N_2O Emissions from N Mineralization/Immobilization

Direct N_2O emissions from mineralization are estimated on lands where land use changes occur with a loss of carbon from soils. These emissions are estimated for forest converted to other lands, grasslands converted to other lands (but forests), croplands converted to other lands (but forests and grasslands).

These emissions are estimated thanks to equations 11.2 and 11.8 of the 2006 IPCC guidelines.

EQUATION 11.2
DIRECT N_2O EMISSIONS FROM MANAGED SOILS (TIER 2)

$$N_2O_{Direct}\text{–}N = \sum_i \left(F_{SN} + F_{ON}\right)_i \bullet EF_{1i} + \left(F_{CR} + F_{SOM}\right) \bullet EF_1 \; + \; N_2O\text{–}N_{OS} \; + \; N_2O\text{–}N_{PRP}$$

Where:

EF_{1i} = emission factors developed for N_2O emissions from synthetic fertiliser and organic N application under conditions *i* (kg N_2O–N (kg N input)$^{-1}$); $i = 1, \ldots n$.

EQUATION 11.8
N MINERALISED IN MINERAL SOILS AS A RESULT OF LOSS OF SOIL C THROUGH CHANGE IN LAND USE OR MANAGEMENT (TIERS 1 AND 2)

$$F_{SOM} = \sum_{LU} \left[\left(\Delta C_{Mineral,\, LU} \bullet \frac{1}{R} \right) \bullet 1000 \right]$$

Where:

F_{SOM} = the net annual amount of N mineralised in mineral soils as a result of loss of soil carbon through change in land use or management, kg N

$\Delta C_{Mineral,\, LU}$ = average annual loss of soil carbon for each land-use type (*LU*), tonnes C (Note: for Tier 1, $\Delta C_{mineral,\, LU}$ will have a single value for all land-uses and management systems. Using Tier 2 the value for $\Delta C_{mineral,\, LU}$ will be disaggregated by individual land-use and/or management systems.

R = C:N ratio of the soil organic matter. A default value of 15 (uncertainty range from 10 to 30) for the C:N ratio (R) may be used for situations involving land-use change from Forest Land or Grassland to Cropland, in the absence of more specific data for the area. A default value of 10 (range from 8 to 15) may be used for situations involving management changes on *Cropland Remaining Cropland*. C:N ratio can change over time, land use, or management practice [17]. If countries can document changes in C:N ratio, then different values can be used over the time series, land use, or management practice.

LU = land-use and/or management system type

6.4.5 Indirect N_2O Emissions from Managed Soils

Indirect N_2O emissions from soils are currently not estimated in the Serbian inventory.

6.4.6 Biomass Burning

Controlled burning is not estimated on all lands and wildfires are estimated on forestlands and grasslands.

For wildfires, the IPCC guidelines 2006 Tier 1 methodology is used (equation 2.27). Emissions from CO_2, CH_4, N_2O, NOx and CO are calculated.

Activity data for burning of forest lands come from Global forest resources assessment 2015 Country report for Serbia. Activity for burning of forest lands is the area burnt (in ha). Two sets of data are available, for the periods 1990-2002 and 2003-2012. For years after 2012, an average from last 5 years is used (2008-2012) due to lack of activity data.

No activity for directly grassland is available. In Global forest resources assessment 2010 Country report for Serbia, data for area of forest burned is available. Also, a total area burned of Forest, other wooded land and other land is available. Other lands are considered as grassland and area burned for grassland is calculated as a difference between total and area of forests burned. Activity for burning of grasslands is the area burnt in ha. Two sets of data are available, for period 1990-2002 and 2003-2012. For years after 2012, area of forest burned and total area are calculated as average of last 5 years and area of grassland burned is difference between those two areas.

Emission factor for calculations of direct emissions as well indirect emissions comes from IPCC guidelines 2006, Volume 4; Chapter 2 Generic Methodologies Applicable to Multiple Land use Categories. As it is a default emission factor it’s the same for all the years and is expressed in g/kg. For fuel biomass consumption also a direct value from IPCC guidelines 2006 is available in tones/ha. Emission factors for extra tropical forest are used because it includes all other forest types.

EQUATION 2.27
ESTIMATION OF GREENHOUSE GAS EMISSIONS FROM FIRE

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

Where:

L_{fire} = amount of greenhouse gas emissions from fire, tonnes of each GHG e.g., CH_4, N_2O, etc.

A = area burnt, ha

M_B = mass of fuel available for combustion, tonnes ha^{-1}. This includes biomass, ground litter and dead wood. When Tier 1 methods are used then litter and dead wood pools are assumed zero, except where there is a land-use change (see Section 2.3.2.2).

C_f = combustion factor, dimensionless (default values in Table 2.6)

G_{ef} = emission factor, g kg^{-1} dry matter burnt (default values in Table 2.5)

Note: Where data for M_B and C_f are not available, a default value for the amount of fuel actually burnt (the product of M_B and C_f) can be used (Table 2.4) under Tier 1 methodology.

6.5 Forestlands (4A)

6.5.1 Description

This category comprises GHG emissions and removals arising from forestlands.

The following graphs give the GHG emission trends for the different subcategories where estimations are developed for Forest lands.

There are two periods when assessing the historical trend of the net sink of LULUCF in Serbia: a first period of high variations of the sink from 1990 to the beginning of the 2000s, showing an increasing trend. The years 1990 and 1991 appears very low and the accuracy of their values and of the sharp increase between 1991 and 1992, is surely an artifact and is not considered here. A second period from the 2000's to the latest years shows more stability but also a slowly decreasing trend, in particular after 2008. In the period 2007–2020, sinks are decreasing, mainly due to the increased use of biomass, some droughts such as in the period 2010-2012, and natural disasters (e.g. fires, breakages due to strong winds, damage caused by the effects of insects and diseases).

The quantities removed from the category of forest land (forestry) in 2020 were 17.6% less compared to 2010. The main reason for less sequestration can be attributed to the increased use of wood for industrial needs and for heating. Furthermore, disruption losses in 2020 were almost three times higher than in 2010. The lowest removals were observed in 1990 due to heavy commercial logging and industrial technical wood for the pulp and paper industry.

In total, the sink has been increased by 159% between 1990 and 2023, but decreased by 22% since 2007.

Figure 121: GHG emissions from Forest land remaining forest land (CRT 4.A.1) (kt CO2e)

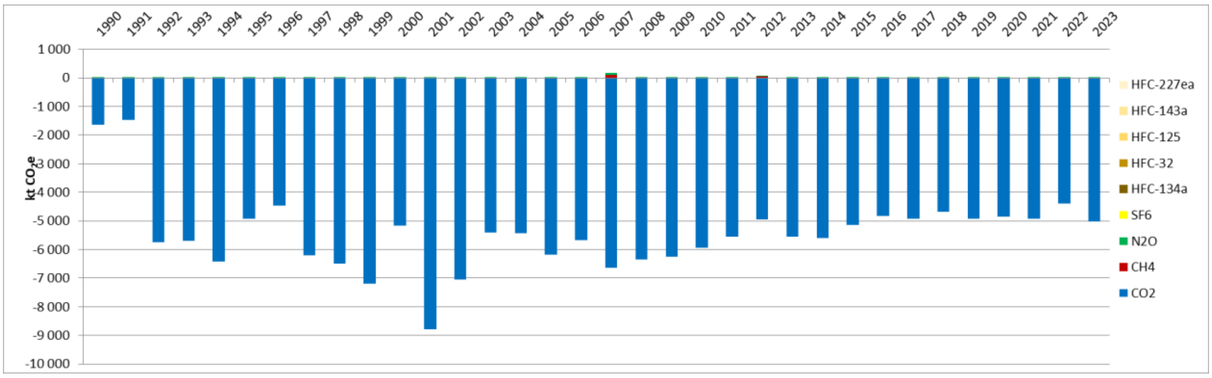


Figure 122: GHG emissions from cropland converted to forest land (CRT 4.A.2.1) (kt CO2e)

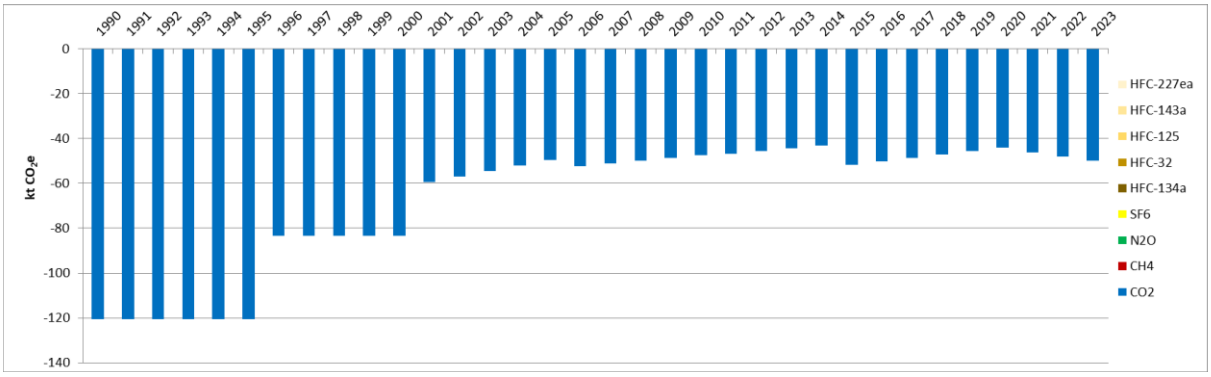
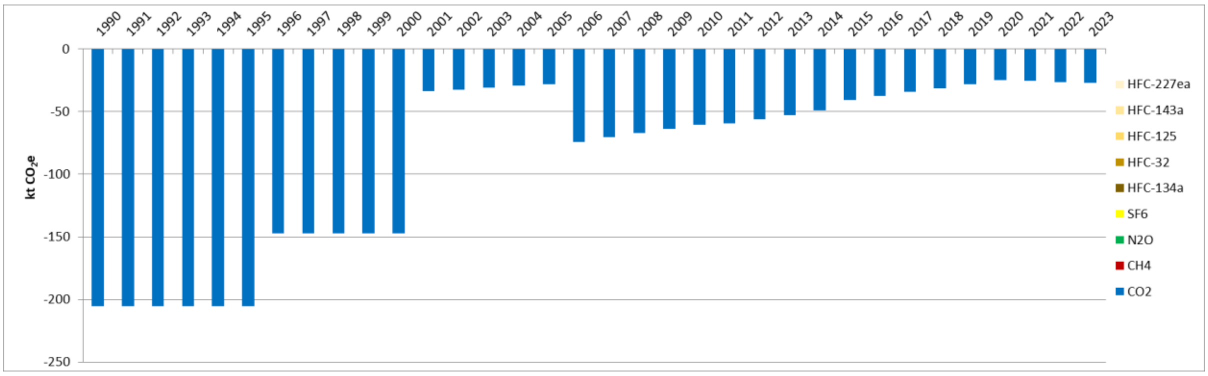


Figure 123: GHG emissions from grassland converted to forest land (CRT 4.A.2.2) (kt CO2e)



As shown in the figure above, trends in some subsectors are reflecting land-use change periods due to the annualization of CLC conversions, creating some abrupt changes between periods.

Figure 124: GHG emissions from wetlands converted to forest land (CRT 4.A.2.3) (kt CO_2e)

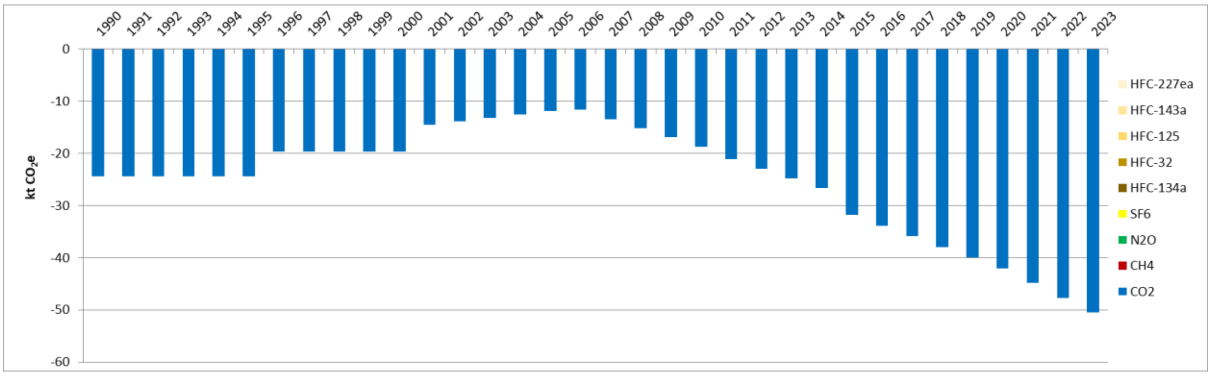


Figure 125: GHG emissions from settlements converted to forest land (CRT 4.A.2.4) (kt CO_2e)

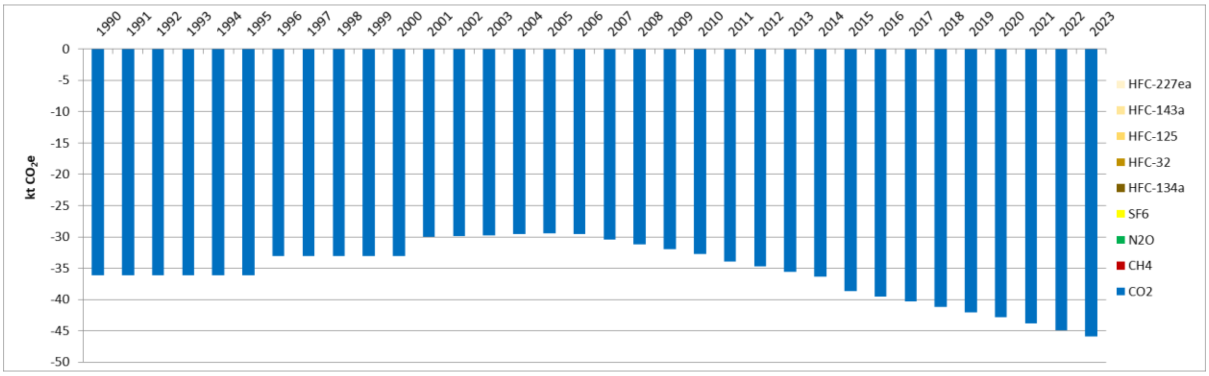
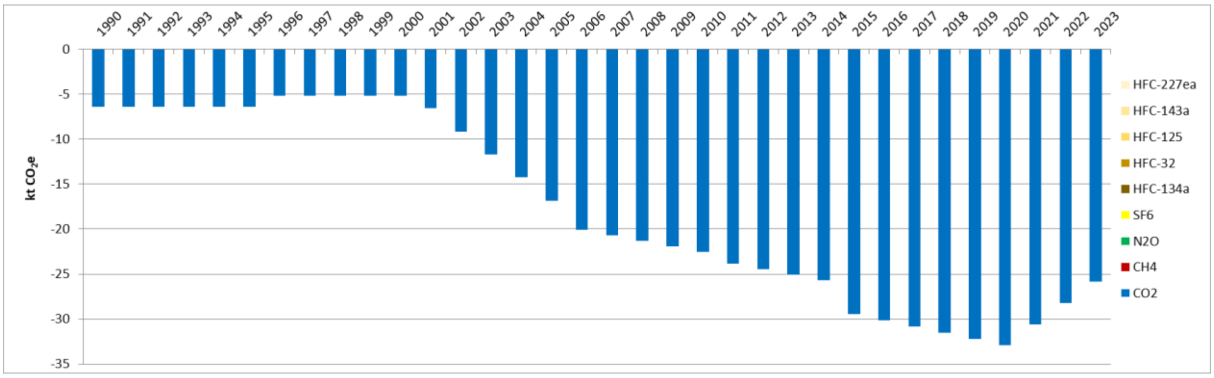


Figure 126: GHG emissions from other land converted to forest land (CRT 4.A.2.5) (kt CO_2e)



6.5.2 Methodological issues

6.5.2.1 Forestlands remaining forestlands (4A1)

6.5.2.1.1 Carbon stock changes

- Living biomass

Carbon stock changes in living biomass in forest are estimated on the basis of the gains-losses method. The area of forest is divided between 3 categories of forest:

- Broadleaves
- Conifers
- Mixed

The increment of forest biomass comes from the publication of FRA 2015 of Serbia. Estimates are used for 2010 and 2015 for 2 categories of forests (broadleaves and conifers), since they are in correlation with data published in National Forest Inventory. The elementary increment of mixed forest is estimated by making the average of broadleaves and conifers. The values of increment per ha per year are prescribed before 2010, and linearly interpolated for the period 2010-2015.

Annual increment (m^3/ha/yr)

	2010	2015
Broadleaves	3.4	3.6
Conifers	8	8
Mixed	5.7	5.8

The increment of forest is calculated thanks to 2006 IPCC guidelines (equation 2.10, tier 2)

EQUATION 2.10
AVERAGE ANNUAL INCREMENT IN BIOMASS

Tier 1

$$G_{TOTAL} = \sum \{G_W \bullet (1 + R)\}$$ Biomass increment data (dry matter) are used directly

Tiers 2 and 3

$$G_{TOTAL} = \sum \{I_V \bullet BCEF_I \bullet (1 + R)\}$$ Net annual increment data are used to estimate G_W by applying a biomass conversion and expansion factor

Where:

G_{TOTAL} = average annual biomass growth above and below-ground, tonnes d. m. ha^{-1} yr^{-1}

G_W = average annual above-ground biomass growth for a specific woody vegetation type, tonnes d. m. ha^{-1} yr^{-1}

R = ratio of below-ground biomass to above-ground biomass for a specific vegetation type, in tonne d.m. below-ground biomass (tonne d.m. above-ground biomass)$^{-1}$. R must be set to zero if assuming no changes of below-ground biomass allocation patterns (Tier 1).

I_V = average net annual increment for specific vegetation type, m^3 ha^{-1} yr^{-1}

$BCEF_I$ = biomass conversion and expansion factor for conversion of net annual increment in volume (including bark) to above-ground biomass growth for specific vegetation type, tonnes above-ground biomass growth (m^3 net annual increment)$^{-1}$, (see Table 4.5 for Forest Land). If $BCEF_I$ values are not

The losses of forest is calculated thanks to 2006 IPCC guidelines (equations 2.11 and 2.12).

EQUATION 2.11
ANNUAL DECREASE IN CARBON STOCKS DUE TO BIOMASS LOSSES IN LAND REMAINING IN THE SAME LAND-USE CATEGORY

$$\Delta C_L = L_{wood-removals} + L_{fuelwood} + L_{disturbance}$$

Where:

ΔC_L = annual decrease in carbon stocks due to biomass loss in land remaining in the same land-use category, tonnes C yr^{-1}

$L_{wood-removals}$ = annual carbon loss due to wood removals, tonnes C yr^{-1} (See Equation 2.12)

$L_{fuelwood}$ = annual biomass carbon loss due to fuelwood removals, tonnes C yr^{-1} (See Equation 2.13)

$L_{disturbance}$ = annual biomass carbon losses due to disturbances, tonnes C yr^{-1} (See Equation 2.14)

EQUATION 2.12
ANNUAL CARBON LOSS IN BIOMASS OF WOOD REMOVALS

$$L_{wood-removals} = \{H \bullet BCEF_R \bullet (1+R) \bullet CF\}$$

Where:

$L_{wood-removals}$ = annual carbon loss due to biomass removals, tonnes C yr^{-1}

H = annual wood removals, roundwood, m^3 yr^{-1}

R = ratio of below-ground biomass to above-ground biomass, in tonne d.m. below-ground biomass (tonne d.m. above-ground biomass)$^{-1}$. R must be set to zero if assuming no changes of below-ground biomass allocation patterns (Tier 1).

CF = carbon fraction of dry matter, tonne C (tonne d.m.)$^{-1}$

$BCEF_R$ = biomass conversion and expansion factor for conversion of removals in merchantable volume to total biomass removals (including bark), tonnes biomass removal (m^3 of removals)$^{-1}$, (see Table 4.5 for Forest Land). However, if $BCEF_R$ values are not available and if the biomass expansion factor for wood removals (BEF_R) and basic wood density (D) values are separately estimated, then the following conversion can be used:

$$BCEF_R = BEF_R \bullet D$$

The losses are based on different sets of data. Commercial woods are based on statistical yearbooks and are available for the entire series 1990-2023.

Different types of data for harvest fuel wood exist:

- FAOSTAT data
- Statistical bulletin- Forestry in the Republic of Serbia 2005-2012
- Energy Balance of Serbia

Considering the recommendation of the forestry Service the most reliable data for fuel wood is the one of FAOSTAT for the most recent years (since 2010). Consequently, FAO was chosen as the reference and the previous years are extrapolated on the basis of the yearbook.

- Dead organic matter (dead wood, litter)

On forest remaining forest equilibrium is assumed for dead organic matter, it is reported as not estimated in the Serbian inventory.

- Soils (mineral and organic soils)

It is assumed that in Serbia no organic soils exist in forestlands.

On forest remaining forest, equilibrium is assumed for mineral soil, it is reported as not estimated in the Serbian inventory.

6.5.2.1.2 Direct N_2O Emissions from N Inputs to Managed Soils

It is assumed that no other land but agricultural land is fertilized in Serbia, thus direct N_2O emissions are reported as not occurring.

6.5.2.1.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.5.2.1.4 Direct N_2O Emissions from N Mineralization/Immobilization

No carbon losses are estimated from soils, thus direct N_2O Emissions from N Mineralization are reported as not occurring for forest remaining forest.

6.5.2.1.5 Indirect N_2O Emissions from Managed Soils

No direct N_2O emissions are estimated on these areas, thus indirect N_2O emissions from soils are also assumed as not occurring.

6.5.2.1.6 Biomass Burning

It is likely that controlled burning exists in Serbia but no data are available. Currently it is reported as not estimated.

Wildfires are estimated and it is considered that all forest wildfires are in the category forestlands remaining forestlands.

6.5.2.2 Land converted to forestlands (4A2)

6.5.2.2.1 Carbon stock changes

- Living biomass

Fluxes on living biomass are estimated thanks to a Gain-loss method.

Gains are based on increment provided by the FRA 2015 report of Serbia. Losses of living biomass are not occurring because it is assumed that the forests are too young for harvesting. It is also important to note that it would be a challenge to distinguish living biomass losses between categories of forest.

- Dead organic matter (deadwood, litter)

Removals on land converted to forest are estimated for land converted to forest. IPCC guidelines do not provide default value for deadwood but a value of 16tC/ha (Table 2.2) for litter. All removals reported under land converted to forest for dead organic matters are related to litter.

- Soils (mineral and organic soils)

It is assumed that in Serbia no organic soils exist in forestlands.

Fluxes on mineral soils are estimated thanks to a stock-difference method.

6.5.2.2.2 Direct N_2O Emissions from N Inputs to Managed Soils

It is assumed that no other land but agricultural land is fertilized in Serbia, thus direct N2O emissions are reported as not occurring.

6.5.2.2.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.5.2.2.4 Direct N_2O Emissions from N Mineralization/Immobilization

No carbon losses are estimated from soils, thus direct N_2O Emissions from N Mineralization are reported as not occurring for land converted to forest.

6.5.2.2.5 Indirect N_2O Emissions from Managed Soils

No direct N_2O emissions are estimated on these areas, thus indirect N_2O emissions from soils are also assumed as not occurring.

6.5.2.2.6 Biomass Burning

It is likely that controlled burning exists in Serbia but no data are available. Currently it is reported as not estimated.

Wildfires are included elsewhere (in forestlands remaining forestlands).

6.5.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 10%, based on expert judgment.

Uncertainty estimates associated with emission factor are 20% for CO_2 and 100% for CH_4 and N_2O, based on expert judgement.

Combined uncertainties are 22% for CO_2 emissions and 100% for CH_4 and N_2O emissions. The uncertainties combined in the national totals of emissions are of 2.0%, 0.008% and 0.004% for CO_2, CH_4 and N_2O, respectively in 2023, in the Republic of Serbia.

6.5.4 Category-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 keys in the CRT tables.

6.5.5 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	-2 012	-5 324	-5 444	-6 313	-6 116	-5 731	-5 061	-5 736	-5 781	-5 311	-5 018	-5 099	-4 854	-5 101	-5 043	-5 100	-4 680	0
Nouveau	kt CO2e	-2 012	-5 324	-5 444	-6 313	-6 116	-5 731	-5 061	-5 736	-5 781	-5 311	-5 018	-5 099	-4 854	-5 101	-5 043	-5 100	-4 579	-5 212
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+101	-5 212
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2,2%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 4.A

For 2022, corrections were made to the **Stock Variations** data, specifically regarding annual and 20-years area changes.

6.5.6 Category-specific planned improvements

For all LULULUCF sector, land-use and land-use change areas monitoring needs to be improved, at least to include more recent CLC datasets available such as 2018 edition; and at best to revise the land-use monitoring approach for enhanced spatial precision, compatibility with forest definition, and temporal consistency.

For the Forest sector, more recent NFI data will be used, if available, to update key parameters.

6.6 Croplands (4B)

6.6.1 Description

This category includes GHG emissions and removals arising from croplands.

In this category, emissions and absorptions are only estimated for land conversions. No emission estimation is calculated for croplands remaining croplands and for biomass burning (4B1).

The emission evolution for lands converted to croplands (4B2) reflects the trend in land-use change areas.

Figure 127: GHG emissions from forest land converted to cropland (CRT 4.B.2.1) (kt CO2e)

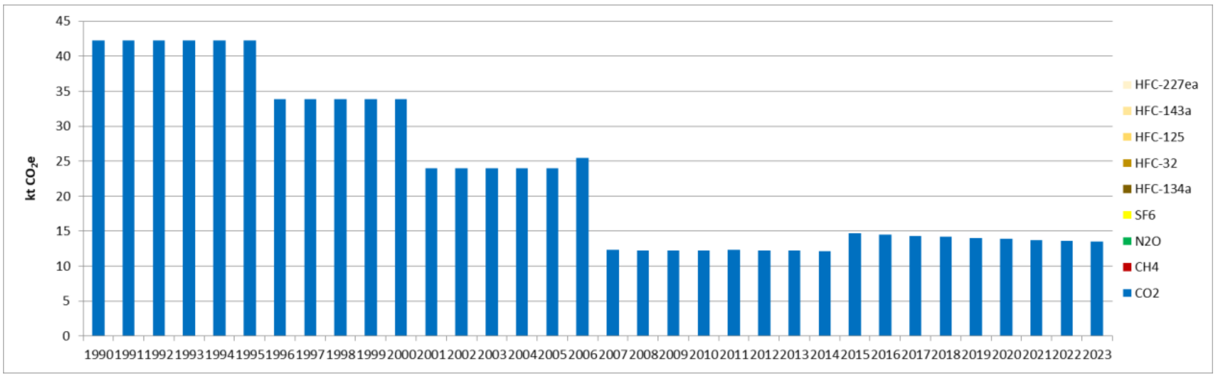


Figure 128: GHG emissions from grassland converted to cropland (CRT 4.B.2.2) (kt CO2e)

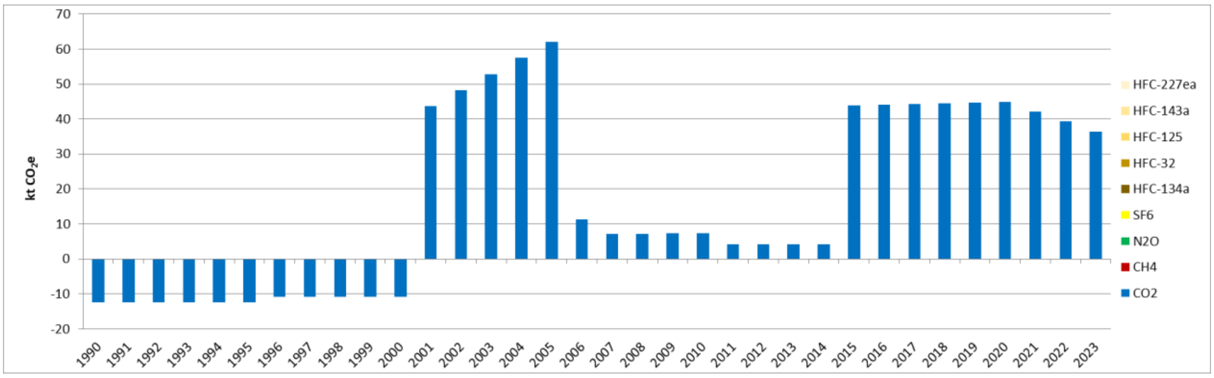


Figure 129: GHG emissions from wetlands converted to cropland (CRT 4.B.2.3) (kt CO2e)

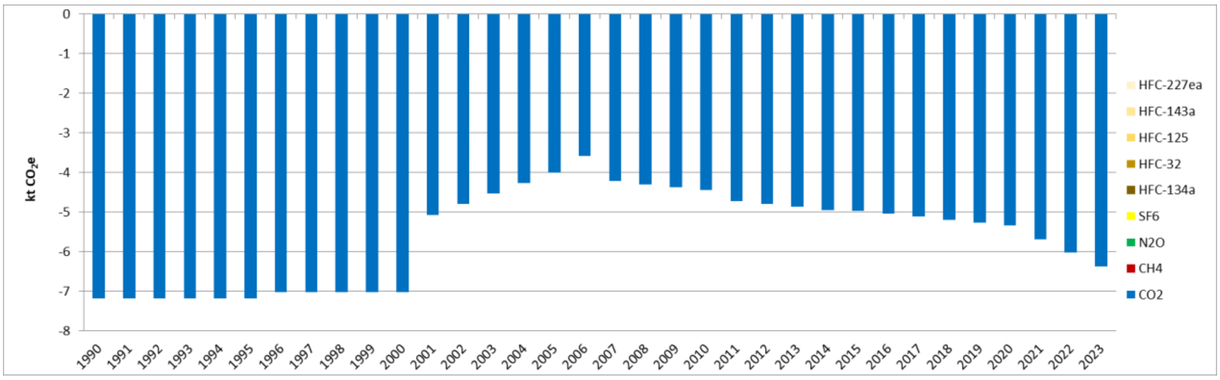


Figure 130: GHG emissions from settlements converted to cropland (CRT 4.B.2.4) (kt CO2e)

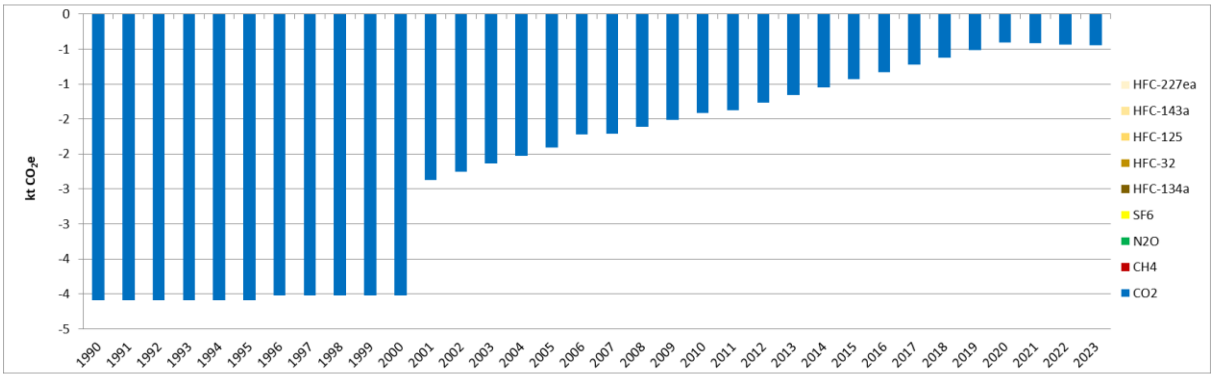
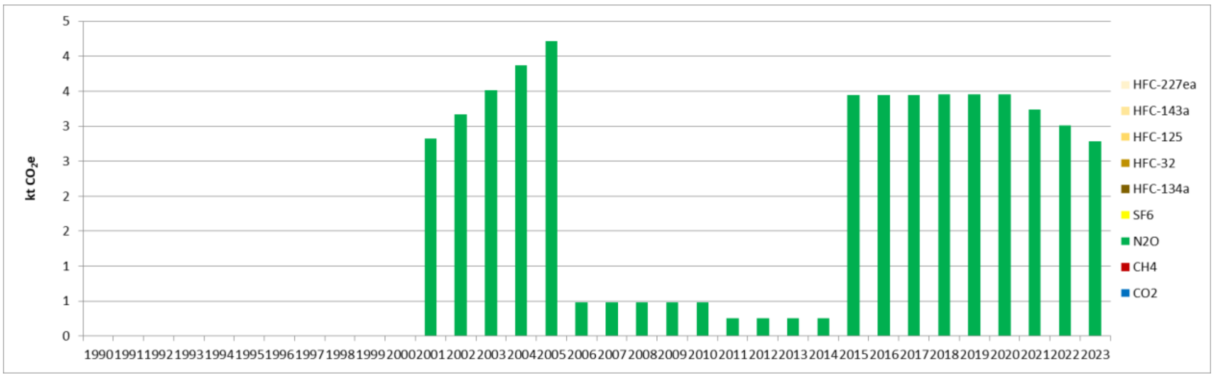


Figure 131: Direct N_2O emissions from N mineralization/immobilization in cropland (CRT 4.B.2) (kt CO2e)



6.6.2 Methodological issues

6.6.2.1 Croplands remaining croplands (4B1)

6.6.2.1.1 Carbon stock changes

- Living biomass

On cropland remaining cropland equilibrium is assumed for living biomass, it is reported as not estimated in the Serbian inventory.

- Dead organic matter (dead wood, litter)

On cropland remaining cropland equilibrium is assumed for dead organic matter, it is reported as not estimated in the Serbian inventory.

- Soils (mineral and organic soils)

On cropland remaining cropland equilibrium is assumed for mineral soils, it is reported as not estimated in the Serbian inventory.

6.6.2.1.2 Direct N_2O Emissions from N Inputs to Managed Soils

Direct N_2O emissions from agriculture are already reported under the sector agriculture.

6.6.2.1.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.6.2.1.4 Direct N_2O Emissions from N Mineralization/Immobilization

No carbon losses are estimated from soils, thus direct N_2O Emissions from N Mineralization are reported as not occurring for cropland remaining cropland.

6.6.2.1.5 Indirect N_2O Emissions from Managed Soils

Indirect N_2O emissions from agriculture are already reported under the sector agriculture.

6.6.2.1.6 Biomass Burning

It is assumed that no biomass burning is occurring on this type of land (prescribed burning of residues are reported under the sector agriculture).

6.6.2.2 Land converted to croplands (4B2)

6.6.2.2.1 Carbon stock changes

- Living biomass

Fluxes on living biomass are estimated thanks to a stock-difference method and default carbon stocks from IPCC guidelines.

- Dead organic matter (dead wood, litter)

Emissions on land converted to croplands are estimated for forest converted to cropland. IPCC guidelines do not provide default value for deadwood but a value of 16tC/ha (Table 2.2) for litter. All emissions reported under land converted to cropland for dead organic matters are related to litter.

- Soils (mineral and organic soils)

It is assumed that in Serbia no organic soils exist in croplands.

Fluxes on mineral soils are estimated thanks to a stock-difference method.

6.6.2.2.2 Direct N_2O Emissions from N Inputs to Managed Soils

Direct N_2O emissions from agriculture are already reported under the sector agriculture.

6.6.2.2.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.6.2.2.4 Direct N_2O Emissions from N Mineralization/Immobilization

Carbon losses are estimated from mineral soils, thus direct N_2O Emissions from N Mineralization are estimated in accordance with IPCC 2006 guidelines for land converted to croplands.

6.6.2.2.5 Indirect N_2O Emissions from Managed Soils

Indirect N_2O emissions from agriculture are already reported under the sector agriculture.

6.6.2.2.6 Biomass Burning

It is assumed that no biomass burning is occurring on this type of land (prescribed burning of residues are reported under the sector agriculture).

6.6.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 10%, based on expert judgment.

Uncertainty estimates associated with emission factor are 40% for CO_2 and 100% for N_2O, based on expert judgement.

Combined uncertainties are 41% for CO_2 emissions and 100% for N_2O emissions. The uncertainties combined in the national totals of emissions are of 0.03% and 0.005% for CO_2 and N_2O, respectively in 2023, in the Republic of Serbia.

6.6.4 Category-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 keys in the CRT tables.

6.6.5 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	19	19	12	84	14	11	11	11	11	56	56	56	56	56	57	53	49	0
Nouveau	kt CO2e	19	19	12	84	14	11	11	11	11	56	56	56	56	56	57	53	49	46
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+46
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 4.B

Negative emissions of N_2O in 4B2 have been put as null when the balance is negative.

6.6.6 Category-specific planned improvements

For all LULULUCF sector, land-use and land-use change areas monitoring needs to be improved, at least to include more recent CLC datasets available such as 2018 edition; and at best to revise the land-use monitoring approach for enhanced spatial precision, compatibility with forest definition, and temporal consistency.

Negative emissions of N_2O from mineralization will be corrected so that only emissions are reported.

6.7 Grasslands (4C)

6.7.1 Description

This category comprises GHG emissions and removals arising from grasslands.

In this category, emissions and absorptions are only estimated for land conversions and for biomass burning. Only emissions from burning are estimated for grassland remaining grassland (included in 4C1).

The emission evolution for lands converted to grassland (4C2) reflects the trend in land-use change areas.

The following graphs give the GHG emission trend for the estimated categories.

The overall reduction in emissions is due to a significantly reduced area of grassland that was affected by fires, as well as due to a change in land use. The two peaks of emissions observed in 2000 and 2007 are related to biomass burning (CRT 4C1).

Figure 132: GHG emissions from wildfires (CRT 4.C.1) (kt CO_2e)

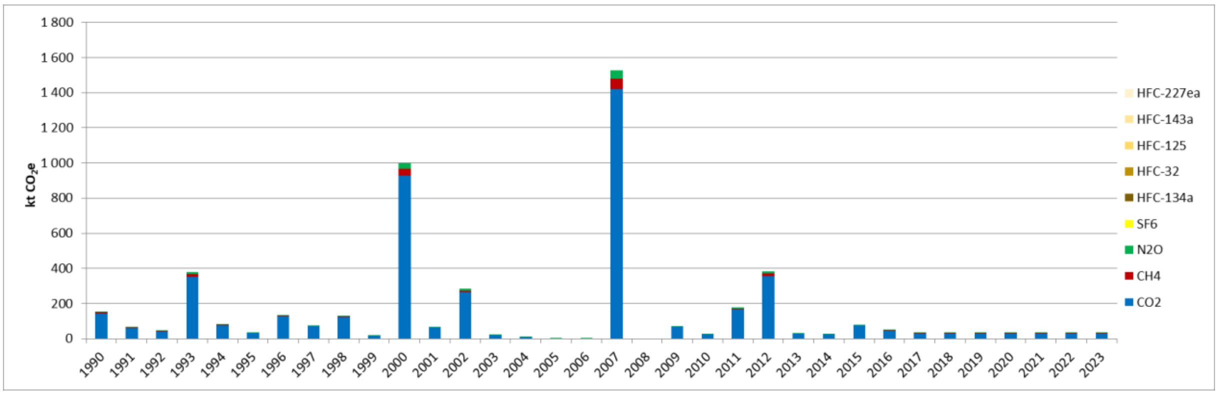


Figure 133: GHG emissions from forest land converted to grassland (CRT 4.C.2.1) (kt CO_2e)

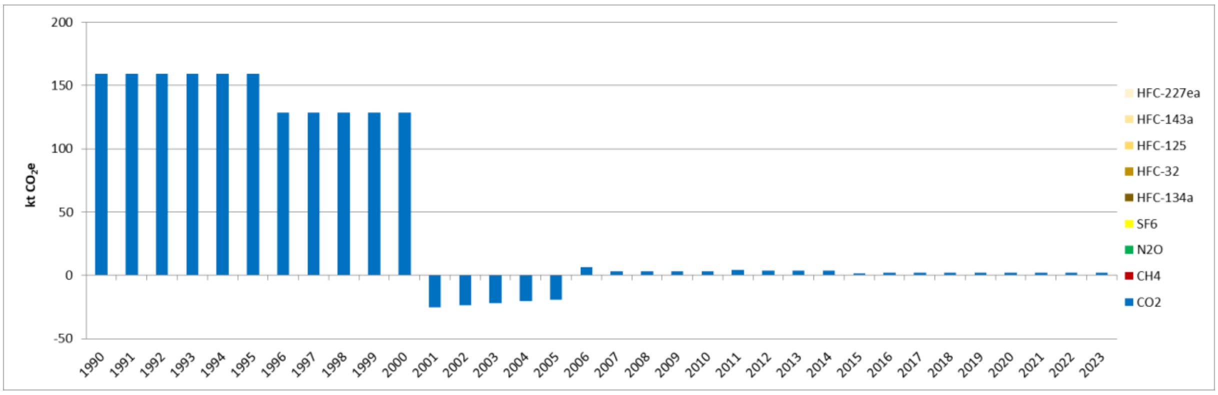


Figure 134: GHG emissions from cropland converted to grassland (CRT 4.C.2.2) (kt CO_2e)

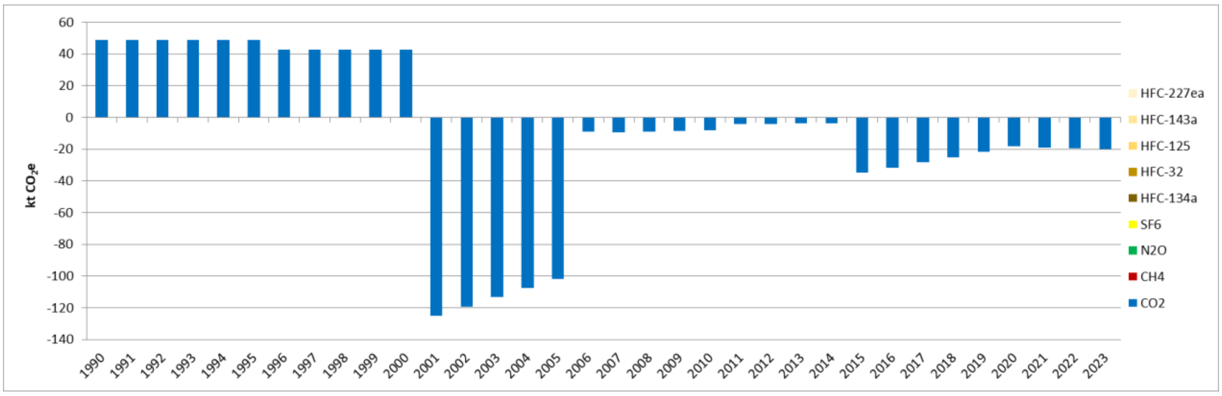


Figure 135: GHG emissions from wetlands converted to grassland (CRT 4.C.2.3) (kt CO_2e)

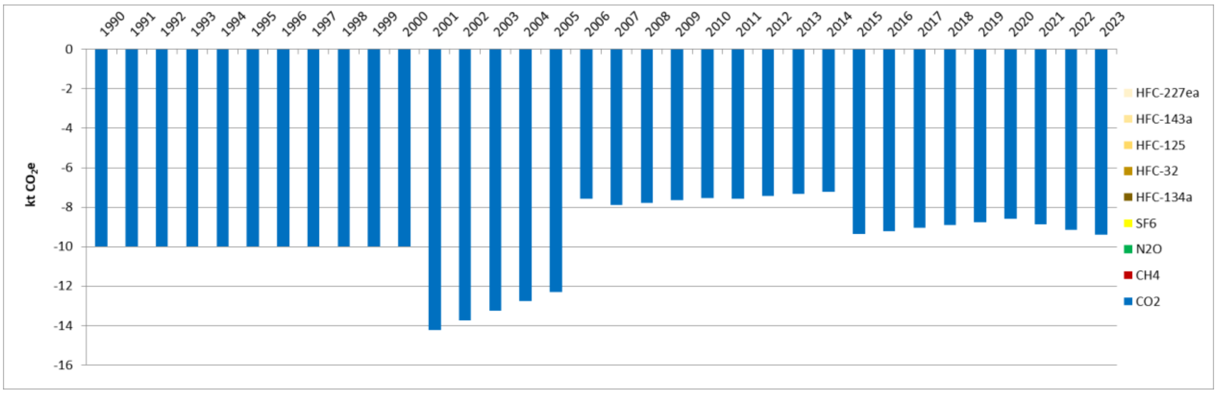


Figure 136: GHG emissions from settlements converted to grassland (CRT 4.C.2.4) (kt CO2e)

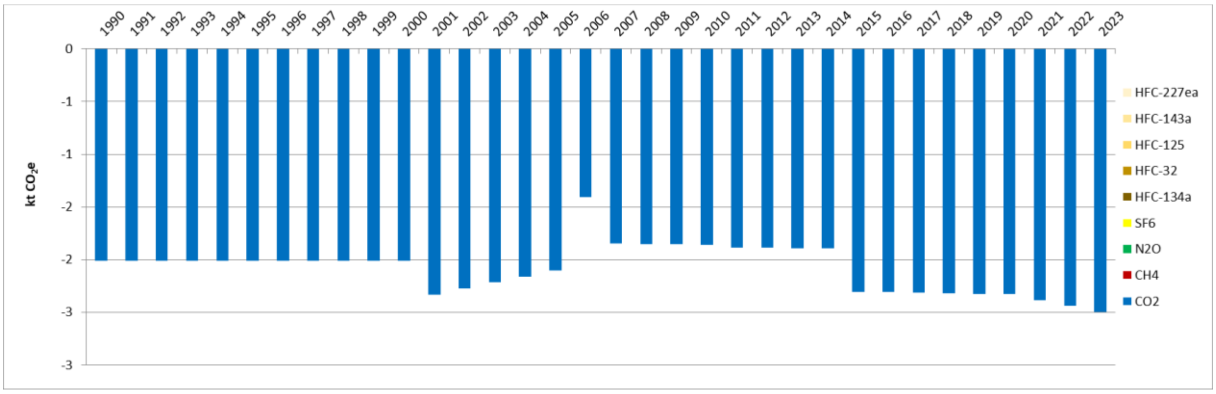


Figure 137: GHG emissions from other land converted to grassland (CRT 4.C.2.5) (kt CO_2e)

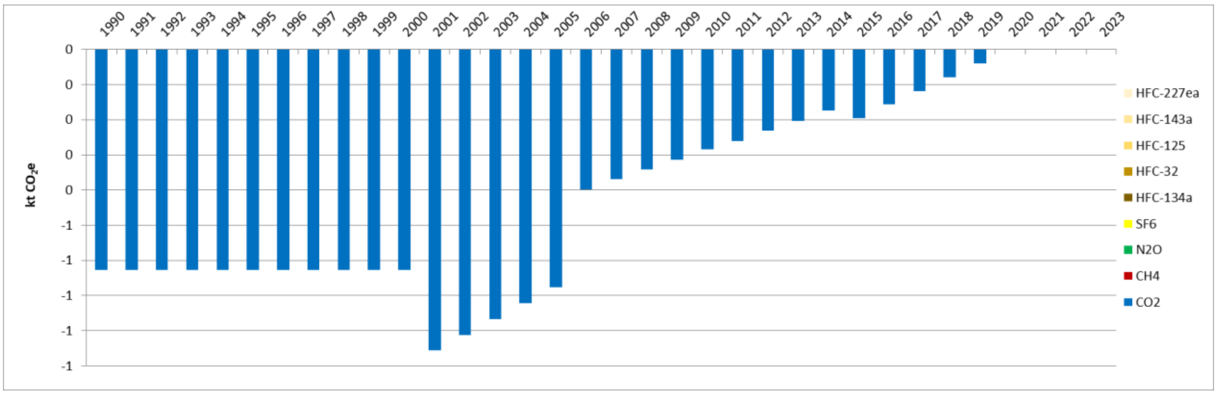
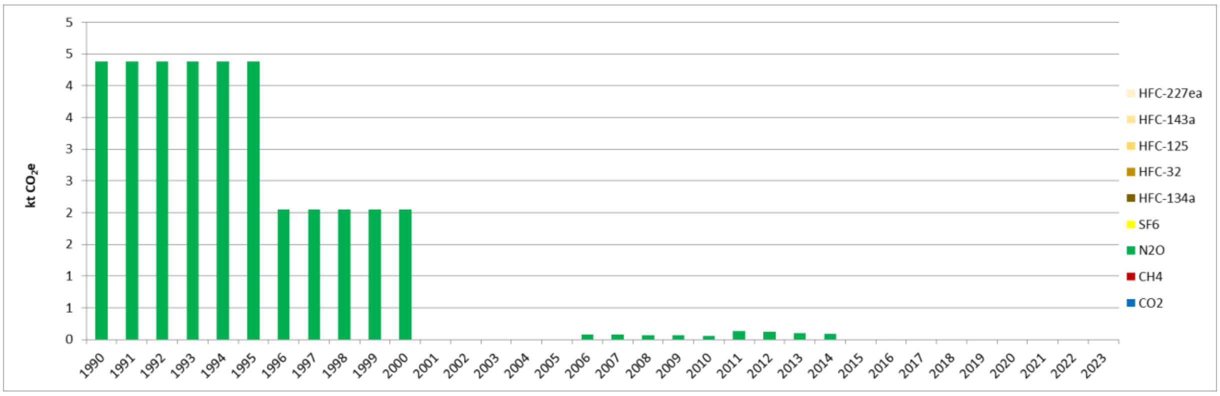


Figure 138: Direct N_2O emissions from N mineralization/immobilization in grassland (CRT 4.C.2) (kt CO_2e)



6.7.2 Methodological issues

6.7.2.1 Grasslands remaining grasslands (4C1)

6.7.2.1.1 Carbon stock changes

- Living biomass

On grassland remaining grassland equilibrium is assumed for living biomass, it is reported as not estimated in the Serbian inventory.

- Dead organic matter (dead wood, litter)

On grassland remaining grassland equilibrium is assumed for dead organic matter, it is reported as not estimated in the Serbian inventory.

- Soils (mineral and organic soils)

On grassland remaining grassland equilibrium is assumed for mineral soils, it is reported as not estimated in the Serbian inventory.

6.7.2.1.2 Direct N_2O Emissions from N Inputs to Managed Soils

Direct N_2O emissions from agriculture are already reported under the sector agriculture.

6.7.2.1.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.7.2.1.4 Direct N_2O Emissions from N Mineralization/Immobilization

No carbon losses are estimated from soils, thus direct N_2O Emissions from N Mineralization are reported as not occurring for grasslands remaining grasslands.

6.7.2.1.5 Indirect N_2O Emissions from Managed Soils

Indirect N_2O emissions from agriculture are already reported under the sector agriculture.

6.7.2.1.6 Biomass Burning

It is likely that controlled burning exists in Serbia but no data are available. Currently it is reported as not estimated.

Wildfires are estimated and it is considered that all wildfires are in category grasslands remaining grasslands.

6.7.2.2 Land converted to grasslands (4C2)

6.7.2.2.1 Carbon stock changes

- Living biomass

Fluxes on living biomass are estimated thanks to a stock-difference method and default carbon stocks from IPCC guidelines.

- Dead organic matter (dead wood, litter)

Emissions on land converted to grasslands are estimated for forest converted to grasslands. IPCC guidelines do not provide default value for deadwood but a value of 16tC/ha (Table 2.2) for litter. All emissions reported under land converted to grassland for dead organic matters are related to litter.

- Soils (mineral and organic soils)

It is assumed that in Serbia no organic soils exist in grasslands.

Fluxes on mineral soils are estimated thanks to a stock-difference method.

6.7.2.2.2 Direct N_2O Emissions from N Inputs to Managed Soils

Direct N_2O emissions from agriculture are already reported under the sector agriculture.

6.7.2.2.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.7.2.2.4 Direct N_2O Emissions from N Mineralization/Immobilization

Carbon losses are estimated from mineral soils, thus direct N_2O Emissions from N Mineralization are estimated in accordance with IPCC 2006 guidelines for land converted to grasslands.

6.7.2.2.5 Indirect N_2O Emissions from Managed Soils

Indirect N_2O emissions from agriculture are already reported under the sector agriculture.

6.7.2.2.6 Biomass Burning

It is likely that controlled burning exists in Serbia but no data are available. Currently it is reported as not estimated.

Wildfires are included elsewhere (in grasslands remaining grasslands).

6.7.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 10%, based on expert judgment.

Uncertainty estimates associated with emission factor are 50% for CO_2 and 100% for CH_4 and N_2O, based on expert judgement.

Combined uncertainties are 51% for CO_2 emissions and 100% for CH_4 and N_2O emissions. The uncertainties combined in the national totals of emissions are of 0.001%, 0.002% and 0.002% for CO_2, CH_4 and N_2O, respectively in 2023, in the Republic of Serbia.

6.7.4 Category-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 keys in the CRT tables.

6.7.5 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	354	233	1 159	-135	12	169	375	20	15	35	7	-5	-2	2	5	5	4	0
Nouveau	kt CO2e	354	233	1 159	-135	12	169	375	20	15	35	7	-5	-2	2	5	5	4	3
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+2,9
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 4.C

Negative emissions of N_2O in 4C2 have been put as null when the balance is negative.

6.7.6 Category-specific planned improvements

For all LULULUCF sector, land-use and land-use change areas monitoring needs to be improved, at least to include more recent CLC datasets available such as 2018 edition; and at best to revise the land-use monitoring approach for enhanced spatial precision, compatibility with forest definition, and temporal consistency.

Negative emissions of N_2O from mineralization will be corrected so that only emissions are reported.

6.8 Wetlands (4D)

6.8.1 Description

This category comprises GHG emissions and removals arising from wetlands.

In this category, emissions and absorptions are only estimated for land conversions. No emission estimation is calculated for croplands remaining croplands and for biomass burning (4D1). In addition, Lands converted to peat extraction (4.D.2.1) are not occurring (NO) in the Republic of Serbia, and the category Lands converted to flooded lands (4.D.2.2) is considered as included elsewhere (IE) in the Serbian inventory.

Hence, the emission evolution for lands converted to croplands (4.D.2.3) reflects the trend in land-use change areas. The following graphs give the GHG emission trend for the estimated categories. In overall, the GHG emissions from the Wetlands (4D) have been progressively and continuously reduced over the timeseries, and the achieved reduction is of 61%. This is mainly due to the decreasing area of wetlands from the category 4.D.2.3

Figure 139: GHG emissions from land converted to other wetlands (CRT 4.D.2.3) (kt CO_2e)

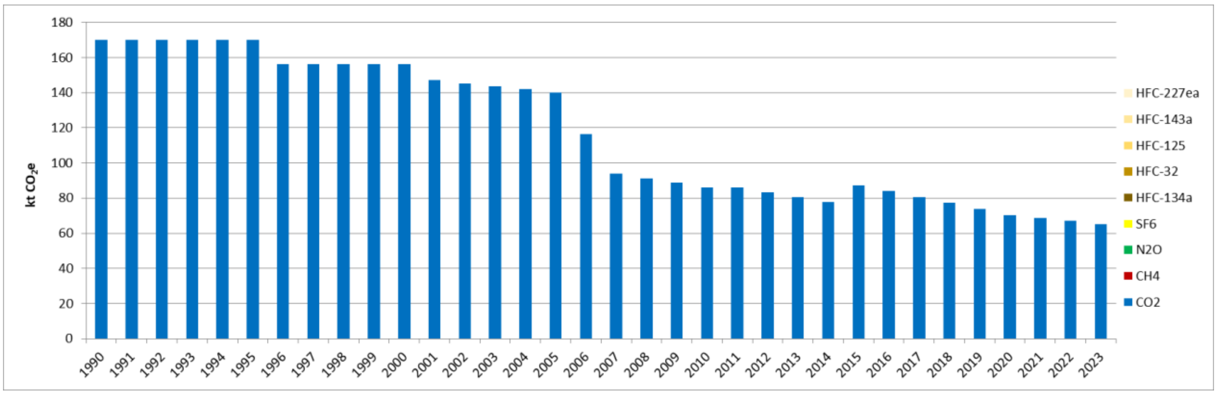
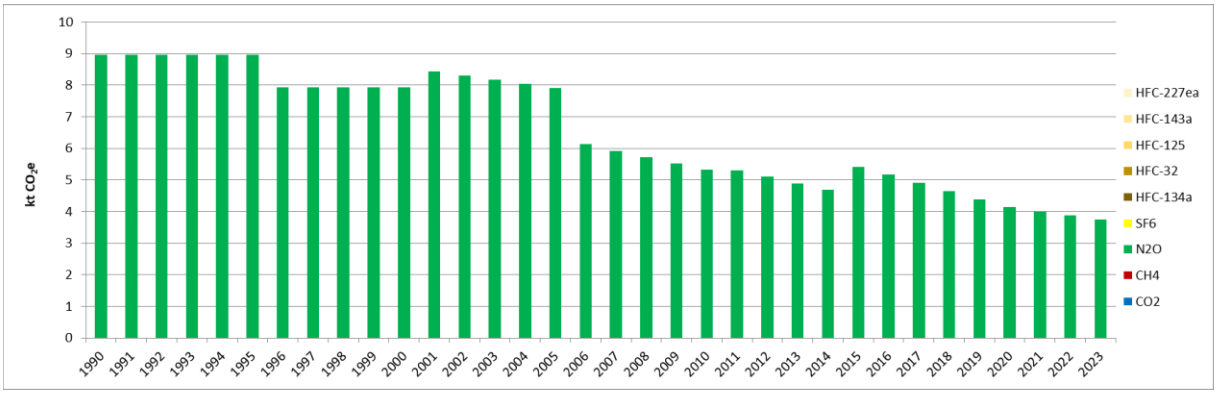


Figure 140: Direct N2O emissions from N mineralization/immobilization in wetlands (CRT 4.D.2) (kt CO2e)



6.8.2 Methodological issues

6.8.2.1 Wetlands remaining wetlands (4D1)

6.8.2.1.1 Carbon stock changes

- Living biomass

Living biomass emissions from peat extraction are not occurring, because there is no peat extraction in Serbia. Living biomass emissions for flooded and other wetlands are not estimated. Equilibrium is assumed, no stock variations are occurring in this category. Also, no information on changes is available.

- Dead organic matter (dead wood, litter)

Dead organic matter emissions from peat extraction are not occurring, because there is no peat extraction in Serbia.

Dead organic matter emissions for flooded and other wetlands are not estimated. Equilibrium is assumed, no stock variations are occurring in this category. Also, no information on changes is available.

- Soils (mineral and organic soils)

Mineral and organic soil emissions from peat extraction are not occurring, because there is no peat extraction in Serbia.

Mineral soil emissions are not estimated and not occurring for organic soils. It is assumed that in Serbia no organic soils exist in grasslands. For mineral soils no stock variations are occurring in this category and no information related to stock variations are available.

6.8.2.1.2 Direct N_2O Emissions from N Inputs to Managed Soils

It is assumed that no other land but agricultural land is fertilized in Serbia, thus direct N_2O emissions are reported as not occurring.

6.8.2.1.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.8.2.1.4 Direct N_2O Emissions from N Mineralization/Immobilization

No carbon losses are estimated from soils, thus direct N_2O Emissions from N Mineralization are reported as not occurring for wetlands remaining wetlands.

6.8.2.1.5 Indirect N_2O Emissions from Managed Soils

No direct N_2O emissions are estimated on these areas, thus indirect N_2O emissions from soils are also assumed as not occurring.

6.8.2.1.6 Biomass Burning

It is assumed that no biomass burning is occurring on this type of land.

6.8.2.2 Land converted to wetlands (4D2)

6.8.2.2.1 Carbon stock changes

- Living biomass

There is no peat extraction in Serbia, thus emissions from peat extraction are reported as not occurring.

All losses from flooded and other wetlands are reported under land converted to other wetlands.

- Dead organic matter (dead wood, litter)

There is no peat extraction in Serbia, thus emissions from peat extraction are reported as not occurring.

All losses from flooded and other wetlands are reported under land converted to other wetlands.

- Soils (mineral and organic soils)

It is assumed that in Serbia no organic soils exist in wetlands.

There is no peat extraction in Serbia, thus emissions from peat extraction are reported as not occurring.

All losses from flooded and other wetlands are reported under land converted to other wetlands.

6.8.2.2.2 Direct N_2O Emissions from N Inputs to Managed Soils

It is assumed that no other land but agricultural land is fertilized in Serbia, thus direct N_2O emissions are reported as not occurring.

6.8.2.2.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.8.2.2.4 Direct N_2O Emissions from N Mineralization/Immobilization

Carbon losses are estimated from mineral soils, thus direct N_2O Emissions from N Mineralization are estimated in accordance with IPCC 2006 guidelines for land converted to wetlands.

6.8.2.2.5 Indirect N_2O Emissions from Managed Soils

Indirect N_2O emissions from soils are currently not estimated in the Serbian inventory.

6.8.2.2.6 Biomass Burning

It is assumed that no biomass burning is occurring on this type of land.

6.8.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 10%, based on expert judgment.

Uncertainty estimates associated with emission factor are 70% for CO_2 and 100% for N_2O, based on expert judgement.

Combined uncertainties are 71% for CO_2 emissions and 100% for N_2O emissions. The uncertainties combined in the national totals of emissions are of 0.08% and 0.007% for CO_2 and N_2O, respectively in 2023, in the Republic of Serbia.

6.8.4 Category-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 keys in the CRT tables.

6.8.5 Category-specific recalculations

No recalculations were made compared with latest NID submission (November 2024).

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	179	179	164	148	91	91	88	85	82	93	89	85	82	78	75	73	71	0
Nouveau	kt CO2e	179	179	164	148	91	91	88	85	82	93	89	85	82	78	75	73	71	69
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+69
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 4.D

6.8.6 Category-specific planned improvements

For all LULUCF sector, land-use and land-use change areas monitoring needs to be improved, at least to include more recent CLC datasets available such as 2018 edition; and at best to revise the land-use monitoring approach for enhanced spatial precision, compatibility with forest definition, and temporal consistency.

6.9 Settlements (4E)

6.9.1 Description

This category comprises GHG emissions and removals arising from settlements.

In this category, emissions and absorptions are only estimated for land conversions. No emission estimation is calculated for croplands remaining croplands and for biomass burning (4E1).

The emission evolution for lands converted to croplands (4E2) reflects the trend in land-use change areas. The following graphs give the GHG emission trend for the estimated categories. Overall, the GHG emissions from the land-use change in settlements (4E) are rather stable from 1990 to 2000, before increasing rapidly in 2001 (+80% compared with 2000) and reaching another plateau until 2006. In 2007, another sudden increase but smaller is observed (+12% compared with 2006), before being rather stable from 2007 to 2023, although a progressive and continuous growth in emissions is observed. In total, over the whole timeseries, the GHG emissions from settlements have slightly more than doubled (+105%).

Figure 141: GHG emissions from forest land converted to settlements (CRT 4.E.2.1) (kt CO_2e)

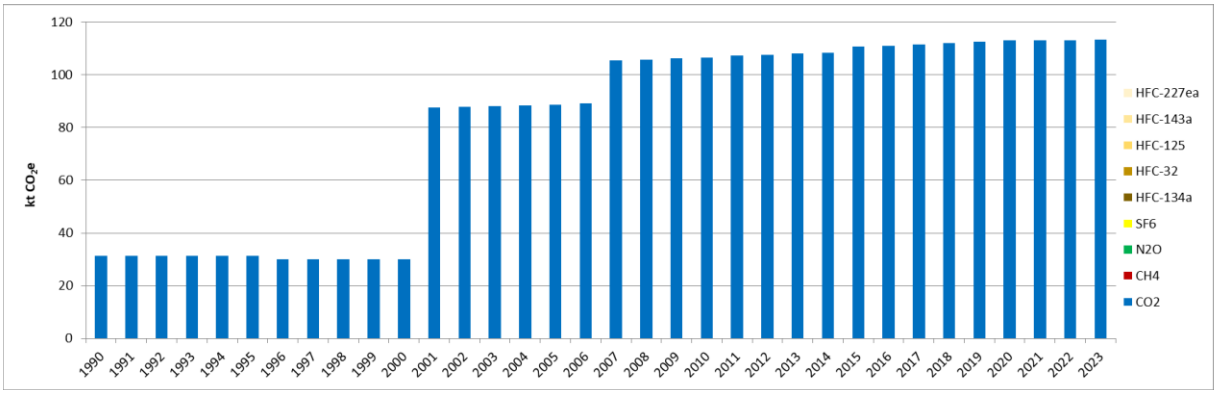


Figure 142: GHG emissions from cropland converted to settlements (CRT 4.E.2.2) (kt CO_2e)

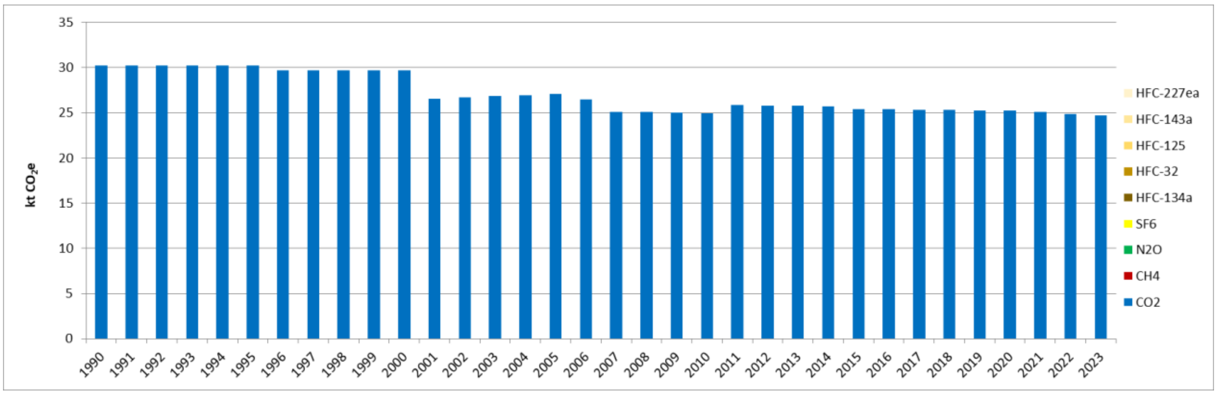


Figure 143: GHG emissions from grassland converted to settlements (CRT 4.E.2.3) (kt CO_2e)

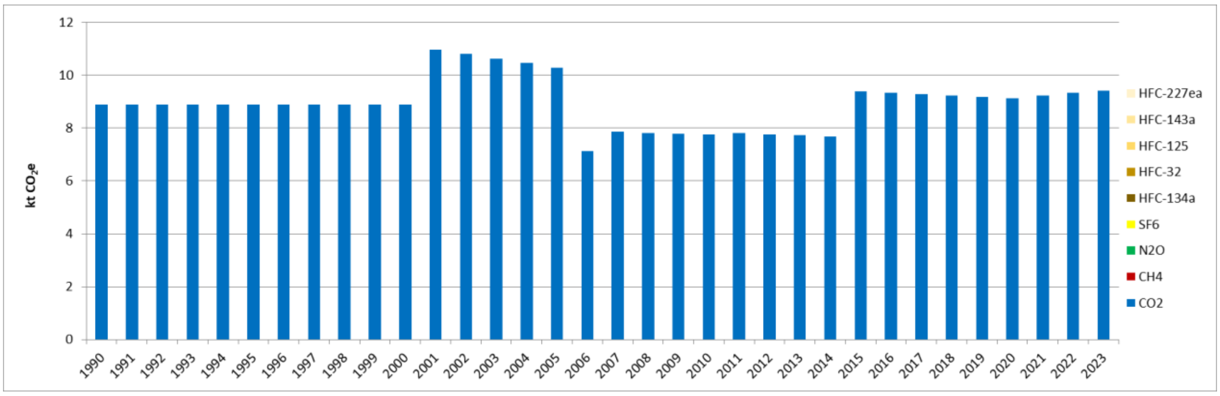
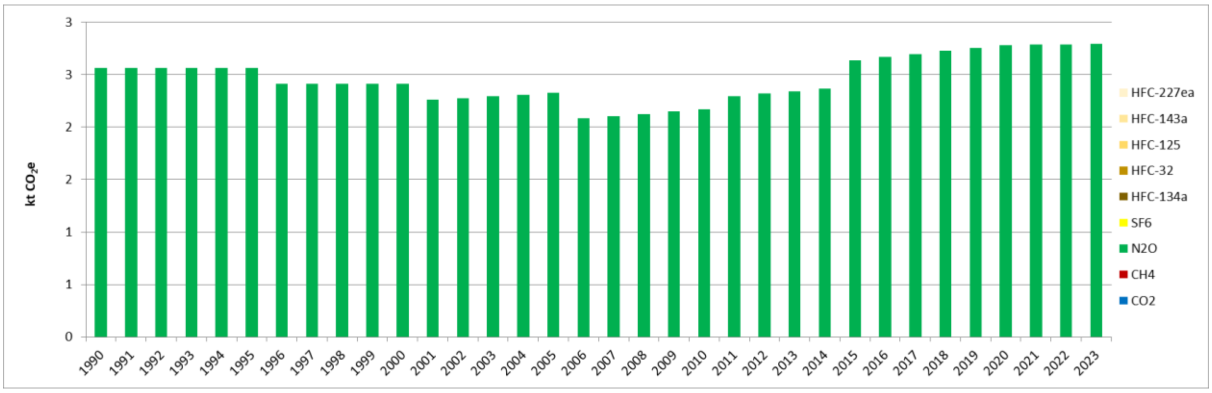


Figure 144: Direct N2O emissions from N mineralization/immobilization in settlements (CRT 4.E.2) (kt CO_2e)



6.9.2 Methodological issues

6.9.2.1 Settlements remaining settlements (4E1)

6.9.2.1.1 Carbon stock changes

- Living biomass

On settlement remaining settlement equilibrium is assumed for living biomass, it is reported as not estimated in the Serbian inventory.

- Dead organic matter (dead wood, litter)

On settlement remaining settlement equilibrium is assumed for dead organic matter, it is reported as not estimated in the Serbian inventory.

- Soils (mineral and organic soils)

On settlement remaining settlement equilibrium is assumed for mineral soils, it is reported as not estimated in the Serbian inventory.

6.9.2.1.2 Direct N_2O Emissions from N Inputs to Managed Soils

It is assumed that no other land but agricultural land is fertilized in Serbia, thus direct N_2O emissions are reported as not occurring.

6.9.2.1.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.9.2.1.4 Direct N_2O Emissions from N Mineralization/Immobilization

No carbon losses are estimated from soils, thus direct N_2O Emissions from N Mineralization are reported as not occurring for settlements remaining settlements.

6.9.2.1.5 Indirect N_2O Emissions from Managed Soils

No direct N_2O emissions are estimated on these areas, thus indirect N_2O emissions from soils are also assumed as not occurring.

6.9.2.1.6 Biomass Burning

It is assumed that no biomass burning is occurring on this type of land.

6.9.2.2 Land converted to settlements (4E2)

6.9.2.2.1 Carbon stock changes

- Living biomass

Fluxes on living biomass are estimated thanks to a stock-difference method and default carbon stocks from IPCC guidelines.

- Dead organic matter (dead wood, litter)

Emissions on land converted to settlements are estimated for forest converted to settlements. IPCC guidelines do not provide default value for deadwood but a value of 16tC/ha (Table 2.2) for litter. All emissions reported under land converted to settlements for dead organic matters are related to litter.

- Soils (mineral and organic soils)

It is assumed that, in the Republic of Serbia, no organic soil exists in settlements.

Fluxes on mineral soils are estimated thanks to a stock-difference method.

6.9.2.2.2 Direct N_2O Emissions from N Inputs to Managed Soils

It is assumed that no other land but agricultural land is fertilized in Serbia, thus direct N_2O emissions are reported as not occurring.

6.9.2.2.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.9.2.2.4 Direct N_2O Emissions from N Mineralization/Immobilization

Carbon losses are estimated from mineral soils, thus direct N_2O Emissions from N Mineralization are estimated in accordance with IPCC 2006 guidelines for land converted to settlements.

6.9.2.2.5 Indirect N_2O Emissions from Managed Soils

Indirect N_2O emissions from soils are currently not estimated in the Serbian inventory.

6.9.2.2.6 Biomass Burning

It is assumed that no biomass burning is occurring on this type of land.

6.9.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 10%, based on expert judgment.

Uncertainty estimates associated with emission factor are 30% for CO_2 and 100% for N_2O, based on expert judgement.

Combined uncertainties are 32% for CO_2 emissions and 100% for N_2O emissions. The uncertainties combined in the national totals of emissions are of 0.08% and 0.005% for CO_2 and N_2O, respectively in 2023, in the Republic of Serbia.

6.9.4 Category-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 keys in the CRT tables.

6.9.5 Category-specific recalculations

No recalculations were made compared with latest NID submission (November 2024).

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	73	73	71	128	141	143	143	144	144	148	148	149	149	150	150	150	150	0
Nouveau	kt CO2e	73	73	71	128	141	143	144	144	144	148	148	149	149	150	150	150	150	150
Différence	kt CO2e	+0,0000	+0,0000	+0,20	+0,13	+0,14	+0,15	+0,15	+0,15	+0,15	+0,18	+0,18	+0,18	+0,0000	-0,0000	-0,0000	-0,0000	+0,0000	+150
	%	+0,0%	+0,0%	+0,3%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	+0,1%	+0,0%	-0,0%	-0,0%	-0,0%	+0,0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 4.E

6.9.6 Category-specific planned improvements

For all LULULUCF sector, land-use and land-use change areas monitoring needs to be improved, at least to include more recent CLC datasets available such as 2018 edition; and at best to revise the land-use monitoring approach for enhanced spatial precision, compatibility with forest definition, and temporal consistency.

6.10 Other lands (4F)

6.10.1 Description

This category comprises GHG emissions and removals arising from other lands.

In this category, emissions and absorptions are only estimated for land conversions. No emission estimation is calculated for croplands remaining croplands and for biomass burning (4F1).

The emission evolution for lands converted to croplands (4F2) reflects the trend in land-use change areas. The emissions follow the trend of the category “forest land converted to other land” (4.F.2.1). After being rather stable from 1990 to 2006, they decreased for the period 2001 to 2006, until increasing significantly in 2007 (about 11 times more important). Since 2007, the emissions increase progressively, by 44% in 2023 compared with 2007, as the area of forest being converted to other lands grows.

Figure 145: GHG emissions from forest land converted to other land (CRT 4.F.2.1) (kt CO_2e)

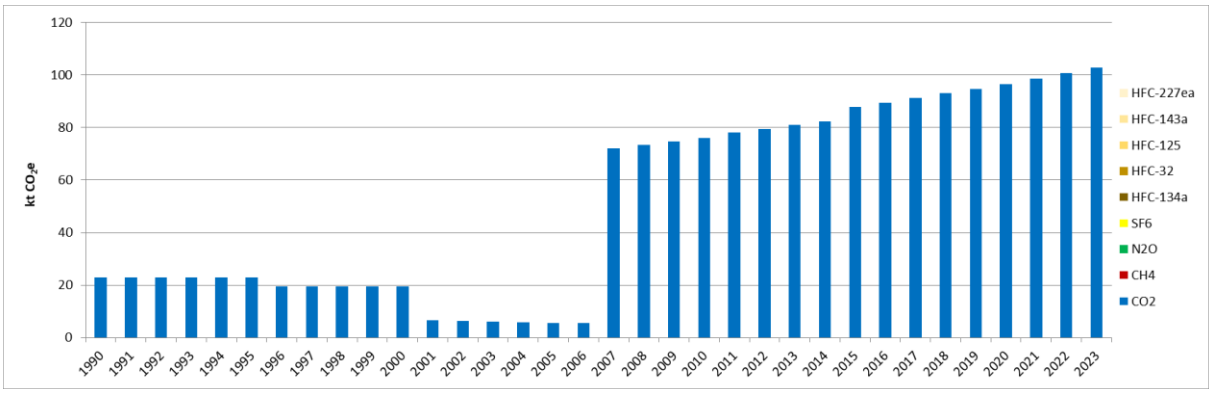


Figure 146: GHG emissions from grassland converted to other land (CRT 4.F.2.3) (kt CO_2e)

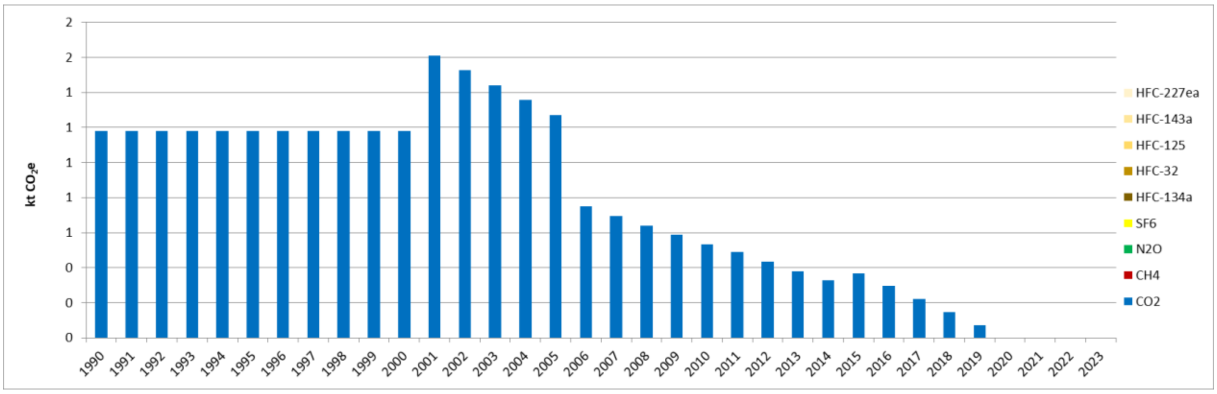
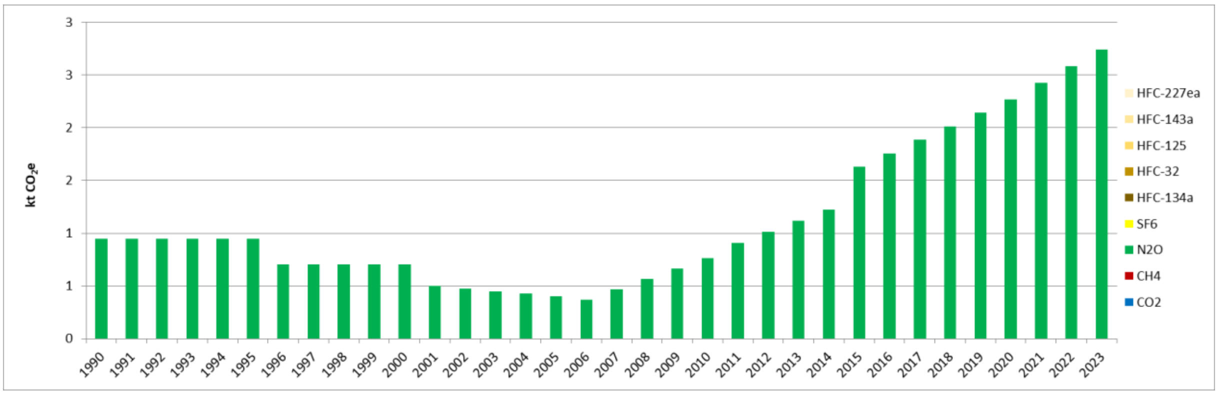


Figure 147: Direct N2O emissions from N mineralization/immobilization in other lands (CRT 4.F.2) (kt CO2e)



6.10.2 Methodological issues

6.10.2.1 Other lands remaining other lands (4F1)

6.10.2.1.1 Carbon stock changes

- Living biomass

On other lands remaining other lands equilibrium is assumed for living biomass, it is reported as not estimated in the Serbian inventory.

- Dead organic matter (dead wood, litter)

On other lands remaining other lands equilibrium is assumed for dead organic matter, it is reported as not estimated in the Serbian inventory.

- Soils (mineral and organic soils)

On other lands remaining other lands equilibrium is assumed for mineral soils, it is reported as not estimated in the Serbian inventory.

6.10.2.1.2 Direct N_2O Emissions from N Inputs to Managed Soils

It is assumed that no other land but agricultural land is fertilized in Serbia, thus direct N_2O emissions are reported as not occurring.

6.10.2.1.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.10.2.1.4 Direct N_2O Emissions from N Mineralization/Immobilization

No carbon losses are estimated from soils, thus direct N_2O Emissions from N Mineralization are reported as not occurring for other lands remaining other lands.

6.10.2.1.5 Indirect N_2O Emissions from Managed Soils

No direct N_2O emissions are estimated on these areas, thus indirect N_2O emissions from soils are also assumed as not occurring.

6.10.2.1.6 Biomass Burning

It is assumed that no biomass burning is occurring on this type of land.

6.10.2.2 Land converted to other lands (4F2)

6.10.2.2.1 Carbon stock changes

- Living biomass

Fluxes on living biomass are estimated thanks to a stock-difference method and default carbon stocks from IPCC guidelines.

- Dead organic matter (dead wood, litter)

Emissions on land converted to other lands are estimated for forest converted to other lands. IPCC guidelines do not provide default value for deadwood but a value of 16tC/ha (Table 2.2) for litter. All emissions reported under land converted to other lands for dead organic matters are related to litter.

- Soils (mineral and organic soils)

It is assumed that in Serbia no organic soils exist in other lands.

Fluxes on mineral soils are estimated thanks to a stock-difference method.

6.10.2.2.2 Direct N_2O Emissions from N Inputs to Managed Soils

It is assumed that no other land but agricultural land is fertilized in Serbia, thus direct N_2O emissions are reported as not occurring.

6.10.2.2.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Drainage and rewetting of organic and mineral soils are assumed to be not occurring in Serbia, thus related emissions and removals are reported as not occurring.

6.10.2.2.4 Direct N_2O Emissions from N Mineralization/Immobilization

Carbon losses are estimated from mineral soils, thus direct N_2O Emissions from N Mineralization are estimated in accordance with IPCC 2006 guidelines for land converted to other lands.

6.10.2.2.5 Indirect N_2O Emissions from Managed Soils

Indirect N_2O emissions from soils are currently not estimated in the Serbian inventory.

6.10.2.2.6 Biomass Burning

It is assumed that no biomass burning is occurring on this type of land.

6.10.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 10%, based on expert judgment.

Uncertainty estimates associated with emission factor are 80% for CO_2. For N2O, the uncertainty estimate for the emission factor has not been determined for this submission.

Combined uncertainties are 81% for CO_2 emissions. The uncertainty combined in the national totals of emissions is of 0.15% in 2023, in the Republic of Serbia.

6.10.4 Category-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 keys in the CRT tables.

6.10.5 Category-specific recalculations

No recalculations were made compared with latest NID submission (November 2024)

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	25	25	21	7	77	80	81	82	84	90	92	93	95	97	99	101	103	0
Nouveau	kt CO2e	25	25	21	7	77	80	81	82	84	90	92	93	95	97	99	101	103	105
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+105
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 4.F

6.10.6 Category-specific planned improvements

For all LULULUCF sector, land-use and land-use change areas monitoring needs to be improved, at least to include more recent CLC datasets available such as 2018 edition; and at best to revise the land-use monitoring approach for enhanced spatial precision, compatibility with forest definition, and temporal consistency.

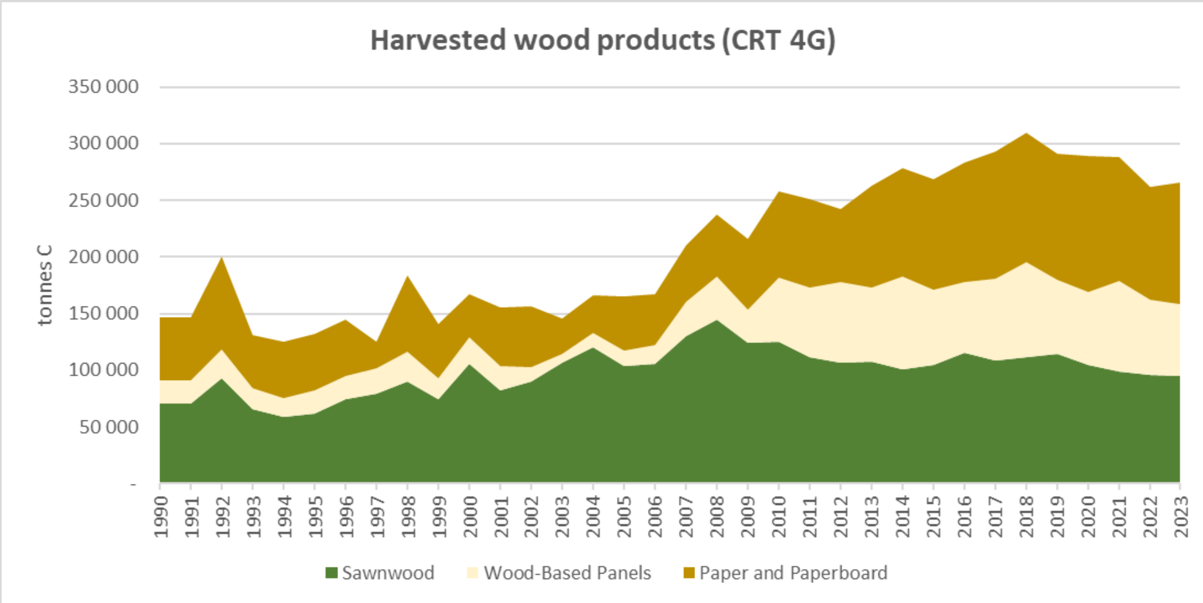
6.11 Harvested wood products (4G)

6.11.1 Description

This category includes GHG emissions and removals arising from biomass which is harvested in order to produce wood products, and hence sequester the CO_2, until its end-of use where it is released. Only CO_2 fluxes are applicable to this category.

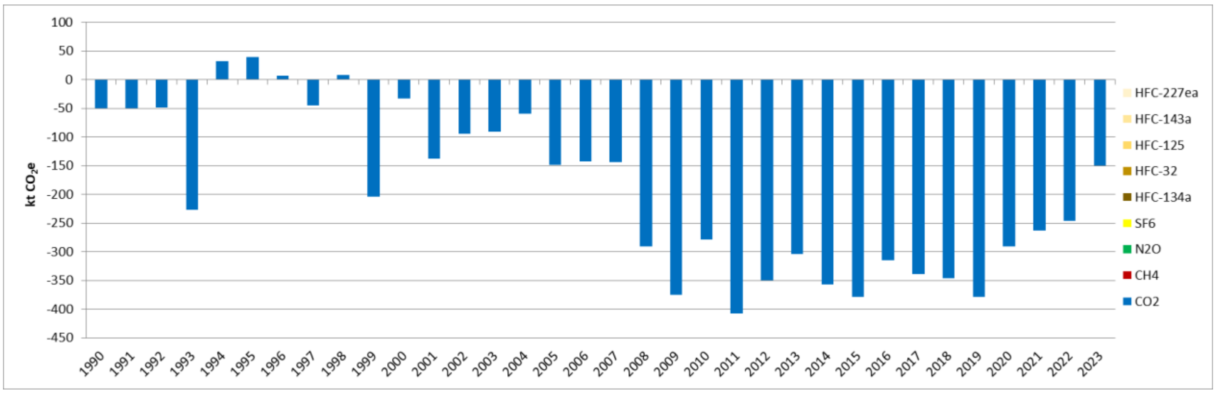
The following graph gives the evolution of the annual amounts of harvested wood products (HWP), in carbon mass produced (tonnes of C), from domestic harvest. The three different types of products considered are sawnwood, wood-based panels, and paper and paperboard. In total, the carbon mass produced from domestic HWP increases continuously for the period 1990-2019, until slightly decreasing. In 2023, the amount of carbon mass produced is 81% superior to the 1990 level. All different types of product have increased over the studied period: by 34% for sawnwood, by 207% for wood-based panels and by 93% for paper and paperboard. In 2023, the amounts of carbon mass produced from domestic HWP are rather evenly spread between the different product types: 36% for sawnwood, 24% for wood-based panels and 41% for paper and paperboard.

Figure 148: Carbon mass produced from domestic harvested wood products (CRT 4G), per product type (in t C)



The emissions from harvested wood products are given in the following graph. Some fluctuations are observed between 1990 to 2004, where most of the years the balances are net removals of CO_2 but, for some years, some net emissions are reported. The emission removals for the years 1993 and 1999 are particularly elevated, following the high levels of harvest wood products from 1992 and 1998 (see previous figure). Then, the net removals increased from 2008 onwards, following the higher level of harvesting observed, starting from 2007. In total, the net removals have increased by 391% between 1990 and 2022 and by 197% between 1990 and 2023.

Figure 149: GHG emissions from harvested wood products (CRT 4G) (kt CO_2e)



6.11.2 Methodological issues

GHG emissions from harvested wood products are calculated based on 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.

Activity data used are the annual quantities of sawnwood, wood-based panels and paper and paperboard produced, imported and exported, which are taken from FAOSTAT [L1].

The emission factors and other parameters used to estimate the emissions are taken from the 2013 KP Supplement. The default values for densities, carbon conversion factors and half-lives, depending on the product type, are given in the following table.

Table 45: Default parameters for emission estimation, for harvested wood products (CRT 4G), used in Serbian inventory

Wood product	Density (t/unit of product)	Carbon conversion factor (t C/unit of product)	Half lives (years)
Sawnwood (m^3)	0.458	0.229	35
Wood-based panels (m^3)	0.595	0.269	25
Paper and paperboard (t)	0.9	0.386	2

6.11.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 10%, based on expert judgment.

Uncertainty estimate associated with emission factor is 100% for CO_2.

Combined uncertainty is 100% for CO_2 emissions. The uncertainty combined in the national totals of emissions is of 0.3% in 2023, in the Republic of Serbia.

6.11.4 Category-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 keys in the CRT tables.

6.11.5 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission of November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	-50	39	-33	-148	-279	-407	-350	-304	-357	-378	-314	-339	-347	-379	-290	-263	-246	0
Nouveau	kt CO2e	-50	39	-33	-148	-279	-407	-350	-304	-357	-378	-314	-339	-347	-379	-290	-263	-246	-149
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-149
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm / 4.G

The Gains and Losses data regarding the Harvest of Wood Products were updated with revised fuelwood data from the Energy Balance covering 2019 to 2023.

6.11.6 Category-specific planned improvements

Refined approach using national parameters could be implemented for this sector.

Chapter 7: Waste (CRT sector 5)

Note: Unless stated otherwise, all results discussed in the sectorial chapters consider national totals, excluding indirect CO_2 emissions.

7.1 Overview of sector

In the Republic of Serbia, the Waste sector (CRT 5) includes the emissions from the following activities:

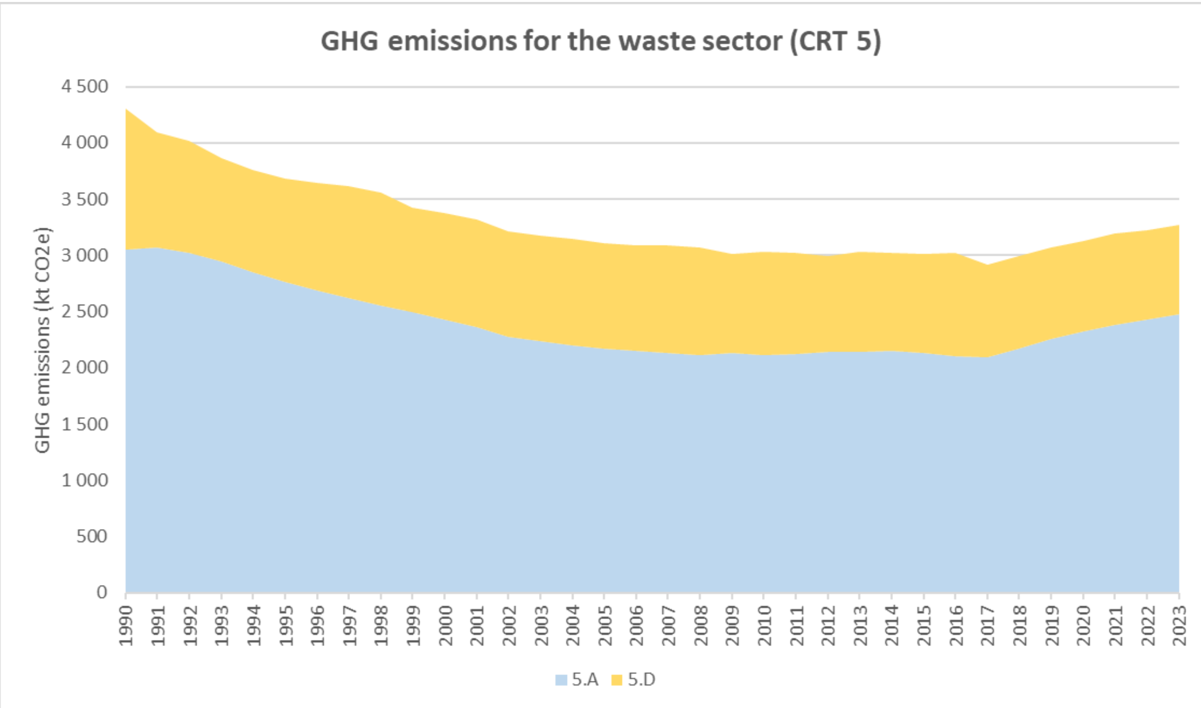
- Solid waste disposal (SWD) (5A), including for managed SWD (5A1), unmanaged SWD (5A2) and uncategorized SWD (5A3). It should be noted that all emissions are reported under the 5A1 category.
- Wastewater treatment and discharge (5D), including domestic (5D1) and industrial (5D2) wastewater.

There is no incineration of waste (5C1) in the Republic of Serbia for the studied period, neither composting (5B1) or biogas production (5B2). Open burning of waste (5C2) may occur in rural areas but there is no data about this practice and no estimations (NE) for the emissions of this sector in the current inventory.

Among the different GHG, only CH_4 and N_2O emissions are estimated for the Waste sector. In 2023, the CRT 5 contributes to 38% of the national CH_4 emissions and 3.2% of the national N_2O emissions, excluding LULUCF contribution. In 1990, the share in the national emissions for the methane was smaller (34%), meanwhile the share for N_2O was slightly higher (3.6%). Hence, the waste sector is particularly preponderant in the Serbian methane emissions. In terms of GHG contribution, the waste sector accounts for slightly more than 5% of the national emissions in 1990 and in 2023, as well as on average on the entire timeseries (with a maximum at 6.7%). For the CRT 5 sector, methane emissions are predominant and represent more than 97% of its emissions.

The following graph presents the CRT 5 GHG emission trend.

Figure 150: GHG emission trends for waste (CRT 5), for the period 1990-2023 (in kt CO_2e)

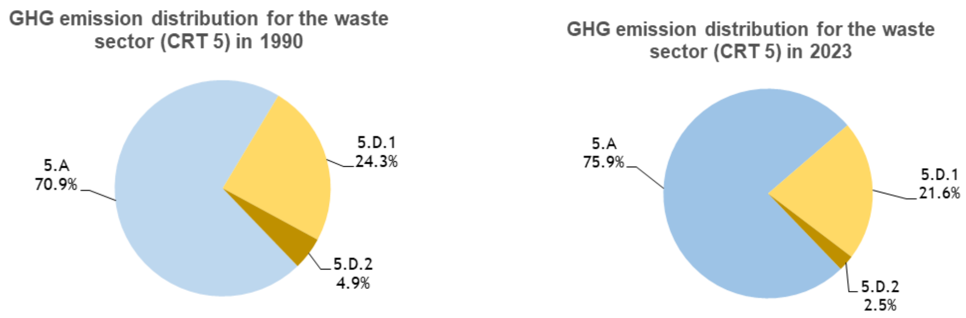


The GHG emissions trend for the waste sector is rather stable and does not present significant and rapid changes related to events such as wars, economic crisis or meteorological phenomena (flood, drought, etc.), except for category 5.D.2, which is related to industrial activities. However, this subsector is relatively marginal compared to the total sectoral emissions. Emissions are declining slightly but gradually between 1990 and 2009 (-30%), before being relatively constant until 2018. From 2018 onwards, emissions gradually increased until 2023, primarily due to the rise in solid waste disposal activity, but remained lower than in 1990. Overall, the CRT 5 GHG emissions have been reduced by 24% between 1990 and 2023, due to emission reductions in both categories.

In 2023, GHG emissions from Sector 5 Waste amounted to 3.3 Mt CO_2e, compared to 4.3 Mt CO_2e in 1990.

The following graph presents the GHG emission distribution between the different emission sources from the waste sector. The emissions from all subsectors decreased between 1990 and 2023, but to different orders of magnitude. Overall, the activity of solid waste disposal (5A) is predominant for the sector GHG emissions, and its contribution increases from 71% in 1990 to 76% in 2023. The other major emission source is the domestic wastewater treatment (5D1), which is responsible for 24% of the sector GHG emissions in 1990 and 22% in 2023. Finally, the industrial wastewater treatment (5D2), which contributed to 5% of the sector emissions in 1990, has seen its share divided by two over the period.

Figure 151: GHG emission distribution for waste sector (CRT 5), for the period 1990-2023, per subcategory (in %)



7.2 Solid waste disposal sites (5A)

7.2.1 Category description

The category of the disposal of solid waste disposal sites (5A) is responsible of emissions of methane (CH_4), and of biogenic CO_2, which is not reported in the national totals.

In 2023, the CRT category 5A Solid Waste Disposal Sites (which includes emissions from 5A1 (managed SWD), as well from 5A2 (unmanaged SWD) and 5A3 (uncategorized SWD)) is a key category for CH_4 emissions in the Republic of Serbia, both in terms of emission levels as well as emission trend. This sector contributes 4.0% in terms of emissions level without LULUCF (rank 3) and 0.8% in terms of trend (rank 28).

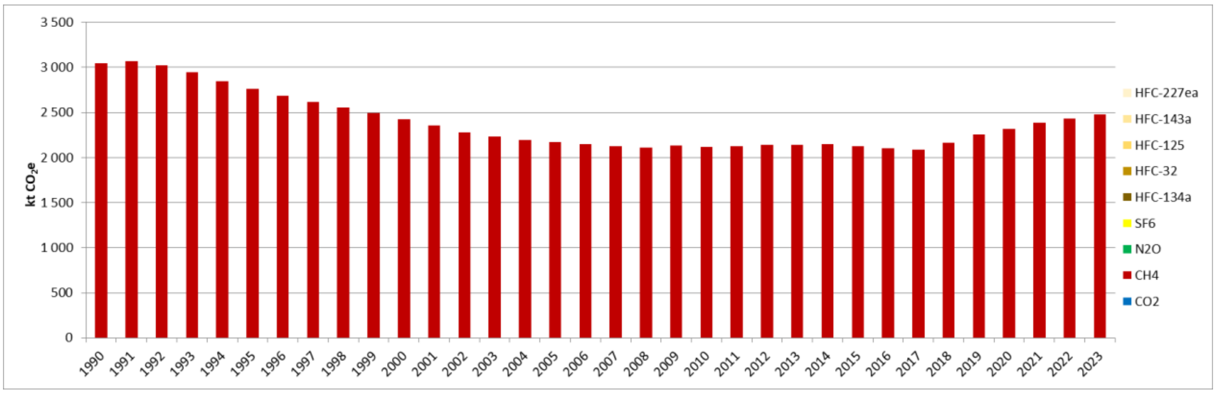
The evolution of the emissions is presented in the following graph. Three distinct phases can be observed: a gradual emission reduction from 1991 to 2007 (-31%), a stagnation between 2008 and 2017, before a gradual increase from 2018 to 2023 (+14%). In total, methane emissions have been reduced by 19% over the entire time serie.

The managed industrial waste, which contributed to 41% of the emissions of the CRT 5A1 in 1990, is responsible for an important part of this reduction, with a decrease of its emissions by 70% between 1990 and 2015, due to a large reduction of the amounts of industrial waste deposited in disposal sites for 1990-2014 (-87%), although some important variations are observed over the period. In particular, the amount of industrial waste disposed of dropped sharply by 80% between 1990 and 1993 (-80%), mainly due to the decline in GDP and in waste generation rates, linked to the war and the hyperinflation during that period. Nevertheless, emissions have decreased less drasticly but more progressively, as they depend on the kinetic of waste degradation.

For domestic waste, the amount deposited in landfills varies in direct proportion to the population, which varies at a slower rate. However, a significant 20% reduction was observed between 1990 and 1991. Throughout the rest of the studied period, the population continues to decrease gradually, with an overall reduction of 16% from 1991 to2023. In addition, the amount of domestic waste deposited depends on the annual waste generation rate per inhabitant. This rate remained constant from 1990 to 2008, fluctuated slightly until 2013, then decreased significantly between 2013 and 2015 (-24%). It then surged in 2017 (+50% compared to 2016), before increasing gradually between 2018 and 2023 (+15%, see Table 46). As a result, after a sudden 20% drop in 1991 compared to 1990, the total amount of domestic waste deposited declined gradually but slowly by 8% between 1991 and 2015. In 2017, a sharp 47% increase was observed compared to 2016, primarily driven by the rise in the waste generation rate. Finally, between 2017 and 2023, the slow decline in Serbia's population did not offset the increase in the generation rate, leading to an 11% rise in the amount of domestic waste disposed of in landfills. In terms of methane emissions, domestic waste, which accounted for 59% of CRT 5A1 emissions in 1990, represented 85% of emissions in 2023.

The emissions shown in the graph below reflect a combination of the various factors discussed above, including the trends in industrial and domestic waste quantities. Additionally, from 2002 onwards, 10% of the disposed waste has been considered anaerobically managed, following the construction of the first landfill site compliant with EC regulations. This landfill received municipal solid waste as well as commercial and industrial waste

Figure 152: GHG emissions for managed waste disposal sites (kt CO_2e)



7.2.2 Methodological issues

The Tier 1 methodology recommended by the 2006 IPCC Guidelines is applied. The IPCC Waste Software, developped by the IPCC, was implemented, specifically using the "waste by composition" approach.

As far as possible country-specific parameters have been used as input data in the IPCC Waste Software.

7.2.2.1 Municipal Solid Waste (MSW)

7.2.2.1.1 Population and fraction of urban population

National data on population used in the Serbian inventory are from Statistical Office.

Concerning waste disposal, the Serbian inventory has been developed to allow a distinction between urban and rural population. Anyway, up to now national data are not precise enough and the same average generation rate is applied to urban and rural population.

7.2.2.1.2 Municipal Solid Waste (MSW) generation rate

The Serbian generation rate is based on national data. SEPA collects annual data on the average coverage of waste collection (fraction of generated MSW going to landfills) and the amount of waste reported from municipal companies in local self-governments in accordance with the Rulebook on the Form of daily records and annual report on waste (Official Gazette of RS, number 95/10). In accordance with the Rulebook on the methodology for collecting data on composition and quantities municipal waste in the territory of the local self-government unit (Official Gazette of the Republic of Serbia, No. 61/2010), local governments have an obligation to conduct four times a year analyses of quantities and composition of municipal waste on its territory.

Table 46: MSW generation rate, for the period 1990-2023, used in the Serbian inventory (in kg/inhabitant/year)

Year	Generation rate (kg /inhab./year)
1950-2008	350
2009	360
2010	360
2011	370
2012	360
2013	340
2014	300
2015	260
2016	270
2017	390
2018	401
2019	405
2020	419
2021	416
2022	467
2023	460

The regional default value proposed in the 2006 IPCC Guidelines (Vol 5, Chap 2, table 3.3) is 380 kg/inhabitant/year in the 2000th, which is quite consistent with the country-specific historical values.

7.2.2.1.3 Fraction of generated MSW going to landfills (% to SWDS)

The fraction of generated MSW going to landfills is based on national data, provided in the described manner.

Table 47: Fraction of generated MSW going to landfills, for the period 1990-2023, used in the Serbian inventory (in %)

Year	% to SWDS
1950-2008	60.0%
2009	60.0%
2010	72.0%
2011	77.0%
2012	70.0%
2013	80.0%
2014	80.0%
2015	82.0%
2016	82.0%
2017	83.7%
2018	87.2%
2019	86.2%
2020	86.4%
2021	88.0%
2022	87.0%
2023	88.3%

In absence of further information, these fractions are both applied in urban and rural areas.

The regional default value proposed in the 2006 IPCC Guidelines (Vol 5, Chap 2, table 3.3) is 90% in the 2000th.

7.2.2.1.4 MSW disposed in landfills

The amount of MSW disposed in landfills is estimated based on the above parameters and evolves as follows.

Table 48: Evolution of the amount of MSW disposed in landfills, for the period 1990-2023, in the Republic of Serbia (in kt)

Year	MSW in landfills (Gg)	Year	MSW in landfills (Gg)	Year	MSW in landfills (Gg)	Year	MSW in landfills (Gg)
1950	1,414.1	**1970**	1,760.9	**1990**	2,049.0	**2010**	1,889.8
1951	1,433.5	**1971**	1,777.9	**1991**	1,643.3	**2011**	2,067.8
1952	1,449.0	**1972**	1,794.5	**1992**	1,644.7	**2012**	1,814.1
1953	1,469.8	**1973**	1,809.6	**1993**	1,646.6	**2013**	1,947.5
1954	1,491.6	**1974**	1,826.4	**1994**	1,648.3	**2014**	1,711.2
1955	1,514.3	**1975**	1,843.6	**1995**	1,649.8	**2015**	1,511.6
1956	1,529.2	**1976**	1,861.7	**1996**	1,647.2	**2016**	1,561.8
1957	1,544.6	**1977**	1,879.5	**1997**	1,643.9	**2017**	2,291.5
1958	1,559.3	**1978**	1,896.3	**1998**	1,639.5	**2018**	2,440.7
1959	1,576.7	**1979**	1,912.5	**1999**	1,634.0	**2019**	2,419.3
1960	1,592.4	**1980**	1,937.7	**2000**	1,626.9	**2020**	2,487.0
1961	1,609.4	**1981**	1,959.7	**2001**	1,622.7	**2021**	2,488.3
1962	1,627.1	**1982**	1,970.9	**2002**	1,575.0	**2022**	2,698.3
1963	1,644.7	**1983**	1,981.6	**2003**	1,570.8	**2023**	2,682.9
1964	1,660.9	**1984**	1,992.7	**2004**	1,567.2		
1965	1,678.7	**1985**	2,003.2	**2005**	1,562.4		
1966	1,696.8	**1986**	2,013.5	**2006**	1,556.3		
1967	1,712.8	**1987**	2,022.7	**2007**	1,550.0		
1968	1,729.4	**1988**	2,023.1	**2008**	1,543.5		
1969	1,745.5	**1989**	2,041.0	**2009**	1,581.1		

7.2.2.1.5 Waste composition

MSW composition is based on national data, through the project "Determination of waste composition and quantity estimation in order to define a management strategy on secondary raw materials within the sustainable development of the Republic of Serbia ". Methodology for estimating the generated quantities and composition of municipal waste used, is the result of analysis by the experiences of EU Member States and is proposed as the official method under the name S.W.A.-Tool (Development of a Methodological Tool to enhance the Precision & Comparability of Solid Waste Analysis Data). The goal of its development is to increase precision and comparability of municipal waste data at the level of Europe. The methodology consists of two segments. The first segment is to evaluate the generated amount of municipal waste in the selected municipalities of Serbia, in the period from seven days of the amount of municipal waste before its disposal to the landfill. The second step represents the sampling and analysis of the morphological composition of waste for reference municipalities in accordance with defined catalogue for classification of waste. In this way, municipalities with associated districts will have a clear insight into the amount of generated waste in its territory, as well as the structure of that waste. Also, municipalities are representative in terms of using adequate statistical instruments, so that data obtained can be projected at the level of the entire Republic.

Table 49: Municipal solid waste composition used in the Serbian inventory, per waste category (in %)

Year	Food (%)	Garden (%)	Paper (%)	Wood (%)	Textile (%)	Nappies (%)	Plastics, other inert (%)
1950-1990	32%	13%	18%	0%	6%	0%	31%
1991-2023	31%	12%	17%	0%	5%	4%	31%

7.2.2.2 Industrial waste disposed in SWDS

The **Gross Domestic Product (GDP)** is used in the Serbian Inventory to estimate the amount of industrial waste generated, and based on national data published on Worldbank website.

The **Industrial waste production per GDP unit** is based on national data.

The **fraction of industrial waste going to landfills** is calculated according to data provided by Statistical Office.

Table 50: Industrial waste generation and destination, for the period 1990-2023, used in the Serbian inventory

Year	GDP ($ millions)	Waste generation rate (Gg/$m GDP/yr)	Total industrial waste (Gg)	% to SWDS (%)
1950-1990	40,444	0.144	5,817.35	24%
1991	36,915	0.132	4,856.66	23%
1992	27,132	0.097	2,626.02	22%
1993	19,325	0.069	1,329.81	21%
1994	20,249	0.072	1,459.46	20%
1995	16,750	0.078	1,302.40	19%
1996	20,949	0.083	1,737.25	18%
1997	24,148	0.081	1,947.59	17%
1998	18,284	0.075	1,378.47	16%
1999	18,409	0.048	888.09	15%
2000	6,540	0.039	253.66	14%
2001	12,267	0.051	623.06	13%
2002	16,117	0.067	1,080.10	12%
2003	21,189	0.087	1,840.93	11%
2004	24,861	0.105	2,612.17	10%
2005	26,252	0.112	2,943.31	9%
2006	30,608	0.130	3,974.31	8%
2007	40,290	0.129	5,183.32	7%
2008	49,260	0.212	10,454.31	7%
2009	42,617	0.179	7,622.09	4%
2010	39,460	0.189	7,445.96	3%
2011	46,467	0.132	6,115.30	2%
2012	40,742	0.201	8,207.00	3%
2013	45,520	0.193	8,773.35	2%
2014	44,211	0.139	6,124.98	3%
2015	37,160	0.207	7,690.97	4%
2016	38,300	0.191	7,307.10	5%
2017	41,430	0.225	9,327.61	6%
2018	50,597	0.185	9,366.23	6%
2019	51,409	0.187	9,613.48	5%
2020	52,960	0.180	9,532.80	5%
2021	63,070	0.140	8,829.80	4%
2022	63,563	0.130	8,263.19	2%
2023	75,187	0.10	7,744.26	2%

7.2.2.2.1 - Repartition between management practices

The same repartition between management practices is applied to MSW and Industrial waste.

Table 51: Repartition between management practices, used in the Serbian inventory

Year	Unmanaged, shallow (%)	Unmanaged, deep (%)	Managed (%)	Managed, semi-aerobic (%)	Uncategorised (%)
1950-2001	25%	55%	0%	0%	20%
2002-2023	25%	55%	10%	0%	10%

Default values recommended by the 2006 IPCC Tool have been applied for the other parameters:

7.2.2.2.2 Degradable organic carbon (DOC) content of each category of waste

Table 52: Degradable Organic Content (DOC), used in the Serbian inventory, per waste type

DOC (weight fraction, wet basis)	Range	IPCC Default	Applied
Food waste	0.08-0.20	0.15	0.15
Garden	0.18-0.22	0.2	0.2
Paper	0.36-0.45	0.4	0.4
Wood and straw	0.39-0.46	0.43	0.43
Textiles	0.20-0.40	0.24	0.24
Disposable nappies	0.18-0.32	0.24	0.24
Sewage sludge	0.04-0.05	0.05	0.05
Industrial waste	0-0.54	0.15	0.15

**Recommended in the 2006 IPCC Guidelines, Vol5, Chap 2, Table 2.4*

7.2.2.2.3 Fraction of DOC dissimilated (DOC_f):

Table 53: Dissimilated degradable organic content (DOC_f), used in the Serbian inventory

Parameter	IPCC Default	Applied
DOC_f	0.5	0.5

**Recommended in the 2006 IPCC Guidelines, Vol5, Chap 3, page 3.13*

7.2.2.2.4 Methane generation rate constant (k):

On the basis of the map of delineation of major climatic zones presented in the chapter 3.A.5 of the 2006 IPCC Guidelines, the climatic Zone of Serbia is between “Warm temperate Moist” and “Cool Temperate Moist”. Therefore, the Serbian Republic has been classified as “**Temperate Wet**” in the IPCC Waste Software.

The default values recommended in the 2006 IPCC Guidelines for a climate “Temperate Wet” are applied to each category of waste.

Table 54: Methane generation rate constant (k), used in the Serbian inventory, per waste type (in years^{-1})

k (years^{-1})	Range	IPCC Default*	Applied
Food waste	0.1–0.2	0.185	0.185
Garden	0.06–0.1	0.1	0.1
Paper	0.05–0.07	0.06	0.06
Wood and straw	0.02–0.04	0.03	0.03
Textiles	0.05–0.07	0.06	0.06
Disposable nappies	0.06–0.1	0.1	0.1
Sewage sludge	0.1–0.2	0.185	0.185
Industrial waste	0.08–0.1	0.09	0.09

**Recommended in the 2006 IPCC Guidelines, Vol5, Chap 3, Table 3.3*

7.2.2.2.5 Methane Correction Factor (MCF):

The default values of the methane correction factors (MCF) used in the Serbian inventory, for both municipal and industrial waste, are as follows:

Table 55: Methane correction factor (MCF) , used in the Serbian inventory, per waste management type

MCF	Unmanaged shallow	Unmanaged deep	Managed	Managed, semi-aerobic	Uncategorised
IPCC default	0.4	0.8	1	0.5	0.6
Applied	0.4	0.8	1	0.5	0.6

**Recommended in the 2006 IPCC Guidelines, Vol5, Chap 3, Table 3.1*

7.2.2.2.6 Oxidation factor (OX):

An average oxidation factor (OX) is calculated. An OX of 0.1 is applied to sanitary landfills assuming in-operation covering as required in recent EC landfills. The fraction of waste disposed in sanitary landfills is rather low (10% since 2002). Therefore, the averaged OX is low.

Table 56: Oxidation factor (F), used in the Serbian inventory, for the period 1990-2022

F	IPCC default for managed landfills covered with oxidating material*	IPCC default for other landfills	Averaged OX
1950-2001	0.1	0	0
2002-2022	0.1	0	0.01

**Recommended in the 2006 IPCC Guidelines, Vol5, Chap 3, Table 3.2*

7.2.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 30%, based on 2006 IPCC Guidelines (Volume 5, Chapter 3, Table 3.5).

Uncertainty estimate associated with emission factor amounts to 175%, based on expert judgment.

Combined uncertainty for emissions is 178%. The uncertainty combined in the national total emissions, excluding LULUCF contribution, is of 7.7% in 2023, and contributes the highest to the overall emission inventory uncertainty between all sectors.

7.2.4 Category-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 keys in the CRT.

7.2.5 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	3 047	2 765	2 426	2 171	2 115	2 124	2 142	2 141	2 147	2 129	2 102	2 089	2 167	2 252	2 319	2 385	2 433	0
Nouveau	kt CO2e	3 047	2 765	2 426	2 171	2 115	2 124	2 142	2 141	2 147	2 129	2 102	2 089	2 167	2 252	2 319	2 385	2 433	2 481
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+2 481
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm /5.A

Landfilling (5A) data were corrected for 2022.

7.2.6 Category-specific planned improvements

Concerning landfilling, the planned improvements deal mainly with the historical trends of the country-specific parameters, especially concerning the following aspects:

- improve the historical trend of the parameters considered as constant over the timeseries (MSW generation rate, waste composition…),
- improve the repartition between management practices on the basis of the landfill database managed by the SEPA.
- improve the estimations using 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (new default values for DOC_f)

In addition, open burning of waste (5C2) will be included when some data are available.

7.3 Wastewater treatment and discharge (5D)

7.3.1 Category description

In 2023, the category 5D Wastewater treatment and discharge is a key category for CH_4 emissions in the Republic of Serbia, both in terms of emission levels and trend. The methane emissions related to domestic wastewater treatment and discharge (5D1) contribute 1.0% in terms of emissions level without LULUCF (rank 14), and to 0.3% in terms of emission trend (rank 62). The methane emissions related to industrial wastewater (5D2) are only a key category in terms of emission trends, with a contribution of 0.3% (rank 54).

Under this category, the following sources must be considered:

- Wastewater treatment (domestic and industrial),
- Water discharge in water bodies,
- One biogas production plant.

In the Republic of Serbia, for urban areas, around 20% of domestic wastewater treatment occurs in centralized WasteWater Treatment Plants (WWTP), 10% is treated in septic tanks, 20% is treated in flowing sewer and the remainder (i.e., 50%), is directly discharged in water bodies without treatment. For rural areas, half the share is considered to be treated in septic tanks, 10% in flowing sewer and the remainder (i.e., 40%) is treated in stagnant sewer (see Figure 156). For the industry, the generated wastewater is based on the industrial productions of some products (see Table 64).

Data concerning industrial wastewater treatment are available through SEPAs Information system.

On-site biogas production in WWTP does not occur over the territory.

The GHG emission trends for these two categories are presented in the following graphs.

For the CRT 5D1, after a sudden decline in 1991 (-20% compared with 1990), for both CH_4 and N_2O, the GHG emissions from domestic industrial wastewater treatment and discharge are rather stable until 1998, before gradually declining until 2023. GHG emissions evolves according to the population trend as all other parameters are taken as constant over the entire period (see chapter 7.3.2.1 for details on the methodology). Overall, total GHG emission in 2023 were reduced by 32%, compared with 1990 levels.

For the CRT 5D2, the methane emissions are proportional to the evolution of the industrial productions, as well as the average wastewater generation rate and the chemical oxygen demand (COD) of each product. For example, the pulp and paper industries produce large volumes of wastewater which contain high levels of degradable organics (1,458 kg COD/t product), whereas other products have a much lower COD production rate, such as meat and poultry (53 kg COD/t product). However, depending on their production, the different products have various impacts on the emissions from the industrial wastewater treatment and discharge. Indeed, as all the industrial wastewater is considered to be directly discharged, no matter the product, the emission are directly proportional to the total chemical oxygen demand aggregated among the different productions. In 1990, organic chemicals were responsible for more than half the emissions from the CRT 5D2, and after the emission trend follows closely the evolution of this production, the other productions being less preponderant or more stable (see Table 64). The figure gives the evolution of the chemical oxygen demand by product type. In 2017, the organic chemical production stopped and thus, the CH_4 emissions of industrial wastewater treatment and discharge decreased significantly, before being rather stable up to 2023. Overall, methane emissions from this category have been reduced by 37% for the period 1990-2023.

Figure 153: GHG emissions for domestic wastewater treatment and discharge (CRT 5D1) (kt CO_2e)

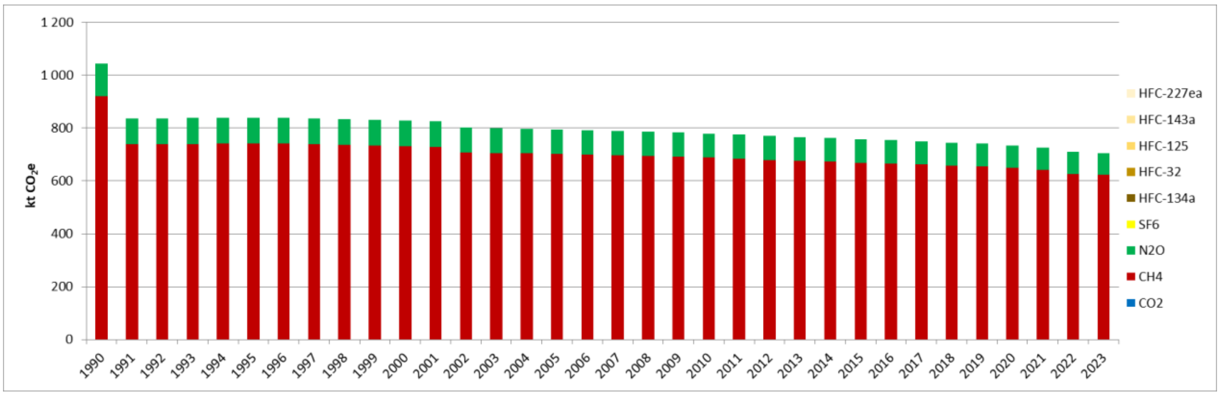


Figure 154: GHG emissions for industrial wastewater treatment and discharge (CRT 5D2) (kt CO_2e)

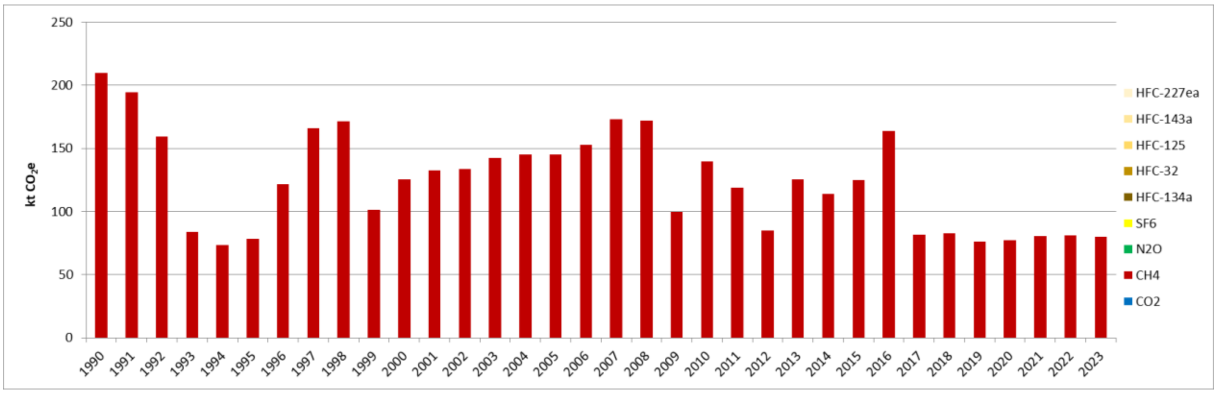
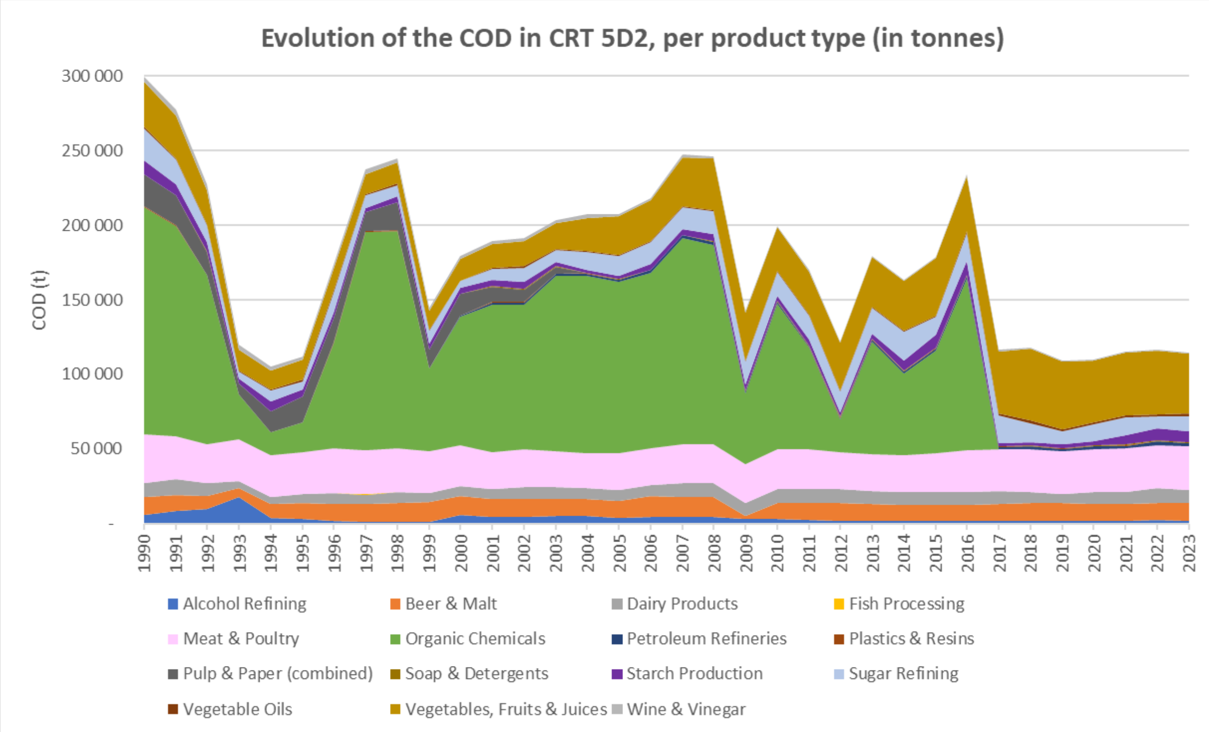


Figure 155: Evolution of the COD for industrial wastewater, depending on the product type (CRT 5D2) (in t)



7.3.2 Methodological issues

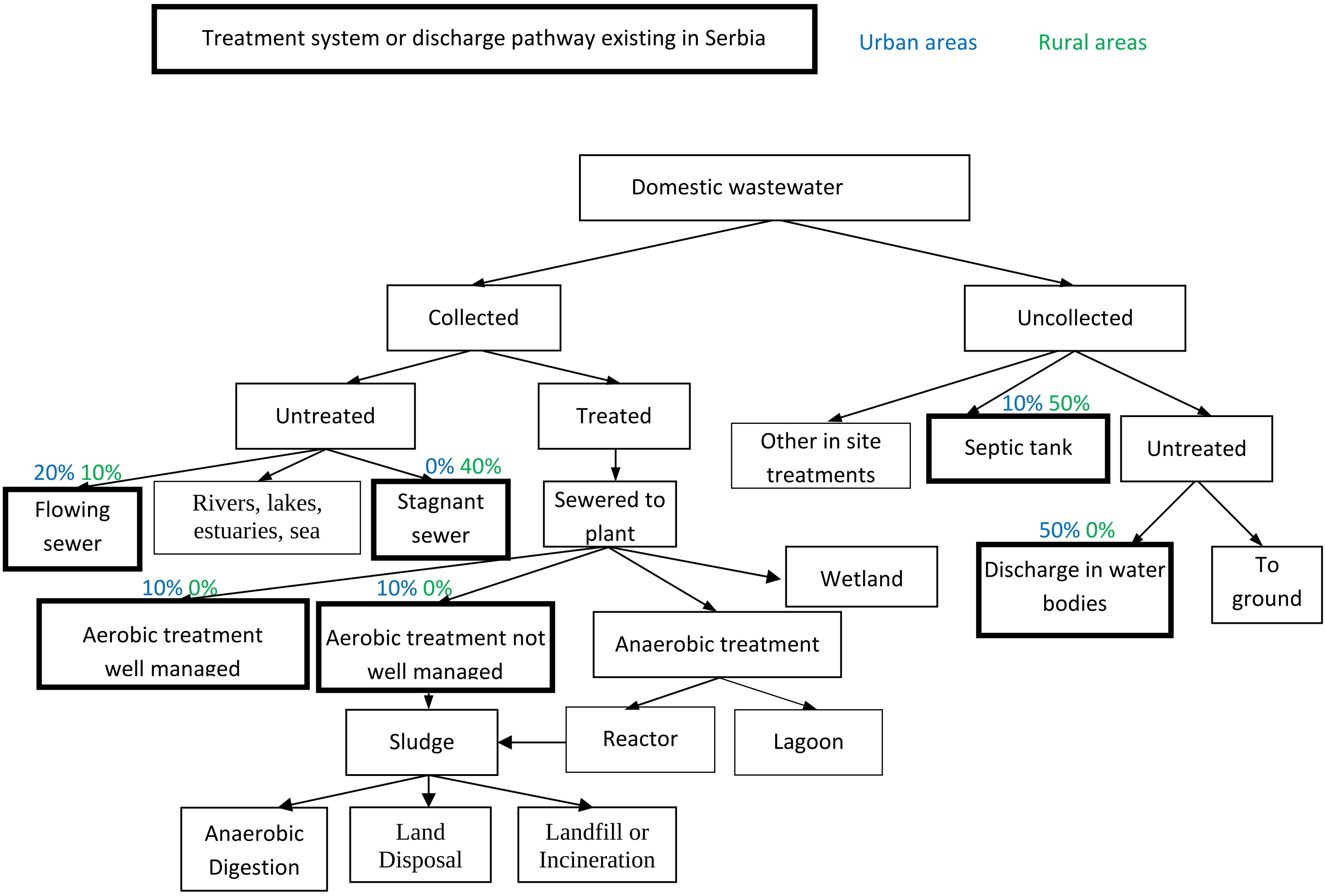
A Tier 1 methodology recommended by the 2006 IPCC Guidelines is applied to estimate CH_4 and N_20 emissions from domestic and industrial wastewater treatment and discharge.

7.3.2.1 Domestic wastewaters (DWW)

7.3.2.1.1 CH_4 emissions

The treatment systems and discharge pathways presented in Figure 6.1 of the 2006 IPCC Guidelines have been adapted to national circumstances.

Figure 156: Serbian treatment systems and pathways for domestic wastewater



In order to estimate CH_4 emissions from domestic wastewater treated and discharged, the equation 6.1 of the 2006 IPCC Guidelines is applied.

7.3.2.1.1.1 - Total organically degradable material (TOW)

TOW in domestic wastewater is estimated using the equation 6.3 of the 2006 IPCC Guidelines.

As far as possible, country-specific parameters have been used as input data in the calculation.

- Population (P)

National data on population used in the Serbian inventory are from Statistical Office. The population data used for the category 5D are consistent with the data used for the category 5A.

Table 57: Evolution of Serbian population (P), in millions of inhabitants, for the period 1990-2023

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Population (Millions inhab.)	9.76	7.83	7.83	7.84	7.85	7.86	7.84	7.83	7.81	7.78	7.75	7.73	7.50	7.48	7.46	7.44	7.41
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Population (Millions inhab.)	7.38	7.35	7.32	7.29	7.26	7.20	7.16	7.13	7.09	7.05	7.02	6.96	6.93	6.87	6.80	6.64	6.61

- Fraction of urban/rural population (Ui)

Concerning wastewater treatment, consistently with the 2006 IPCC Guidelines recommendation, the Serbian inventory has been developed to allow a distinction between urban and rural populations.

The fraction of urban population is considered to be 59% all over the timeseries.

- Degree of utilisation of treatment/discharge pathway or system (Ti,j)

Two Ti,j are used in the Serbian inventory, one dedicated to urban areas and the other one to rural areas. These parameters are considered as constant all over the timeseries.

Table 58: Degree of utilisation of treatment/discharge pathway or system (Ti,j), used in Serbian inventory

Treatment/discharge system	Urban	Rural
Wastewater treatment plants well managed	10%	0%
Wastewater treatment plants not well managed	10%	0%
Anaerobic shallow lagoons	0%	0%
Anaerobic deep lagoons	0%	0%
Discharge of treated wastewater	0%	0%
Direct discharge (Untreated)	50%	0%
Septic tanks	10%	50%
Latrine	0%	0%
Flowing sewer (open or closed)	20%	10%
Stagnant sewer	0%	40%

- Correction factor for additional Industrial BOD (I)

The default I values proposed in the 2006 IPCC Guidelines are considered for all different treatment and discharge system.

Table 59: Correction factor for additional Industrial BOD (I), per treatment/discharge system

I (ratio)	Applied
Wastewater treatment plants well managed	1.25
Wastewater treatment plants not well managed	1.25
Anaerobic shallow lagoons	1
Anaerobic deep lagoons	1
Discharge of treated wastewater	1.25
Direct discharge (Untreated)	1
Septic tanks	1
Latrine	1
Flowing sewer (open or closed)	1.25
Stagnant sewer	1.25

7.3.2.1.1.2 Organic component removed as sludge (S)

In absence of data, the default value recommended in the 2006 IPCC Guidelines (0) is applied in the Serbian inventory.

7.3.2.1.1.3 Emission factor (EF)

Emission factors for domestic wastewater, for each discharge/treatment system, are estimated using the equation 6.2 of the 2006 IPCC Guidelines.

- Methane Correction factor (MCF)

In the Serbian inventory, the default values recommended in the 2006 IPCC Guidelines are applied to each treatment system and discharge pathway.

Table 60: Methane correction factor per treatment systems and discharge pathways (MCF)

MCF (ratio)	Applied
Wastewater treatment plants well managed	0
Wastewater treatment plants not well managed	0.3
Anaerobic shallow lagoons	0.2
Anaerobic deep lagoons	0.8
Discharge of treated wastewater	0
Direct discharge (Untreated)	0
Septic tanks	0.5
Latrine	0.7
Anaerobic digester for sludge	0.8
Flowing sewer (open or closed)	0
Stagnant sewer	0.5

- Maximum CH_4 producing capacity (B_0)

In the Serbian inventory, the default value recommended in the 2006 IPCC Guidelines (0.6 kg CH_4/kg BOD) is applied.

7.3.2.1.1.4 Amount of CH4 recovered (R)

In absence of national data, the default value recommended in the 2006 IPCC Guidelines (0) is applied in the Serbian inventory.

7.3.2.1.2 N_2O emissions from wastewater discharge

In order to estimate N_2O emissions from domestic wastewater discharged, the equation 6.7 of the 2006 IPCC Guidelines is applied.

7.3.2.1.2.1 Total nitrogen in effluent (Neffluent)

TOW in domestic wastewater is estimated using the equation 6.3 of the 2006 IPCC Guidelines.

- Population (P)

The population data used for the category 5D are consistent with the data used for the category 5A and population data used for CH_4 emissions from 5D.

- Annual per capita protein consumption (Protein)

National data on the annual amount of protein consumed per capita used in the Serbian inventory are from FAO Statistics (Dietary Protein Consumption: g/person/day); average data in kg/year are considered in calculations. The value is used all over the time series.

Table 61: Protein consumption per capita (Protein)

Parameter	Applied
Protein (kg/person/year)	27.3

- Fraction of Nitrogen in protein (F_{npr}), Factor for non-consumed protein ($F_{non-con}$) and factor for industrial and commercial co-discharged ($F_{ind-com}$)

In absence of country specific information, default values recommended in the 2006 IPCC Guidelines are applied for the fraction of Nitrogen in protein, the factor for non-consumed protein added to the wastewater and for the factor for industrial and commercial co-discharged protein into the sewer system.

Table 62: Fraction of Nitrogen in protein (Fnpr), Factor for non-consumed protein (Fnon-con) and factor for industrial and commercial co-discharged (Find-com)

Parameters	IPCC Default*	Applied
Fraction of Nitrogen in protein (kg N/kg protein)	0.16	0.16
Factor for non-consumed protein ($F_{non-com}$)	1.1	1.1
Factor for industrial and commercial co-discharged ($F_{ind-com}$)	1.25	1.25

**Recommended in the 2006 IPCC Guidelines, Vol5, Chap 5, paragraph 6.3.1.3*

7.3.2.1.2.2 Nitrogen removed with sludge (Nsludge)

In absence of country specific information, the default value recommended in the 2006 IPCC Guidelines is applied.

Table 63: Nitrogen removed with sludge (N_{sludge}) (in kg N/year)

Parameter	IPCC Default*	Applied
Nsludge- Nitrogen removed with sludge, kg N/yr	0	0

**Recommended in the 2006 IPCC Guidelines, Vol5, Chap 5, page 6.25*

7.3.2.1.2.3 Emission factor (EF)

The default EF recommended in the 2006 IPCC Guidelines (0.005 kg N_2O-N/kg N) is applied in the Serbian inventory.

7.3.2.1.3 N_2O emissions from advanced WWTP

In order to estimate N_2O emissions from domestic wastewater discharged, the equation 6.9 of the 2006 IPCC Guidelines is applied.

7.3.2.1.3.1 Degree of utilisation of modern, centralized WWTP (T_{plant})

In the Serbian inventory, a distinction is done between urban and rural areas. In the urban areas Tplant is considered to be 20% and in rural areas it is considered to be 10%. These values are applied all over the timeseries.

Population data (P) and the fraction of industrial and commercial co-discharged protein into the sewer system (Find-com) are consistent with the values presented above.

7.3.2.1.3.2 Emission factor (EF)

The default EF recommended in the 2006 IPCC Guidelines (3.2 g N_2O-N/person) is applied in the Serbian inventory.

7.3.2.2 Industrial wastewaters (IWW)

In order to estimate CH_4 emissions from industrial wastewater treated and discharged, the equation 6.4 of the 2006 IPCC Guidelines is applied.

7.3.2.2.1 Total organically degradable material for industry I (TOW_i)

TOW in industrial wastewater is estimated using the equation 6.6 of the 2006 IPCC Guidelines.

- Total industrial product (P_i)

National data on total industrial product used in the Serbian inventory are from Statistical Office.

Table 64: Total industrial productions (Pi) used in the CRT 5D2, for the period 1990-2022, in the Republic of Serbia (in kt)

Pi (kt)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Alcohol Refining	21,996	30,668	35,934	66,988	13,831	12,350	5,605	3,494	3,798	3,624	22,701
Beer & Malt	653,505	614,543	502,877	326,175	532,526	588,077	650,056	650,594	708,698	717,942	694,386
Dairy Products	486,486	535,877	435,686	268,695	244,414	302,425	359,648	348,692	377,818	349,920	330,637
Fish Processing	644	568	516	546	549	553	591	578	579	544	542
Meat & Poultry	616,000	543,000	493,000	522,000	525,000	529,000	565,000	553,000	554,000	520,000	518,000
Organic Chemicals	757,563	703,160	564,273	150,631	73,846	99,446	350,479	728,610	724,091	275,060	426,769
Petroleum Refineries	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1,134,610
Plastics & Resins	232,667	194,388	115,259	12,248	13,491	13,778	95,016	203,901	214,610	78,151	126,966
Pulp & Paper (combined)	14,686	13,788	10,571	4,807	9,865	11,769	11,282	8,752	12,783	8,756	10,028
Soap & Detergents	80,427	47,893	71,709	46,404	41,226	51,129	61,679	76,870	71,107	57,261	51,144
Starch Production	101,710	77,114	73,172	37,903	70,921	51,811	43,377	32,351	45,465	40,418	47,449
Sugar Refining	619,213	469,520	314,227	126,646	209,964	155,750	382,040	239,527	212,874	248,442	115,440

Vegetable Oils	375,593	429,254	365,290	365,375	364,662	396,517	342,346	392,192	398,447	294,645	239,866
Vegetables, Fruits & Juices	303,288	285,717	225,572	140,338	122,820	131,847	149,749	129,642	140,914	126,140	145,208
Wine & Vinegar	97,834	123,704	115,807	82,857	86,253	66,946	79,306	92,256	83,374	59,657	61,766

Pi (kt)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Alcohol Refining	17,434	16,969	19,166	20,166	15,286	17,761	16,543	16,553	12,702	11,159	9,135
Beer & Malt	638,216	644,141	631,954	591,520	594,380	733,840	739,817	739,950	97,611	603,157	607,970
Dairy Products	368,976	423,436	410,288	390,053	398,541	408,644	469,448	478,676	468,834	496,932	503,858
Fish Processing	367	470	434	556	245	837	857	925	257	545	227
Meat & Poultry	455,000	481,000	451,000	445,000	460,000	458,000	498,000	492,000	481,000	496,000	502,000
Organic Chemicals	493,954	481,870	584,032	590,327	571,479	587,232	688,068	665,934	237,417	485,963	337,799
Petroleum Refineries	2,060,114	2,601,276	2,564,281	2,734,216	2,599,138	2,486,890	2,443,181	2,412,889	2,258,953	2,009,319	1,775,260
Plastics & Resins	154,771	161,036	140,088	94,926	114,028	102,410	113,655	128,409	107,353	99,692	110,842
Pulp & Paper (combined)	7,271	5,672	3,196	NO	NO	NO	NO	NO	NO	NO	NO
Soap & Detergents	57,597	45,809	68,349	75,911	89,542	101,085	122,128	134,865	143,077	169,395	156,765
Starch Production	46,287	51,355	32,560	22,268	20,663	38,546	39,955	51,417	42,908	33,795	39,226
Sugar Refining	209,475	282,442	222,576	340,000	387,000	430,000	427,000	445,000	433,000	469,000	463,103
Vegetable Oils	203,855	298,055	331,489	302,671	323,647	276,804	229,948	307,228	345,421	257,666	229,012
Vegetables, Fruits & Juices	162,474	173,182	172,267	223,501	258,372	273,563	327,672	343,446	317,708	289,672	291,497
Wine & Vinegar	55,311	44,768	62,489	75,626	35,937	43,253	47,728	44,263	36,501	23,582	22,382

Pi (kt)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Alcohol Refining	7,593	7,588	5,775	6,006	6,460	7,389	7,226	7,143	6,757	7,407	8,023
Beer & Malt	638,064	598,498	592,531	608,753	601,991	614,067	638,032	644,923	604,721	625,788	641,116
Dairy Products	483,587	455,513	452,803	431,845	449,121	455,275	405,956	316,568	447,211	406,679	521,805
Fish Processing	239	200	192	194	50	101	1	2	6	194	6
Meat & Poultry	472,000	463,000	473,000	493,000	523,000	524,000	539,000	538,000	541,000	548,000	546,000
Organic Chemicals	108,687	377,336	270,453	341,226	573,064	NO	NO	NO	NO	NO	NO
Petroleum Refineries	1,526,159	1,937,787	2,105,846	2,393,902	2,482,231	2,658,813	2,874,262	2,678,192	2,705,027	2,959,652	3,428,015
Plastics & Resins	232,714	194,404	174,918	202,198	238,367	160,530	160,185	164,448	158,056	167,950	162,246

Pulp & Paper (combined)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Soap & Detergents	167,224	157,590	152,730	157,619	152,988	162,256	171,056	157,710	190,791	223,789	234,013
Starch Production	32,919	32,836	75,188	97,779	102,665	19,451	24,942	25,529	27,359	70,848	86,715
Sugar Refining	402,593	508,452	545,957	329,440	536,121	528,417	361,746	247,194	330,046	328,879	235,300
Vegetable Oils	247,709	236,567	262,232	274,342	535,374	558,161	563,288	629,254	562,635	500,245	544,772
Vegetables, Fruits & Juices	316,186	331,236	333,847	388,661	366,771	414,404	480,440	449,707	412,911	423,274	423,274
Wine & Vinegar	21,740	22,827	19,623	23,863	35,665	32,950	29,225	27,543	21,190	20,662	17,796

Pi (kt)	2023
Alcohol Refining	7,052
Beer & Malt	656,279
Dairy Products	455,093
Fish Processing	10
Meat & Poultry	549,000
Organic Chemicals	NO
Petroleum Refineries	3,261,471
Plastics & Resins	161,542
Pulp & Paper (combined)	NO
Soap & Detergents	199,876
Starch Production	78,387
Sugar Refining	296,511
Vegetable Oils	563,874
Vegetables, Fruits & Juices	404,719
Wine & Vinegar	18,428

- Chemical Oxygen Demand (COD_i), wastewater generated (W_i)

Default values recommended in the 2006 IPCC Guidelines are applied in the Serbian inventory.

Table 65: Chemical Oxygen Demand (COD_i) and Wastewater generated (W_i), per product type

Industrial sector (i)	CODi (kg COC/m³)	Wi (m³/t of product)
Alcohol Refining	11.00	24.00
Beer & Malt	2.90	6.30
Dairy Products	2.70	7.00
Fish Processing	2.50	13.00
Meat & Poultry	4.10	13.00
Organic Chemicals	3.00	67.00
Petroleum Refineries	1.00	0.60
Plastics & Resins	3.70	0.60
Pulp & Paper (combined)	9.00	162.00
Soap & Detergents	0.85	3.00
Starch Production	10.00	9.00
Sugar Refining	3.20	11.00
Vegetable Oils	0.85	3.10
Vegetables, Fruits y& Juices	5.00	20.00
Wine & Vinegar	1.50	23.00

- Degree of utilisation of treatment/discharge pathway or system (T_j)

All industrial wastewater, whatever is the industrial sector, is considered as discharged in water bodies without treatment.

Table 66: Correction factor for additional industrial BOD, per treatment/discharge system

Treatment/discharge system	BOD
Wastewater treatment plants well managed	1.25
Wastewater treatment plants not well managed	1.25
Anaerobic shallow lagoons	1
Anaerobic deep lagoons	1
Discharge of treated wastewater	1.25
Direct discharge (Untreated)	1
Septic tanks	1
Latrine	1
Flowing sewer (open or closed)	1.25
Stagnant sewer	1.25

7.3.2.2.2 Organic component removed as sludge (S_i)

In absence of data, the default value recommended in the 2006 IPCC Guidelines (0) is applied in the Serbian inventory.

7.3.2.2.3 Emission factor (EF)

Emission factor for domestic wastewater is estimated using the equation 6.2 of the 2006 IPCC Guidelines.

- Methane Correction factor (MCF)

In the Serbian inventory, the default value of 0.1 recommended in the 2006 IPCC Guidelines is applied to the direct discharge.

- Maximum CH_4 producing capacity (B_0)

In the Serbian inventory, the default value **recommended** in the 2006 IPCC Guidelines (0.25 kg CH_4/kg COD) is applied.

7.3.2.2.4 Amount of CH_4 recovered (R_i)

In absence of national data, the default value recommended in the 2006 IPCC Guidelines (0) is applied in the Serbian inventory.

7.3.3 Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts to 50%, based on expert judgment.

Uncertainty estimates associated with emission factor amount to 50% for CH_4 and 100% for N_2O, based on 2006 IPCC Guidelines (Volume 5, Chapter 6, Table 6.11).

Hence, combined uncertainties for emissions are 71% for CH_4 and 112% for N_2O. The uncertainties combined in the total national emissions, excluding LULUCF contribution, in 2023, are of 0.9% and 0.16%, for CH_4 and N_2O, respectively, in the Republic of Serbia.

7.3.4 Category-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 keys in the CRT tables.

7.3.5 Category-specific recalculations

The following recalculations were made between the first National Inventory Report for Serbia (submission of November 2024) and the present document:

PRG	unité	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Ancien	kt CO2e	1 253	918	954	941	919	895	855	891	877	883	918	832	827	817	812	807	791	0
Nouveau	kt CO2e	1 253	918	954	941	919	895	855	891	877	883	918	832	827	817	812	807	791	786
Différence	kt CO2e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+786
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-

Source Serbia / mars_2025 Recalculations_CRT.xlsm /5.D

- The Fraction connected to wastewater treatment plants (%) for rural areas was updated based on revised 2018 data.
- The N_2O emission factor (g N_2O/person/year) was corrected for 2022 to reflect more accurate emission estimates.
    - Data for industrial wastewater were updated for 2022, including corrections for Vegetables, Fruits & Juices processing data as well as for wine production activity data.

7.3.6 Category-specific planned improvements

Concerning wastewater treatment, the planned improvements deal mainly with the historical trends of the country-specific parameters, especially concerning the following aspects:

- improve the historical trend of the parameters considered as constant over the timeseries (degree of utilisation of treatment/discharge pathway or system, degree of utilisation of modern centralized WWTP, fraction of urban/rural population, protein consumption).
- Improve the estimations using 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Chapter 8: Other

Serbia has no additional information on emissions to add in this chapter.

Chapter 9: Indirect CO_2 and N_2O emissions

9.1. Description of sources of indirect emissions in GHG inventory

Following an EU WG1 recommendation, indirect emissions of CO_2 from NMVOC of solvents are accounted for as indirect CO_2, for which emission estimations and methodologies are presented in chapter 4.5.3.

No indirect emissions of N_2O are estimated in the Serbian inventory, except those of agricultural soils, which are directly estimated and presented in the agriculture sector (CRT 3, see chapter 5.4.2).

9.2. Methodological issues

See chapter 4.5.3.1 for methodologies about indirect CO_2 from Solvent use (CRT 2D3).

9.3. Uncertainties and time-series consistency

See chapter 4.5.3.2 for uncertainties about indirect CO_2 from Solvent use (CRT 2D3).

9.4. Category-specific QA/QC and verification

See chapter 4.5.5 for QA/QC about indirect CO_2 from Solvent use (CRT 2D3).

9.5 Category-specific recalculations

See chapter 4.5.6 for recalculations about indirect CO_2 from Solvent use (CRT 2D3).

9.6. Category-specific planned improvements

See chapter 4.5.7 for improvements about indirect CO_2 from Solvent use (CRT 2D3).

Chapter 10: Recalculations and improvements

Recalculations were made between the first National Inventory Report for Serbia and the present document. A summary is given in the following table.

Table 67: Summary of major methodological modifications and recalculations

Member State:	Serbia		
Reporting year:	2025		
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please **mark the relevant cell** where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	Please **mark the relevant cell** where this is also reflected in recalculations compared to the previous years' CRT	If the cell is marked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed.
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (sectoral approach)			
1. Energy industries	x	x	The natural gas consumptions from oil refining (1A1b), which are estimated separately from energy balance, are now subtracted to total consumptions from energy transformation: impact on CRT 1A1a, decrease of -100 kt CO2 in 1990 and -300 kt CO2 in 2022 (see section 3.2.5.6) For 2011-2022, the emissions which were estimated for solid biomass consumption in manufacture of solid fuels (CRT 1A1c) are now considered as NEU for charcoal production in CRT 1B1b (see section 3.2.5.6)
2. Manufacturing industries and construction		x	
3. Transport			
4. Other sector	x	x	CRT 1A4b: addition of other kerosene consumptions from energy balances for 1990-2007 which were omitted before: increase of CO_2 emissions of +156 kt CO_2 in 1990) (see section 3.2.8.6)
5. Other			
B. Fugitive emissions from fuels			
1. Solid fuels	x	x	For 2011-2022, the emissions which were estimated for solid biomass consumption in manufacture of solid fuels (CRT 1A1c) are now considered as NEU for charcoal production in CRT 1B1b (see section 3.3.5)
2. Oil and natural gas and other emissions from energy production			
C. CO2 transport and storage			
2. Industrial processes and product use			
A. Mineral industry			
B. Chemical industry		x	For the year 2021, activity data for methanol production has been significantly increased (+89 kt CO_2) (see section 4.3.7)
C. Metal industry			
D. Non-energy products from fuels and solvent use	x	x	The CO_2 emissions from solvent use (2D3) have now been considered as indirect CO_2 and reported as such (see section 4.5.6)
E. Electronic industry			
F. Product uses as substitutes for ODS			

G. Other product manufacture and use			
H. Other			
3. Agriculture			
A. Enteric fermentation			
B. Manure management			
C. Rice cultivation			
D. Agricultural soils		x	Significant change in the activity data which was incorrect before: impact of +900 kt CO_2e in 1990 down progressively to 500 kt CO_2e (see section 5.4.5)
E. Prescribed burning of savannahs			
F. Field burning of agricultural residues			
G. Liming			
H. Urea application			
I. Other carbon containing fertilisers			
J. Other			
4. Land use, land-use change and forestry			
A. Forest land		x	For the year 2022, corrections made to the stock variations (increase of +101 kt CO_2) (see section 6.5.5)
B. Cropland			
C. Grassland			
D. Wetlands			
E. Settlements			
F. Other land			
G. Harvested wood products			
H. Other			
5. Waste			
A. Solid waste disposal			
B. Biological treatment of solid waste			
C. Incineration and open burning of waste			
D. Wastewater treatment and discharge			
E. Other			
6. Other (as specified in Summary 1.A)			

10.1 Explanations and justifications for recalculations, including in response to the review process

For each submission, different modifications can be applied to the GHG inventory emissions, which could of two kinds: methodological or statistical (activity data).

The reasons can be different:

- Improvement and refinement of methodologies through new developed guidelines;
- Improvement and refinement of methodologies through specific data or higher Tier methodology implementation (i.e., bottom-up approach);
- Change in historical national statistics or delivery of statistics with one year of difference;
- Change in methodologies after UNFCCC and EU reviews;
- Corrections of errors;
- Inclusion of new emission source.

An improvement plan has been developed and is updated after each submission.

Methodological changes in the GHG inventory are implemented for the whole timeseries, since 1990, the reference year of the emission inventory, in order to ensure consistency for the whole studied period.

The different revisions implemented are described in each sectoral chapter (chapters 3 to 9). A specific file is developed to compare the emissions between two submissions, is named “Recalculations_CRT.xlsx” and serve as the basis for those sectoral comparisons. Comparisons are made between the two last submissions, which is to say the submission for November 2024 and the one in March 2025.

10.2Implications for emission and removal levels

The following table provides the difference in emissions and removals between the latest inventory submission (November 2024) and the actual one (March 2025) for national totals.

In summary, the main changes are as follows:

- For CO_2 without LULUCF, the changes in emission which have been realized in order to improve the reference approach (i.e., consistency with energy balances) imply rather marginal changes in national totals: +0.2% in 1990 and -0.6% in 2022. This is mainly due to the inclusion of other kerosene consumptions in residential heating for 1990-2007, whereas some natural gas consumptions from petroleum refining have been subtracted to the energy balances (impact in the CRT 1A1a) for the whole timeseries, but with an impact more important in the latest years;

- For CO_2 with LULUCF, the only change which has been realized is the change in the Forest land (CRT 4A) about the stock variations, which impacts only the emissions in 2022;

- For CH_4, the national totals have been barely revised between the two last submissions;

- The emissions of N_2O have been the ones with the most significant recalculations between the last submissions, related to the change of activity data for animal manure applied to soils (CRT 3D1ai, cf. section 5.4.5). The impact is significant for the whole timeseries, with +35% on national totals in 1990 and +21% in 2022;

- The emissions of fluorinated gases (HFC, PFC, SF_6 and NF_3) have only been revised for HFCs from CRT 2F1 in 2022 after the correction of an error, which is rather marginal on national totals (-5%);

- Finally, for the total GHG, the impact is rather significant, in particular due to the changes in N_2O from agricultural soils, and the emission totals from 1990 have increased by 1.3% whereas the ones for 2022 have increased by 0.4%.

Table 68: Emission differences due to recalculations between this new inventory submission and the former one

			1990	2005	2022
CO2 with LULUCF	Former	kt CO2e	66 297	50 304	46 876
	New	kt CO2e	66 436	50 324	46 647
	Difference	kt CO2e	+140	+19	-228
		%	+0,2%	+0,0%	-0,5%
CO2 without LULUCF	Former	kt CO2e	67 747	56 548	51 446
	New	kt CO2e	67 887	56 567	51 117
	Difference	kt CO2e	+140	+19	-329
		%	+0,2%	+0,0%	-0,6%
CH4	Former	kt CO2e	12 308	9 082	8 718
	New	kt CO2e	12 309	9 082	8 720
	Difference	kt CO2e	+0,81	+0,25	+1,8
		%	+0,0%	+0,0%	+0,0%
N2O	Former	kt CO2e	2 515	3 415	2 216
	New	kt CO2e	3 396	4 089	2 686
	Difference	kt CO2e	+881	+673	+470
		%	+35%	+20%	+21%
GazF	Former	kt CO2e	136	56	213
	New	kt CO2e	136	56	202
	Difference	kt CO2e	0	0	-11
		%	0%	0%	-5,1%
GHG	Former	kt CO2e	81 255	62 858	58 023
	New	kt CO2e	82 277	63 551	58 256
	Difference	kt CO2e	+1 022	+693	+233
		%	+1,3%	+1,1%	+0,4%

10.3 Implications for emission and removal trends, including time-series consistency

In terms of GHG emission and removal trends, the following changes have been observed between the two last GHG emission inventory submissions:

- In this new submission, the total net GHG emissions differ from about 0.6% compared to the previous evolution, as all emission have been increased but more significantly in 1990 than in 2022 (-29.2% in current submission compared with -28.6% in the last one);

- The evolution of N_2O emissions have been observed to change the most significantly, with -20.9% in the national totals in the new submission, between 1990 and 2022, compared with -11.9% in the former submission;

- The national emission trend for fluorinated gases has also change significantly with +48.5% in the new submission for the period 1990-2022, compared with +56.4% in the former one, but this is rather marginal in the national GHG totals;

- Finally, the trend for the emissions of CO_2, which are the more preponderant in the national GHG totals, has changed slightly for the period 1990-2022, by 0.5% for the net CO_2 emissions (29.8% in the new submission compared with 29.3% in the former one).

Table 69: Relative emission changes between this new inventory submission and the former one

			2022 / 1990
CO2 with LULUCF	Former	kt CO2e	-29,3%
	New	kt CO2e	-29,8%
CO2 without LULUCF	Former	kt CO2e	-24,1%
	New	kt CO2e	-24,7%
CH4	Former	kt CO2e	-29,2%
	New	kt CO2e	-29,2%
N2O	Former	kt CO2e	-11,9%
	New	kt CO2e	-20,9%
GazF	Former	kt CO2e	56,4%
	New	kt CO2e	48,5%
GHG	Former	kt CO2e	-28,6%
	New	kt CO2e	-29,2%

10.4 Areas of improvement and/or capacity building in response to the review process

As the Serbian inventory and NID have not been reviewed officially yet, this chapter is not applicable to this submission.

Annex 1: Key categories from CRT Reporter

Table 70: Key Source Categories for the latest reported year (including and excluding LULUCF) – CRT Reporter

TABLE 7 SUMMARY OVERVIEW FOR KEY CATEGORIES

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2023

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Threshold used in identifying key categories [(1)]: 95%

KEY CATEGORIES OF EMISSIONS AND REMOVALS [(2)]	Gas	Criteria used for key source		Key category excluding LULUCF	Key category including LULUCF
		L	T		
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	X	X	X	X
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	X	X	X	X
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	X	X	X	X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	X	X	X	X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	X	X	X	X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	X	X	X	X
1.A.3.b Road Transportation	CO_2	X	X	X	X
1.A.4 Other Sectors - Liquid Fuels	CO_2	X	X	X	X
1.A.4 Other Sectors - Solid Fuels	CO_2	X	X	X	X
1.A.4 Other Sectors - Gaseous Fuels	CO_2	X	X	X	X
1.A.4 Other Sectors - Biomass	CH_4	X	X	X	X
1.B.1 Fugitive emissions from Solid Fuels	CH_4	X	X	X	X
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH_4	X		X	X
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CO_2		X	X	X
2.A.1 Cement Production	CO_2	X	X	X	X
2.A.2 Lime Production	CO_2		X	X	X
2.C.1 Iron and Steel Production	CO_2	X	X	X	X
2.F.1 Refrigeration and Air conditioning	Aggregate F-gases		X	X	X
3.A Enteric Fermentation	CH_4	X	X	X	X
3.B Manure Management	CH_4	X	X	X	X
3.B Manure Management	N_2O		X	X	X
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	X	X	X	X
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	X	X	X	X
3.H Urea Application	CO_2		X	X	X
4.A.1 Forest Land Remaining Forest Land	CO_2	X	X		X
4.A.2 Land Converted to Forest Land	CO_2		X		X
4.C.2 Land Converted to Grassland	CO_2		X		X
4.E.2 Land Converted to Settlements	CO_2		X		X
5.A Solid Waste Disposal	CH_4	X	X	X	X
5.D Wastewater Treatment and Discharge	CH_4	X	X	X	X

(1) In accordance with decision 18/CMA1 paragraph 25, those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead identify key categories using a threshold no lower than 85 per cent in place of the 95 per cent threshold defined in the IPCC

(2) This table is filled automatically based on the IPCC approach 1 methodology.

Note: Minimum level of aggregation is needed to protect confidential business and military information, where it would identify particular entity's/entities' confidentia

Note: L = level assessment; T = trend assessment.

Table 71: Key Source Categories for the base year (including and excluding LULUCF) – CRT Reporter

TABLE 7 SUMMARY OVERVIEW FOR KEY CATEGORIES

(Sheet 1 of 1)

1990

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Threshold used in identifying key categories [(1)]: 95%

KEY CATEGORIES OF EMISSIONS AND REMOVALS [(2)]	Gas	Criteria used for key source identification		Key category excluding LULUCF	Key category including LULUCF
		L	T		
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	X		X	X
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	X		X	X
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	X		X	X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	X		X	X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	X		X	X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	X		X	X
1.A.3.b Road Transportation	CO_2	X		X	X
1.A.4 Other Sectors - Liquid Fuels	CO_2	X		X	X
1.A.4 Other Sectors - Solid Fuels	CO_2	X		X	X
1.A.4 Other Sectors - Gaseous Fuels	CO_2	X		X	X
1.B.1 Fugitive emissions from Solid Fuels	CH_4	X		X	X
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH_4	X		X	X
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CO_2	X		X	X
2.A.1 Cement Production	CO_2	X		X	X
2.A.2 Lime Production	CO_2	X			X
2.B.2 Nitric Acid Production	N_2O	X		X	X
2.C.1 Iron and Steel Production	CO_2	X		X	X
3.A Enteric Fermentation	CH_4	X		X	X
3.B Manure Management	CH_4	X		X	X
3.B Manure Management	N_2O	X		X	X
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	X		X	X
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	X			X
4.A.1 Forest Land Remaining Forest Land	CO_2	X			X
5.A Solid Waste Disposal	CH_4	X		X	X
5.D Wastewater Treatment and Discharge	CH_4	X		X	X

Annex 2: Assessment of uncertainty

Table 72: Uncertainty estimates excluding LULUCF, base year to the latest reported year

IPCC Category	Gas	Base year emissions 1990 kt CO2-eq	Latest reported year 2023 kt CO2-eq	Activity data uncertainty 2023 (%)	Emission factor uncertainty 2023 (%)	Combined uncertainty 2023 (%)	Uncertainty combined (%) in the total national emissions excl. LULUCF 2023 (%)	Uncertainty into the trend in total national emissions excl. LULUCF 2023 (%)
1.A.1-Energy Industries/Liquid fuels	CO2	1 901,6	738,0	1	2	2	0,0	0,0
1.A.1-Energy Industries/Liquid fuels	CH4	1,7	0,6	1	100	100	0,0	0,0
1.A.1-Energy Industries/Liquid fuels	N2O	2,9	1,1	1	100	100	0,0	0,0
1.A.1-Energy Industries/Solid fuels	CO2	39 352,5	27 986,3	1	3	3	1,4	0,5
1.A.1-Energy Industries/Solid fuels	CH4	10,4	7,0	1	100	100	0,0	0,0
1.A.1-Energy Industries/Solid fuels	N2O	147,1	99,8	1	100	100	0,2	0,0
1.A.1-Energy Industries/Gaseous fuels	CO2	1 194,0	2 428,0	1	2	2	0,1	0,1
1.A.1-Energy Industries/Gaseous fuels	CH4	0,6	1,2	1	100	100	0,0	0,0
1.A.1-Energy Industries/Gaseous fuels	N2O	0,6	1,1	1	100	100	0,0	0,0
1.A.1-Energy Industries/Other fossil fuels	CO2	0,0	0,0	1	7	7	0,0	0,0
1.A.1-Energy Industries/Other fossil fuels	CH4	0,0	0,0	1	100	100	0,0	0,0
1.A.1-Energy Industries/Other fossil fuels	N2O	0,0	0,0	1	100	100	0,0	0,0
1.A.1-Energy Industries/Biomass	CH4	0,0	0,5	1	100	100	0,0	0,0
1.A.1-Energy Industries/Biomass	N2O	0,0	0,6	1	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Liquid fuels	CO2	4 001,7	1 225,5	2	7	7	0,1	0,2
1.A.2-Manufacturing Industries/Liquid fuels	CH4	3,5	1,2	2	100	100	0,002	0,0
1.A.2-Manufacturing Industries/Liquid fuels	N2O	6,6	2,2	2	100	100	0,0036	0,0
1.A.2-Manufacturing Industries/Solid fuels	CO2	1 525,2	1 521,4	2	7	7	0,2	0,1
1.A.2-Manufacturing Industries/Solid fuels	CH4	3,3	3,7	2	100	100	0,006	0,0
1.A.2-Manufacturing Industries/Solid fuels	N2O	5,9	5,9	2	100	100	0,0096	0,0
1.A.2-Manufacturing Industries/Gaseous fuels	CO2	2 284,4	1 472,9	2	7	7	0,2	0,1
1.A.2-Manufacturing Industries/Gaseous fuels	CH4	1,1	0,7	2	100	100	0,001	0,0
1.A.2-Manufacturing Industries/Gaseous fuels	N2O	1,1	0,7	2	100	100	0,0011	0,0
1.A.2-Manufacturing Industries/Other fossil fuels	CO2	0,0	8,4	2	7	7	0,0	0,0
1.A.2-Manufacturing Industries/Other fossil fuels	CH4	0,0	0,0	2	100	100	0,000	0,0
1.A.2-Manufacturing Industries/Other fossil fuels	N2O	0,0	0,1	2	100	100	0,0001	0,0
1.A.2-Manufacturing Industries/Biomass	CH4	0,0	5,7	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Biomass	N2O	0,0	7,2	2	100	100	0,0	0,0
1.A.3-Transport/Liquid fuels	CO2	4 469,8	7 850,3	5	5	7	0,9	0,7
1.A.3-Transport/Liquid fuels	CH4	30,0	34,3	5	200	200	0,11	0,0
1.A.3-Transport/Liquid fuels	N2O	59,0	106,7	5	200	200	0,343	0,2
1.A.3-Transport/Solid fuels	CO2	1,2	0,0	5	14	15	0,0	0,0
1.A.3-Transport/Solid fuels	CH4	0,0	0,0	5	135	135	0,00	0,0
1.A.3-Transport/Solid fuels	N2O	0,0	0,0	5	150	150	0,000	0,0
1.A.3-Transport/Gaseous fuels	CO2	0,0	51,0	5	5	7	0,0	0,0
1.A.3-Transport/Gaseous fuels	CH4	0,0	2,3	5	200	200	0,01	0,0
1.A.3-Transport/Gaseous fuels	N2O	0,0	0,7	5	200	200	0,002	0,0
1.A.3-Transport/Other fossil fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.3-Transport/Other fossil fuels	CH4	0,0	0,0	0	0	0	0,00	0,0
1.A.3-Transport/Other fossil fuels	N2O	0,0	0,0	0	0	0	0,000	0,0
1.A.3-Transport/Biomass	CH4	0,0	0,0	0	0	0	0,00	0,0
1.A.3-Transport/Biomass	N2O	0,0	0,0	0	0	0	0,000	0,0
1.A.4-Commercial, resid., agriculture.../Liquid fuels	CO2	1 618,0	506,1	10	7	12	0,1	0,1
1.A.4-Commercial, resid., agriculture.../Liquid fuels	CH4	5,8	1,2	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Liquid fuels	N2O	3,2	24,7	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Solid fuels	CO2	2 883,2	1 241,6	10	7	12	0,2	0,2
1.A.4-Commercial, resid., agriculture.../Solid fuels	CH4	8,7	3,5	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Solid fuels	N2O	11,4	4,9	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Gaseous fuels	CO2	2 328,7	1 292,9	10	7	12	0,3	0,2
1.A.4-Commercial, resid., agriculture.../Gaseous fuels	CH4	5,8	3,2	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Gaseous fuels	N2O	1,1	0,6	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Other fossil fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Other fossil fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Other fossil fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Biomass	CH4	411,1	510,7	10	100	100	0,8	0,3
1.A.4-Commercial, resid., agriculture.../Biomass	N2O	51,9	64,4	10	100	100	0,1	0,0
1.A.5-Other (Not specified elsewhere)/Liquid fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Liquid fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Liquid fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Solid fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Solid fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Solid fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Gaseous fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Gaseous fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Gaseous fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Other fossil fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Other fossil fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Other fossil fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Biomass	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Biomass	CO2	0,0	0,0	0	0	0	0,0	0,0

IPCC Category	Gas	Base year emissions 1990 kt CO2-eq	Latest reported year 2023 kt CO2-eq	Activity data uncertainty 2023 (%)	Emission factor uncertainty 2023 (%)	Combined uncertainty 2023 (%)	Uncertainty combined (%) in the total national emissions excl. LULUCF 2023 (%)	Uncertainty into the trend in total national emissions excl. LULUCF 2023 (%)
1.B.1-Fugitive Emissions / Solid Fuels/Solid fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.B.1-Fugitive Emissions / Solid Fuels/Solid fuels	CH4	1 086,9	911,9	5	20	21	0,3	0,1
1.B.1-Fugitive Emissions / Solid Fuels/Solid fuels	N2O	0,0	0,1	5	20	21	0,0	0,0
1.B.2-Fugitive Emissions from Fuels / Oil/Liquid fuels	CO2	1 453,2	2,0	10	2	10	0,0	0,0
1.B.2-Fugitive Emissions from Fuels / Oil/Liquid fuels	CH4	1 064,0	801,8	10	100	100	1,3	0,1
1.B.2-Fugitive Emissions from Fuels / Oil/Liquid fuels	N2O	6,0	0,0	10	100	100	0,0	0,0
1.B.2-Fugitive Emissions / Natural gas/Gaseous fuels	CO2	45,1	22,1	10	2	10	0,0	0,0
1.B.2-Fugitive Emissions / Natural gas/Gaseous fuels	CH4	465,8	322,6	10	100	100	0,5	0,1
1.B.2-Fugitive Emissions / Natural gas/Gaseous fuels	N2O	0,0	0,0	10	100	100	0,0	0,0
2.A-Mineral industry /-	CO2	2 023,8	1 586,1	2	2	3	0,1	0,1
2.B-Chemical industry/-	CO2	788,2	237,1	5	6	8	0,0	0,0
2.B-Chemical industry/-	CH4	19,6	10,2	2	2	3	0,0	0,0
2.B-Chemical industry/-	N2O	563,4	0,0	2	40	40	0,0	0,2
2.C-Metal industry/-	CO2	1 726,8	2 612,2	10	25	27	1,1	0,4
2.C-Metal industry/-	CH4	0,0	0,0	10	25	27	0,0	0,0
2.C-Metal industry/-	SF6	136,0	0,0	20	5	21	0,0	0,0
2.D-Non-energy products from fuels and solvent use /-	CO2	194,0	38,5	15	50	52	0,0	0,1
2.F-Product uses as substitutes for ODS/-	HFC	0,0	148,7	20	20	28	0,1	0,1
2.G-Other Product manufacture and Use/-	SF6	0,0	5,6	1	30	30	0,0	0,0
3.A-Enteric Fermentation/-	CH4	4 090,4	2 077,6	20	40	45	1,5	0,5
3.B-Manure Management/-	CH4	822,4	433,6	20	30	36	0,3	0,1
3.B-Manure Management/-	N2O	650,5	293,5	20	50	54	0,3	0,1
3.D.1-Direct N2O emissions from managed soils/-	N2O	1 179,1	1 313,1	5	28	28	0,6	0,1
3.D.2-Indirect N2O Emissions from managed soils /-	N2O	537,1	514,9	5	101	101	0,8	0,1
3.F-Field burning of agricultural residues/-	CH4	85,9	81,8	30	100	104	0,14	0,0
3.F-Field burning of agricultural residues/-	N2O	21,1	20,1	30	100	104	0,03	0,0
3.G-Liming/-	CO2	0,0	0,0	0	0	0	0,0	0,0
3.H-Urea application/-	CO2	32,2	189,6	5	50	50	0,2	0,1
4.A-Forest Land/-	CO2	-2 023,1	-5 219,3	10	20	22		
4.A-Forest Land/-	CH4	7,5	4,5	10	100	100		
4.A-Forest Land/-	N2O	3,9	2,4	10	100	100		
4.B-Cropland/-	CO2	18,6	43,1	10	40	41		
4.B-Cropland/-	N2O	0,0	2,8	10	100	100		
4.C-Grassland/-	CO2	339,3	0,6	10	50	51		
4.C-Grassland/-	CH4	5,7	1,2	10	100	100		
4.C-Grassland/-	N2O	9,4	1,0	10	100	100		
4.D-Wetlands/-	CO2	170,0	65,2	10	70	71		
4.D-Wetlands/-	N2O	9,0	3,7	10	100	100		
4.E-Settlements/-	CO2	70,5	147,4	10	30	32		
4.E-Settlements/-	N2O	2,6	2,8	10	100	100		
4.F-Other Land/-	CO2	24,0	102,7	10	80	81		
4.F-Other Land/-	N2O	1,0	2,7	0	0	0		
4.G-Harvested Wood Products/-	CO2	-50,2	-149,2	10	100	100		
5.A-Solid Waste Disposal on Land/-	CH4	3 047,3	2 481,0	30	175	178	7,1	0,5
5.D-Wastewater treatment and discharge/-	CH4	1 131,1	703,9	50	50	71	0,80	0,1
5.D-Wastewater treatment and discharge/-	N2O	122,0	82,6	50	100	112	0,15	0,0
indirect CO2-indirect CO2/-	CO2	63,7	46,1	15	50	52	0,04	0,0
						Incertitude sur les émissions totales	**7,8**	**1,3**

Table 73: Uncertainty estimates including LULUCF, base year to the latest reported year

IPCC Category	Gas	Base year emissions 1990 kt CO2-eq	Latest reported year 2023 kt CO2-eq	Activity data uncertainty 2023 (%)	Emission factor uncertainty 2023 (%)	Combined uncertainty 2023 (%)	Uncertainty combined (%) in the total national emissions incl. LULUCF 2023 (%)	Uncertainty into the trend in total national emissions incl. LULUCF 2023 (%)
1.A.1-Energy Industries/Liquid fuels	CO2	1 901,6	738,0	1	2	2	0,0	0,0
1.A.1-Energy Industries/Liquid fuels	CH4	1,7	0,6	1	100	100	0,0	0,0
1.A.1-Energy Industries/Liquid fuels	N2O	2,9	1,1	1	100	100	0,0	0,0
1.A.1-Energy Industries/Solid fuels	CO2	39 352,5	27 986,3	1	3	3	1,5	0,5
1.A.1-Energy Industries/Solid fuels	CH4	10,4	7,0	1	100	100	0,0	0,0
1.A.1-Energy Industries/Solid fuels	N2O	147,1	99,8	1	100	100	0,2	0,0
1.A.1-Energy Industries/Gaseous fuels	CO2	1 194,0	2 428,0	1	2	2	0,1	0,1
1.A.1-Energy Industries/Gaseous fuels	CH4	0,6	1,2	1	100	100	0,0	0,0
1.A.1-Energy Industries/Gaseous fuels	N2O	0,6	1,1	1	100	100	0,0	0,0
1.A.1-Energy Industries/Other fossil fuels	CO2	0,0	0,0	1	7	7	0,0	0,0
1.A.1-Energy Industries/Other fossil fuels	CH4	0,0	0,0	1	100	100	0,0	0,0
1.A.1-Energy Industries/Other fossil fuels	N2O	0,0	0,0	1	100	100	0,0	0,0
1.A.1-Energy Industries/Biomass	CH4	0,0	0,5	1	100	100	0,0	0,0
1.A.1-Energy Industries/Biomass	N2O	0,0	0,6	1	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Liquid fuels	CO2	4 001,7	1 225,5	2	7	7	0,2	0,1
1.A.2-Manufacturing Industries/Liquid fuels	CH4	3,5	1,2	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Liquid fuels	N2O	6,6	2,2	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Solid fuels	CO2	1 525,2	1 521,4	2	7	7	0,2	0,1
1.A.2-Manufacturing Industries/Solid fuels	CH4	3,3	3,7	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Solid fuels	N2O	5,9	5,9	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Gaseous fuels	CO2	2 284,4	1 472,9	2	7	7	0,2	0,1
1.A.2-Manufacturing Industries/Gaseous fuels	CH4	1,1	0,7	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Gaseous fuels	N2O	1,1	0,7	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Other fossil fuels	CO2	0,0	8,4	2	7	7	0,0	0,0
1.A.2-Manufacturing Industries/Other fossil fuels	CH4	0,0	0,0	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Other fossil fuels	N2O	0,0	0,1	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Biomass	CH4	0,0	5,7	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Biomass	N2O	0,0	7,2	2	100	100	0,0	0,0
1.A.3-Transport/Liquid fuels	CO2	4 469,8	7 850,3	5	5	7	1,0	0,7
1.A.3-Transport/Liquid fuels	CH4	30,0	34,3	5	200	200	0,1	0,0
1.A.3-Transport/Liquid fuels	N2O	59,0	106,7	5	200	200	0,4	0,2
1.A.3-Transport/Solid fuels	CO2	1,2	0,0	5	14	15	0,0	0,0
1.A.3-Transport/Solid fuels	CH4	0,0	0,0	5	135	135	0,0	0,0
1.A.3-Transport/Solid fuels	N2O	0,0	0,0	5	150	150	0,0	0,0
1.A.3-Transport/Gaseous fuels	CO2	0,0	51,0	5	5	7	0,0	0,0
1.A.3-Transport/Gaseous fuels	CH4	0,0	2,3	5	200	200	0,0	0,0
1.A.3-Transport/Gaseous fuels	N2O	0,0	0,7	5	200	200	0,0	0,0
1.A.3-Transport/Other fossil fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.3-Transport/Other fossil fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.3-Transport/Other fossil fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.3-Transport/Biomass	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.3-Transport/Biomass	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Liquid fuels	CO2	1 618,0	506,1	10	7	12	0,1	0,1
1.A.4-Commercial, resid., agriculture.../Liquid fuels	CH4	5,8	1,2	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Liquid fuels	N2O	3,2	24,7	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Solid fuels	CO2	2 883,2	1 241,6	10	7	12	0,3	0,2
1.A.4-Commercial, resid., agriculture.../Solid fuels	CH4	8,7	3,5	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Solid fuels	N2O	11,4	4,9	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Gaseous fuels	CO2	2 328,7	1 292,9	10	7	12	0,3	0,2
1.A.4-Commercial, resid., agriculture.../Gaseous fuels	CH4	5,8	3,2	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Gaseous fuels	N2O	1,1	0,6	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Other fossil fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Other fossil fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Other fossil fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture.../Biomass	CH4	411,1	510,7	10	100	100	0,9	0,3
1.A.4-Commercial, resid., agriculture.../Biomass	N2O	51,9	64,4	10	100	100	0,1	0,0
1.A.5-Other (Not specified elsewhere)/Liquid fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Liquid fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Liquid fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Solid fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Solid fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Solid fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Gaseous fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Gaseous fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Gaseous fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Other fossil fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Other fossil fuels	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Other fossil fuels	N2O	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Biomass	CH4	0,0	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Biomass	CO2	0,0	0,0	0	0	0	0,0	0,0

IPCC Category	Gas	Base year emissions 1990 kt CO2-eq	Latest reported year 2023 kt CO2-eq	Activity data uncertainty 2023 (%)	Emission factor uncertainty 2023 (%)	Combined uncertainty 2023 (%)	Uncertainty combined (%) in the total national emissions incl. LULUCF 2023 (%)	Uncertainty into the trend in total national emissions incl. LULUCF 2023 (%)
1.B.1-Fugitive Emissions / Solid Fuels/Solid fuels	CO2	0,0	0,0	0	0	0	0,0	0,0
1.B.1-Fugitive Emissions / Solid Fuels/Solid fuels	CH4	1 086,9	911,9	5	20	21	0,3	0,1
1.B.1-Fugitive Emissions / Solid Fuels/Solid fuels	N2O	0,0	0,1	5	20	21	0,0	0,0
1.B.2-Fugitive Emissions from Fuels / Oil/Liquid fuels	CO2	1 453,2	2,0	10	2	10	0,0	0,0
1.B.2-Fugitive Emissions from Fuels / Oil/Liquid fuels	CH4	1 064,0	801,8	10	100	100	1,4	0,2
1.B.2-Fugitive Emissions from Fuels / Oil/Liquid fuels	N2O	6,0	0,0	10	100	100	0,0	0,0
1.B.2-Fugitive Emissions / Natural gas/Gaseous fuels	CO2	45,1	22,1	10	2	10	0,0	0,0
1.B.2-Fugitive Emissions / Natural gas/Gaseous fuels	CH4	465,8	322,6	10	100	100	0,6	0,1
1.B.2-Fugitive Emissions / Natural gas/Gaseous fuels	N2O	0,0	0,0	10	100	100	0,0	0,0
2.A-Mineral industry /-	CO2	2 023,8	1 586,1	2	2	3	0,1	0,1
2.B-Chemical industry/-	CO2	788,2	237,1	5	6	8	0,0	0,0
2.B-Chemical industry/-	CH4	19,6	10,2	2	2	3	0,0	0,0
2.B-Chemical industry/-	N2O	563,4	0,0	2	40	40	0,0	0,2
2.C-Metal industry/-	CO2	1 726,8	2 612,2	10	25	27	1,2	0,5
2.C-Metal industry/-	CH4	0,0	0,0	10	25	27	0,0	0,0
2.C-Metal industry/-	SF6	136,0	0,0	20	5	21	0,0	0,0
2.D-Non-energy products from fuels and solvent use /-	CO2	194,0	38,5	15	50	52	0,0	0,1
2.F-Product uses as substitutes for ODS/-	HFC	0,0	148,7	20	20	28	0,1	0,1
2.G-Other Product manufacture and Use/-	SF6	0,0	5,6	1	30	30	0,0	0,0
3.A-Enteric Fermentation/-	CH4	4 090,4	2 077,6	20	40	45	1,6	0,4
3.B-Manure Management/-	CH4	822,4	433,6	20	30	36	0,3	0,1
3.B-Manure Management/-	N2O	650,5	293,5	20	50	54	0,3	0,1
3.D.1-Direct N2O emissions from managed soils/-	N2O	1 179,1	1 313,1	5	28	28	0,6	0,2
3.D.2-Indirect N2O Emissions from managed soils /-	N2O	537,1	514,9	5	101	101	0,9	0,2
3.F-Field burning of agricultural residues/-	CH4	85,9	81,8	30	100	104	0,1	0,0
3.F-Field burning of agricultural residues/-	N2O	21,1	20,1	30	100	104	0,0	0,0
3.G-Liming/-	CO2	0,0	0,0	0	0	0	0,0	0,0
3.H-Urea application/-	CO2	32,2	189,6	5	50	50	0,2	0,1
4.A-Forest Land/-	CO2	-2 023,1	-5 219,3	10	20	22	2,0	1,0
4.A-Forest Land/-	CH4	7,5	4,5	10	100	100	0,0	0,0
4.A-Forest Land/-	N2O	3,9	2,4	10	100	100	0,0	0,0
4.B-Cropland/-	CO2	18,6	43,1	10	40	41	0,0	0,0
4.B-Cropland/-	N2O	0,0	2,8	10	100	100	0,0	0,0
4.C-Grassland/-	CO2	339,3	0,6	10	50	51	0,0	0,1
4.C-Grassland/-	CH4	5,7	1,2	10	100	100	0,0	0,0
4.C-Grassland/-	N2O	9,4	1,0	10	100	100	0,0	0,0
4.D-Wetlands/-	CO2	170,0	65,2	10	70	71	0,1	0,0
4.D-Wetlands/-	N2O	9,0	3,7	10	100	100	0,0	0,0
4.E-Settlements/-	CO2	70,5	147,4	10	30	32	0,1	0,0
4.E-Settlements/-	N2O	2,6	2,8	10	100	100	0,0	0,0
4.F-Other Land/-	CO2	24,0	102,7	10	80	81	0,1	0,1
4.F-Other Land/-	N2O	1,0	2,7	0	0	0	0,0	0,0
4.G-Harvested Wood Products/-	CO2	-50,2	-149,2	10	100	100	0,3	0,1
5.A-Solid Waste Disposal on Land/-	CH4	3 047,3	2 481,0	30	175	178	7,7	0,8
5.D-Wastewater treatment and discharge/-	CH4	1 131,1	703,9	50	50	71	0,9	0,1
5.D-Wastewater treatment and discharge/-	N2O	122,0	82,6	50	100	112	0,2	0,0
indirect CO2-indirect CO2/-	CO2	63,7	46,1	15	50	52	0,0	0,0
Incertitude sur les émissions totales							8,8	1,8

Table 74: Uncertainty estimates for the base year (including and excluding LULUCF)

IPCC Category/fuels	Gas	Emissions 1990 kt CO2-eq	Activity data uncertainty 1990 (%)	Emission factor uncertainty 1990 (%)	Combined uncertainty 1990 (%)	Uncertainty combined (%) in the total national emissions excl. LULUCF 1990 (%)	Uncertainty combined (%) in the total national emissions incl. LULUCF 1990 (%)
1.A.1-Energy Industries/Liquid fuels	CO2	1 901,6	1	2	2	0,1	0,1
1.A.1-Energy Industries/Liquid fuels	CH4	1,7	1	100	100	0,0	0,0
1.A.1-Energy Industries/Liquid fuels	N2O	2,9	1	100	100	0,0	0,0
1.A.1-Energy Industries/Solid fuels	CO2	39 352,5	1	3	3	1,8	1,5
1.A.1-Energy Industries/Solid fuels	CH4	10,4	1	100	100	0,0	0,0
1.A.1-Energy Industries/Solid fuels	N2O	147,1	1	100	100	0,2	0,2
1.A.1-Energy Industries/Gaseous fuels	CO2	1 194,0	1	2	2	0,0	0,0
1.A.1-Energy Industries/Gaseous fuels	CH4	0,6	1	100	100	0,0	0,0
1.A.1-Energy Industries/Gaseous fuels	N2O	0,6	1	100	100	0,0	0,0
1.A.1-Energy Industries/Other fossil fuels	CO2	0,0	1	7	7	0,0	0,0
1.A.1-Energy Industries/Other fossil fuels	CH4	0,0	1	100	100	0,0	0,0
1.A.1-Energy Industries/Other fossil fuels	N2O	0,0	1	100	100	0,0	0,0
1.A.1-Energy Industries/Biomass	CH4	0,0	1	100	100	0,0	0,0
1.A.1-Energy Industries/Biomass	N2O	0,0	1	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Liquid fuels	CO2	4 001,7	2	7	7	0,4	0,4
1.A.2-Manufacturing Industries/Liquid fuels	CH4	3,5	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Liquid fuels	N2O	6,6	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Solid fuels	CO2	1 525,2	2	7	7	0,2	0,1
1.A.2-Manufacturing Industries/Solid fuels	CH4	3,3	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Solid fuels	N2O	5,9	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Gaseous fuels	CO2	2 284,4	2	7	7	0,2	0,2
1.A.2-Manufacturing Industries/Gaseous fuels	CH4	1,1	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Gaseous fuels	N2O	1,1	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Other fossil fuels	CO2	0,0	2	7	7	0,0	0,0
1.A.2-Manufacturing Industries/Other fossil fuels	CH4	0,0	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Other fossil fuels	N2O	0,0	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Biomass	CH4	0,0	2	100	100	0,0	0,0
1.A.2-Manufacturing Industries/Biomass	N2O	0,0	2	100	100	0,0	0,0
1.A.3-Transport/Liquid fuels	CO2	4 469,8	5	5	7	0,5	0,4
1.A.3-Transport/Liquid fuels	CH4	30,0	5	200	200	0,1	0,1
1.A.3-Transport/Liquid fuels	N2O	59,0	5	200	200	0,2	0,1
1.A.3-Transport/Solid fuels	CO2	1,2	5	14	15	0,0	0,0
1.A.3-Transport/Solid fuels	CH4	0,0	5	135	135	0,0	0,0
1.A.3-Transport/Solid fuels	N2O	0,0	5	150	150	0,0	0,0
1.A.3-Transport/Gaseous fuels	CO2	0,0	5	5	7	0,0	0,0
1.A.3-Transport/Gaseous fuels	CH4	0,0	5	200	200	0,0	0,0
1.A.3-Transport/Gaseous fuels	N2O	0,0	5	200	200	0,0	0,0
1.A.3-Transport/Other fossil fuels	CO2	0,0	0	0	0	0,0	0,0
1.A.3-Transport/Other fossil fuels	CH4	0,0	0	0	0	0,0	0,0
1.A.3-Transport/Other fossil fuels	N2O	0,0	0	0	0	0,0	0,0
1.A.3-Transport/Biomass	CH4	0,0	0	0	0	0,0	0,0
1.A.3-Transport/Biomass	N2O	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Liquid fuels	CO2	1 618,0	10	7	12	0,3	0,2
1.A.4-Commercial, resid., agriculture…/Liquid fuels	CH4	5,8	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Liquid fuels	N2O	3,2	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Solid fuels	CO2	2 883,2	10	7	12	0,5	0,4
1.A.4-Commercial, resid., agriculture…/Solid fuels	CH4	8,7	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Solid fuels	N2O	11,4	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Gaseous fuels	CO2	2 328,7	10	7	12	0,4	0,3
1.A.4-Commercial, resid., agriculture…/Gaseous fuels	CH4	5,8	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Gaseous fuels	N2O	1,1	10	100	100	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Other fossil fuels	CO2	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Other fossil fuels	CH4	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Other fossil fuels	N2O	0,0	0	0	0	0,0	0,0
1.A.4-Commercial, resid., agriculture…/Biomass	CH4	411,1	10	100	100	0,6	0,5
1.A.4-Commercial, resid., agriculture…/Biomass	N2O	51,9	10	100	100	0,1	0,1
1.A.5-Other (Not specified elsewhere)/Liquid fuels	CO2	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Liquid fuels	CH4	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Liquid fuels	N2O	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Solid fuels	CO2	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Solid fuels	CH4	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Solid fuels	N2O	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Gaseous fuels	CO2	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Gaseous fuels	CH4	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Gaseous fuels	N2O	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Other fossil fuels	CO2	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Other fossil fuels	CH4	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Other fossil fuels	N2O	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Biomass	CH4	0,0	0	0	0	0,0	0,0
1.A.5-Other (Not specified elsewhere)/Biomass	CO2	0,0	0	0	0	0,0	0,0

IPCC Category/fuels	Gas	Emissions 1990 kt CO2-eq	Activity data uncertainty 1990 (%)	Emission factor uncertainty 1990 (%)	Combined uncertainty 1990 (%)	Uncertainty combined (%) in the total national emissions excl. LULUCF 1990 (%)	Uncertainty combined (%) in the total national emissions incl. LULUCF 1990 (%)
1.B.1-Fugitive Emissions / Solid Fuels/Solid fuels	CO2	0,0	0	0	0	0,0	0,0
1.B.1-Fugitive Emissions / Solid Fuels/Solid fuels	CH4	1 086,9	5	20	21	0,3	0,3
1.B.1-Fugitive Emissions / Solid Fuels/Solid fuels	N2O	0,0	5	20	21	0,0	0,0
1.B.2-Fugitive Emissions from Fuels / Oil/Liquid fuels	CO2	1 453,2	10	2	10	0,2	0,2
1.B.2-Fugitive Emissions from Fuels / Oil/Liquid fuels	CH4	1 064,0	10	100	100	1,5	1,3
1.B.2-Fugitive Emissions from Fuels / Oil/Liquid fuels	N2O	6,0	10	100	100	0,0	0,0
1.B.2-Fugitive Emissions / Natural gas/Gaseous fuels	CO2	45,1	10	2	10	0,0	0,0
1.B.2-Fugitive Emissions / Natural gas/Gaseous fuels	CH4	465,8	10	100	100	0,7	0,6
1.B.2-Fugitive Emissions / Natural gas/Gaseous fuels	N2O	0,0	10	100	100	0,0	0,0
2.A-Mineral industry /-	CO2	2 023,8	2	2	3	0,1	0,1
2.B-Chemical industry/-	CO2	788,2	5	6	8	0,1	0,1
2.B-Chemical industry/-	CH4	19,6	2	2	3	0,0	0,0
2.B-Chemical industry/-	N2O	563,4	2	40	40	0,3	0,3
2.C-Metal industry/-	CO2	1 726,8	10	25	27	0,7	0,6
2.C-Metal industry/-	CH4	0,0	10	25	27	0,0	0,0
2.C-Metal industry/-	SF6	136,0	20	5	21	0,0	0,0
2.D-Non-energy products from fuels and solvent use /-	CO2	194,0	15	50	52	0,1	0,1
2.F-Product uses as substitutes for ODS/-	HFC	0,0	20	20	28	0,0	0,0
2.G-Other Product manufacture and Use/-	SF6	0,0	1	30	30	0,0	0,0
3.A-Enteric Fermentation/-	CH4	4 090,4	20	40	45	2,6	2,2
3.B-Manure Management/-	CH4	822,4	20	30	36	0,4	0,4
3.B-Manure Management/-	N2O	650,5	20	50	54	0,5	0,4
3.D.1-Direct N2O emissions from managed soils/-	N2O	1 179,1	5	28	28	0,5	0,4
3.D.2-Indirect N2O Emissions from managed soils /-	N2O	537,1	5	101	101	0,8	0,7
3.F-Field burning of agricultural residues/-	CH4	85,9	30	100	104	0,1	0,1
3.F-Field burning of agricultural residues/-	N2O	21,1	30	100	104	0,0	0,0
3.G-Liming/-	CO2	0,0	0	0	0	0,0	0,0
3.H-Urea application/-	CO2	32,2	5	50	50	0,0	0,0
4.A-Forest Land/-	CO2	-2 023,1	10	20	22		0,6
4.A-Forest Land/-	CH4	7,5	10	100	100		0,0
4.A-Forest Land/-	N2O	3,9	10	100	100		0,0
4.B-Cropland/-	CO2	18,6	10	40	41		0,0
4.B-Cropland/-	N2O	0,0	10	100	100		0,0
4.C-Grassland/-	CO2	339,3	10	50	51		0,2
4.C-Grassland/-	CH4	5,7	10	100	100		0,0
4.C-Grassland/-	N2O	9,4	10	100	100		0,0
4.D-Wetlands/-	CO2	170,0	10	70	71		0,1
4.D-Wetlands/-	N2O	9,0	10	100	100		0,0
4.E-Settlements/-	CO2	70,5	10	30	32		0,0
4.E-Settlements/-	N2O	2,6	10	100	100		0,0
4.F-Other Land/-	CO2	24,0	10	80	81		0,0
4.F-Other Land/-	N2O	1,0	0	0	0		0,0
4.G-Harvested Wood Products/-	CO2	-50,2	10	100	100		0,1
5.A-Solid Waste Disposal on Land/-	CH4	3 047,3	30	175	178	7,8	6,6
5.D-Wastewater treatment and discharge/-	CH4	1 131,1	50	50	71	1,1	1,0
5.D-Wastewater treatment and discharge/-	N2O	122,0	50	100	112	0,2	0,2
indirect CO2-indirect CO2/-	CO2	63,7	15	50	52	0,0	0,0
					Incertitude sur les émissions totales	**8,8**	**7,5**

Annex 3: Detailed description of the reference approach (including inputs to the reference approach such as the national energy balance) and the results of the comparison of national estimates of emissions with those obtained using the reference approach

The comparison of the reference approach with the sectoral approach is presented in chapter 3.2.1. The carbon contents (or CO_2 EF) and NCV used are given in chapter 3.2.4.

Annex 4: QA/QC procedures.

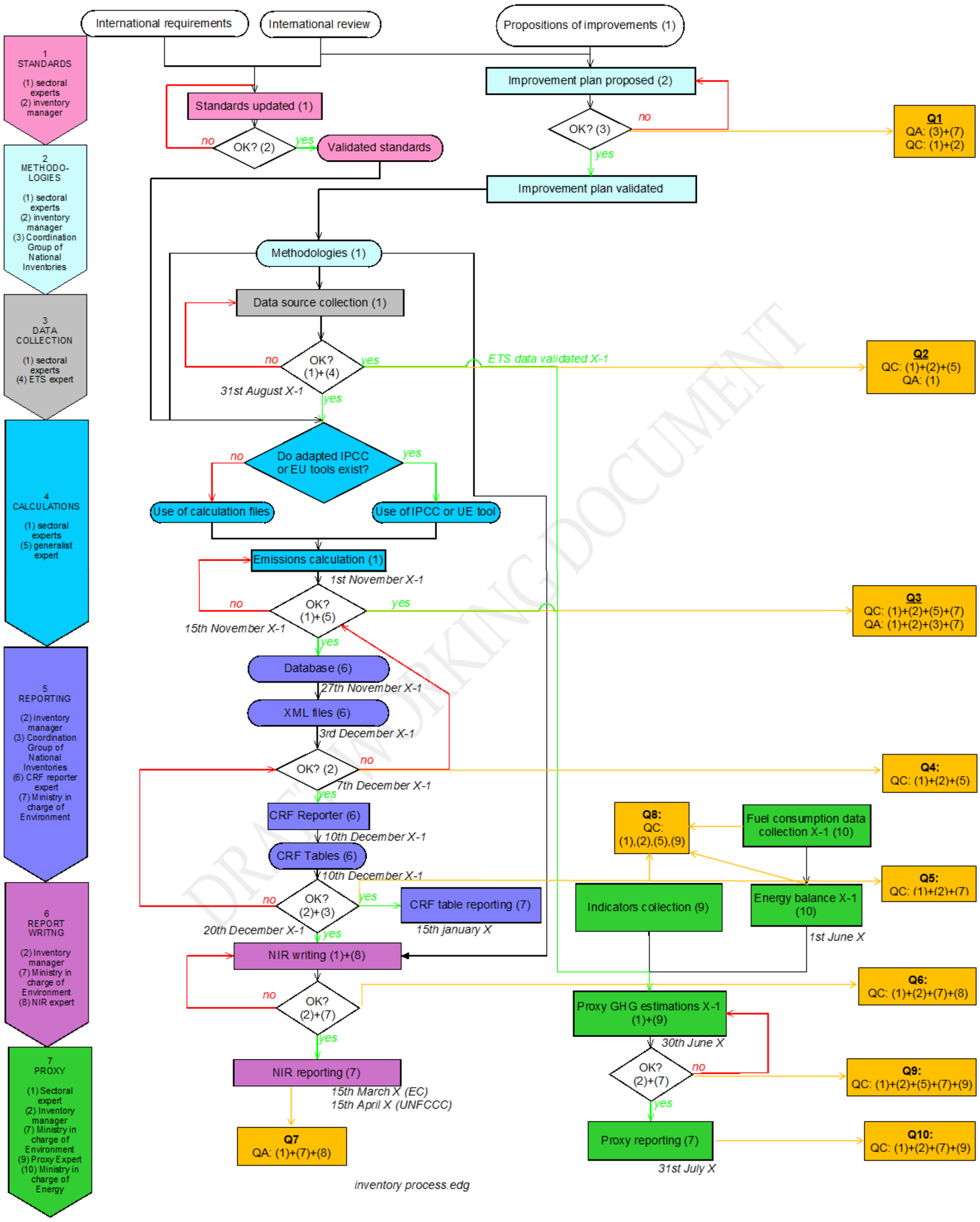
The following table and figure present a list of QA/QC tasks for each actor of the inventory system and for each step of the inventory where each actor needs to intervene. The majority of these tasks are applied, and Serbia will improve its system yearly and tends to fulfil all listed tasks.

Function	Tasks
(1) Sectoral expert	**Q1 Coordination and planning:** - Records the identified errors on the emission calculations; - Documents, analyzes and processes the comments and recommendations of the UNFCCC reviews.
	Q2 Data sources - Is responsible for checking the documentation on assumptions and criteria for the selection of activity data, emission factors, and other estimation parameters; - Is in charge of the verification of data transcription; - Is responsible for the time series consistency; - Is in charge of checking the availability of input data; - Checks the quality of external data; - Records and archives the data sources; - Verifies if external data providers have a QA/QC system.
	Q3 Emissions calculations <u>Tasks for the expert in charge of emission calculation (Calculation files author):</u> - Ensures the consistency between the tool used for calculation and the reporting format required by UNFCCC and EC ; - Compares results with the estimates of the previous inventory; - Compares results of Tier 1 method with Tier 2 method when appropriate; - Clearly displays the unit and the reference of the data used; - Avoids methodological inconsistencies or break in time-series; - Draws graphs showing emissions evolutions and explain significant variations; - Does specific checks when using model or database to estimate the emissions; - Indicates which data are confidential so they are not publicly published; - Records all data which are used to calculate the emissions; - Fills in the follow-up sheet with the name of the author, the description of the actions made for the emission calculations, and the date; - Compares methodologies used by other countries or other organisations with the national ones; - Records the results of the expert peer review and implements actions if needed. <u>Tasks for the expert in charge of calculation verification (Calculation files verifier):</u> - Checks the calculation formulas; - Checks the comparison of the results of Tier 1 and Tier 2 methods (if relevant); - Checks the units used; - Checks if the color code is correctly used (see explanations in the detailed text below); - Checks time series consistency; - Checks the “follow-up” sheet and fills in it with the name of the verifier and the date;

Function	Tasks
(1) Sectoral expert	- Checks if the transversal data used are well updated in compliance with the latest common file done by the generalist expert; - Checks the correct use of confidential notation keys; - Checks that all data which are used to calculate the emissions are recorded and archived; - Checks the implementation of actions coming from the peer reviews; - Fills in the “checklist” sheet.
	Q4 Data reporting <u>Tasks for the calculation files author:</u> - Ensures the completeness of the data exported; - Explains the potential outliers in the database; - Explains the recalculations in the "follow-up" sheet of the calculation file. <u>Tasks for the calculation files verifier:</u> - Checks that the explanations of any changes or recalculations are well recorded as stated in the QA/QC plan.
	Q8/Q9/Q10 Proxy GHG inventories (X-1) - Complies with the current QA/QC procedures for the GHG inventory.
(2) Inventory manager	**Q1 Coordination and planning** - Prepares the QA/QC plan and updates on annual basis; - Ensures the good application of the QA/QC system; - Is responsible for planning and monitoring the QC activities; - Checks and validates the sectoral experts’ answers to the comments and recommendations of the UNFCCC reviews.
	Q2 Data sources - Checks the record of a sample of data sources to verify that they are all archived;
	Q3 Emissions calculations - Implements an automatic calculation procedure which checks that AD x EF = E; - Ensures the consistency between the units used for activity data, emission factors and emissions; - Checks the common file with the common data (e.g. NCVs, number of inhabitants); - Checks the uncertainties estimates; - Archives the calculation files.
	Q4/Q5 Data reporting - Checks consistency between calculation tool and the final reporting products (CRT tables); - Archives all reporting products; - Checks the good import of all data into the database (completeness and date of the import); - Plans trend checks on the database; - Compares the current inventory results vs. the previous one and asks sectoral experts for explaining the potential changes, recalculations to detect potential errors; - Ensures that all recommendations from international reviews have been taken into consideration by the involved sectoral expert;

Function	Tasks
	- Verifies if the complementary information on national emission inventory under the MMR is well fulfilled and updated for the next submission.
(2) Inventory manager	**Q6/Q7 National Inventory Report** - Supports the NID expert in checking and validating the chapters written by other organisations; - Validates the NID; - Archives all information relating to the planning, preparation and management of the NID; - Checks that the tasks of the NID expert are correctly done.
	Q8/Q9/Q10 Proxy GHG inventories (X-1) - Checks that QA/QC procedures are well implemented.
(3) Coordination Group of National Inventories	**Q1 Coordination and planning** - Validates the improvement plan, gives its opinion and approves the methodological changes.
	Q3 Emissions calculations - Gives opinion on the results of estimations produced in the inventories.
(4) ETS expert	**Q5 Data reporting** - ESD template: compares the total CO_2eq emissions filled in the ESD template and the emissions reported under UNFCCC inventory; compares the ETS emissions filled in the ESD template and the official final total of annual ETS emissions transmitted by the Member state to the European Union Register; - Consistency with ETS data: does cross-checks between the data sources and the reported data.
(5) Inventory manager or sectoral experts	**Q2 Data sources** - In charge of the verification of data transcription; - Responsible for the temporal consistency.
	Q3 Emissions calculations - Fills in the follow-up sheet with the name of the verifier and the date for the calculations files checked; - Fills in the checklist sheet for the calculation files checked; - Updates a common file with the common data (e.g. NCVs, number of inhabitants).
(6) CRT reporter expert	**Q4/Q5 Data reporting** - Checks the consistency between export sheets and the XML files in terms of units and sector aggregation (input of the CRT Reporter); - Checks total CO_2eq in the database vs. total CO_2eq in the XML files; - Checks the consistency between the database and the CRT tables produced by the online CRT reporter => plausibility of the implied emission factor in the CRT tables; comparison of total CO_2eq in the CRT tables and the database; checks on a sample of data in one CRT sector; checks the completeness of the notation keys in the CRT tables.

Function	Tasks
(7) Ministry in charge of Environment	**Q1 Coordination and planning:** - Validates the final National Inventory Report; - Checks if mitigation activities/measures have been appropriately reflected in time series calculations.
(7) Ministry in charge of Environment	**Q3 Emissions calculations** - Checks if mitigation activities/measures have been appropriately reflected in time series calculations. - Validates and approves the results of the emissions calculated and transmitted by the national inventory agency.
	Q5 Data reporting - Archives all the products sent to UNFCCC and EC.
	Q6/Q7 National Inventory Report - Approves the NID before the national submission; - Leads audits about the consistency between the document FCCC/CP/2013/10/Add3 and the NID produced.
(8) NID expert	**Q6/Q7 National Inventory Report** - Checks that there is detailed documentation to support the estimations and to enable reproduction of the emissions, removal and uncertainty estimates; - Checks that the timetable is respected and recorded in the NID action plan when a task is realized; - Checks and validates the chapters written by the sectoral experts or other organisations; - Checks if the general structure of the NID is updated regarding the document FCCC/CP/2013/10/Add3; - Archives all the data concerning the NID (inventory data, discussions with the UNFCCC NID/BR/NC expert of MAEP, final version of the NID, exchanges with other countries, etc.).
(9) Proxy expert	**Q8/Q9/Q10 Proxy GHG inventories (X-1)** - Complies with the current QA/QC procedures for the GHG inventory; - Compares the previous proxy (year X-2) and the current estimates done in the inventory for the year X-2 => identifies discrepancies and then identifies proxy methodologies more appropriate (other surrogate parameters).


1 STANDARDS
(1) sectoral experts
(2) inventory manager
2 METHODOLOGIES
(1) sectoral experts
(2) inventory manager
(3) Coordination Group of National Inventories
3 DATA COLLECTION
(1) sectoral experts
(4) ETS expert
4 CALCULATIONS
(1) sectoral experts
(5) generalist expert
5 REPORTING
(2) inventory manager
(3) Coordination Group of National Inventories
(6) CRF reporter expert
(7) Ministry in charge of Environment
6 REPORT WRITING
(2) Inventory manager
(7) Ministry in charge of Environment
(8) NIR expert
7 PROXY
(1) Sectoral expert
(2) Inventory manager
(7) Ministry in charge of Environment
(9) Proxy Expert
(10) Ministry in charge of Energy
International requirements
International review
Propositions of improvements (1)
Improvement plan proposed (2)
OK? (3)
Improvement plan validated
Standards updated (1)
OK? (2)
Validated standards
Q1
QA: (3)+(7)
QC: (1)+(2)
Methodologies (1)
Data source collection (1)
OK? (1)+(4)
31st August X-1
ETS data validated X-1
Q2
QC: (1)+(2)+(5)
QA: (1)
Do adapted IPCC or EU tools exist?
Use of calculation files
Use of IPCC or UE tool
Emissions calculation (1)
1st November X-1
OK? (1)+(5)
15th November X-1
Q3
QC: (1)+(2)+(5)+(7)
QA: (1)+(2)+(3)+(7)
Database (6)
27th November X-1
XML files (6)
3rd December X-1
OK? (2)
7th December X-1
Q4:
QC: (1)+(2)+(5)
CRF Reporter (6)
10th December X-1
CRF Tables (6)
10th December X-1
OK? (2)+(3)
20th December X-1
CRF table reporting (7)
15th january X
Q8:
QC: (1),(2),(5),(9)
Fuel consumption data collection X-1 (10)
Q5:
QC: (1)+(2)+(7)
Indicators collection (9)
Energy balance X-1 (10)
1st June X
NIR writing (1)+(8)
OK? (2)+(7)
Q6:
QC: (1)+(2)+(7)+(8)
Proxy GHG estimations X-1 (1)+(9)
30th June X
OK? (2)+(7)
Q9:
QC: (1)+(2)+(5)+(7)+(9)
NIR reporting (7)
15th March X (EC)
15th April X (UNFCCC)
Proxy reporting (7)
31st July X
Q10:
QC: (1)+(2)+(7)+(9)
Q7
QA: (1)+(7)+(8)
yes
no
inventory process.edg

Annex 5: Any additional information, as applicable, including detailed methodological descriptions of source or sink categories and the national emission balance

All the required information about emission estimation methodologies is presented in the sectoral chapters. Hence, this Annex is kept empty thus far.

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[E11] 2006 IPCC Guidelines, Volume 2 Chapter 3 Table 3.5.2

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Industrial processes (CRT 2)

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[I2] Statistical annual reports, Statistical Office of the Republic of Serbia (SORS), yearly

[I3] 2006 IPCC Guidelines, Volume 3, Chapter 2, equation 2.4

[I4] 2006 IPCC Guidelines, Volume 3, Chapter 2, section 2.3

[I5] 2006 IPCC Guidelines, Volume 3, Chapter 2, Table 2.4

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[I18] 2006 IPCC Guidelines, Volume 3, Chapter 3 – Section 3.9, table 3.16

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[I20] 2006 IPCC Guidelines, Volume 3, Chapter 3 – Section 3.9, table 3.17

[I21] 2006 IPCC Guidelines, Volume 3, Chapter 3 – Section 3.9, table 3.19

[I22] 2006 IPCC Guidelines, Volume 3, Chapter 4

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[I28] 2006 IPCC Guidelines, Volume 3, Chapter 4, Section 4.6

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[I32] 2006 IPCC Guidelines, Volume 3, Chapter 8, Section 8.2, Tables 8.2 and 8.3

[I33] 2006 IPCC Guidelines, Volume 3, Chapter 4, Table 4.24

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[I35] 2006 IPCC Guidelines, Volume 2, Chapter 1, Table 1.3

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[A4] 2006 IPCC Guidelines, Volume 4, Chapter 10, paragraph 10.4.1 Choice of method

[A5] 2006 IPCC Guidelines, Volume 4, Chapter 10, Annex 10A.2, Tables 10A-4 through 10A-9: Manure management system in climate region (MS) and typical animal mass for livestock category (TAM)

[A6] 2006 IPCC Guidelines, Volume 4, Chapter 10, paragraph 10.4.2 Choice of emission factors

[A7] 2006 IPCC Guidelines, Volume 4, Chapter 10, paragraph 10.5.1 Choice of method

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