GREENHOUSE GAS INVENTORY OF BOSNIA AND HERZEGOVINA FOR THE PERIOD 2019 – 2022

25.08.2025

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This publication was prepared within the Project "Development of the First Biennial Transparency Report of Bosnia and Herzegovina and the combined Fifth National Communication and the Second Biennial Transparency Report in line with UNFCCC" (5NC) implemented by UNDP in partnership with the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, the Ministry of Spatial Planning, Construction and Ecology of Republika Srpska, the Federal Ministry of Environment and Tourism and the Department of Spatial Planning and Property Affairs of the Brčko District of Bosnia and Herzegovina.

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List of abbreviations and acronyms

AFOLU	agriculture, forestry and land use
BCEFi	Biomass Conversion and Expansion Factors for Net Annual Increment
$BCEF_S$	Biomass Conversion and Expansion Factors for Growing Livestock
BD BiH	Brčko District of BiH
BiH	Bosnia and Herzegovina
BOF	Basic Oxygen Furnaces
BUR	Biennial Update Reports
$CaCO_3$	calcium carbonate
CBIT	Capacity Building Initiative for Transparency
CC	Carbon content
CCS	carbon capture and storage
CH_4	methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
COP	United Nations Conference on Climate Change
CRT	Common Reporting Format Table
DOM	Dead organic matter.
EEA	European Environment Agency
EF	Emission Factor
EMEP	European Monitoring and Verification Programme
EU	European Union
ETF	Enhanced Transparency Framework
FAO	Food and Agriculture Organisation
FBIH	Federation of Bosnia and Herzegovina
FBUR	First Biennial Update Report
FNC	Fourth National Communication
Gg	gigagram
GHG	greenhouse gases
GIS	GeoChart Information System
GJ	giga-joule
ha	hectare
HFC	hydrofluorocarbon
IE	Included elsewhere
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
km^2	square kilometer
LPG	Liquefied petroleum gas
LULUCF	land use, land use change and forestry
m n.v	meters of altitude
MAES	Mapping and assessment of ecosystems and their services
MPGs	Reporting and monitoring guidelines
MVTEO	Ministry of Foreign Trade and Economic Relations of BiH
N_2O	nitrous oxide
NAP	National Adaptation Plan for Bosnia and Herzegovina

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NCV	Net calorific value
NDC	Nationally Determined Contribution of Bosnia and Herzegovina
NE	not estimated
NF_3	Azote trifluoride
NIR	Greenhouse Gas Inventory for Bosnia and Herzegovina
NMVOC	Non-methane volatile organic compounds
NO	Not available
NOX	oksidi Nitrogen oxide
PFC	perfluorocarbons
QA	Quality Assurance
QC	Quality Control
RS	Republika Srpska
SBUR	Second Biennial Update Report
SF_6	Sulfur Hexafluoride
SNC	Second National Communication
SO_2	Sulfur Dioxide
t	ton
TBUR	Third Biennial Update Report
TJ	Terra-Joule
TNC	Third National Communication
UNDP BiH	United Nations Development Programme in BiH
UNFCCC	United Nations Framework Convention on Climate Change

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1 Summary

1.1 Information on GHG inventories and climate change

A greenhouse gas inventory (GHG inventory) is a systematic set of data on GHG emissions and sinks from different sources and sectors in a country. The inventory is a key document for tracking emissions, identifying trends, and formulating measures to reduce GHG emissions.
The international framework for making GHG inventories is defined by the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, which require countries to regularly submit data on GHG emissions. The methodologies for creating the inventory are based on the guidelines of the Intergovernmental Panel on Climate Change (IPCC), which allow for comparability of data at the global level. The Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina (MVTEO BiH) is responsible for coordinating activities in international relations related to the environment and creating policy in this context. However, specific environmental issues are the responsibility of the entity governments. The Ministry of Spatial Planning, Construction and Ecology of Republika Srpska (RS) acts as BiH's focal point according to the UNFCCC. BiH, as a State Party to the Convention that is not included in Annex I, in accordance with its capacities and principles of sustainable development, strives to contribute to the achievement of the primary objectives of the Convention.

BiH has signed and ratified several key international agreements that require regular monitoring and reporting of GHG emissions:

- UNFCCC – BiH, as a developing country, is obliged to prepare the National Communications on Climate Change (NC) and the Biennial Transparency Reports (BTR), which include an inventory of GHG emissions,
- Paris Agreement (2016) – BiH committed to increasing transparency in reporting through the Enhanced Transparency Framework (ETF) mechanism and
- As a member of the Energy Community, BiH is obliged to align its reporting on GHG emissions with the EU acquis, including the obligation to prepare inventories and reports in accordance with the requirements of the Regulation on the Governance of the Energy Union and Climate Action.

To date, BiH has produced and submitted several key reports as part of its international commitments in the field of climate change:

- Initial National Communication (INC) – 2009
- Second National Communication (SNC) – 2013
- Third National Communication (TNC) – 2017
- Fourth National Communication (FNC) – 2021
- First Biennial Update Report (FBUR) – 2014
- Second Biennial Update Report (SBUR) – 2017
- Third Biennial Update Report (TBUR) – 2022
- Intended Nationally Determined Contribution for Bosnia and Herzegovina (INDC) – 2015
- Nationally Determined Contribution for Bosnia and Herzegovina (NDC) – 2021
- National Adaptation Plan on Climate Change for Bosnia and Herzegovina (NAP) – 2022

- Strategy on adaptation to climate change and low-carbon development – 2020

These documents include data on GHG emissions, sectoral trends, and emission reduction measures. By adopting the enhanced transparency framework under the Paris Agreement, signatory countries have an obligation to report regularly to the UNFCCC by:

- National Communications, which are submitted every four years, and
- Biennial transparency reports, which have replaced the previous BUR and are submitted every two years.

With this reporting, countries are fulfilling transparency obligations and strengthening trust in the global response to climate change. Within the CBIT (Capacity Building Initiative for Transparency) project, BiH has improved the methodology for collecting and analysing data on GHG emissions. The project enabled strengthening of the capacities of relevant institutions, including trainings on the implementation of the IPCC methodology and the use of specialised software for calculating emissions.

According to UNFCCC requirements, the annual GHG emissions inventory covers:

- Five emission sectors: energy, industrial processes and product use, agriculture, forestry and land use, and waste.
- Seven direct GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), fluorocarbons (HFCs, PFCs), sulfur hexafluoride (SF6) and nitrogen trifluoride (NF3).
- Four indirect GHGs: sulfur dioxide (SO2), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), and nitrogen oxides (NOX).
- The year starting in 1990, which should be the base year for the assessment and reporting of emissions.

The calculation of emissions and sinks was perfofrmed in accordance with the methodology set out in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, including relevant amendments from 2019 (Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories).

Global Warming Potential (GWP)

This inventory uses the GWP values defined in the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC AR5), in accordance with the requirements of the UNFCCC and the Modalities, Procedures and Guidelines (MPGs) of Decision 18/CMA.1. The values used are shown in the following table.

Table 1:P Global Warming Potential (GWP) according to AR5, 100-year horizon

Gas	GWP (AR5, 100-year horizon)
CO_2	1
CH_4	28
N_2O	265
HFC-134a	1,300
HFC-125	3,170
HFC-143a	4,800
HFC-152a	138
HFC-23	12,400
SF6	23,500
NF3	16,100

PFC-14 (CF4)	6,630
PFC-116 (C2F6)	11,100

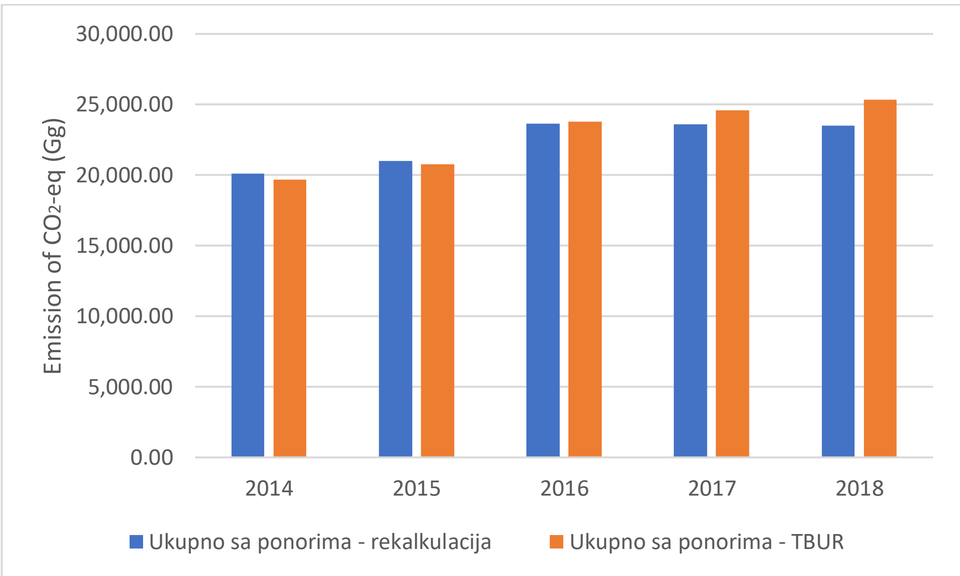
1.2 Recalculation of emissions for the period 2014 – 2018

As part of the preparation of the GHG inventory for the period 2019–2022, a recalculation of emissions for the earlier period 2014–2018 was also performed. This recalculation was performed in accordance with the 2006 IPCC Guidelines and their 2019 amendments (*2019 Refinement*).

The reasons for performing the recalculation include:

- **Applying updated global warming potential values** in line with *the Fifth Assessment Report (AR5),* ensuring greater consistency with international commitments (e.g. Paris Agreement, ETF requirements);
- **Inclusion of self-producers** in the energy sector, which has improved data on fuel consumption and related emissions;
- **Revision of coke consumption in the industrial process and product use sector (IPPU)** in accordance with the 2019 Refinement recommendations related to a more precise mapping of coke inputs and changing their classification from the energy sector to industrial processes,
- **Use of nationally specific data on the thermal capacity of lignite**, which allows for more accurate calculations of emissions from combustion,
- **Use of new data from the research** of the Agency for Statistics of BiH, RS Statistics Bureau and the FbiH Statstics Bureau in agriculture.

This recalculation resulted in differences in total emissions for the years 2014-2018 compared to the previously reported values in the TBUR. The chart below shows the differences between previously reported and recalculated values (with sinks).



(LEGEND: Ukupno sa ponorima – rekalkulacija – Total with sinks – recalculation; Ukupno sa ponorima – TBUR – Total with sinks – TBUR.)

Chart 1- Emissions with sinks before and after recalculation (CO2-eq/year)

The chart shows the differences in total emissions with sinks before and after the recalculation for the period 2014–2018. It is noted that the recalculated values are higher for 2014 and 2015 (up to 2%), while in the following years they are lower, with a particularly pronounced decrease in 2017 and 2018 (−4% and −7%). These differences are the result of the application of improved methodological approaches and updated input data.

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1.3 Trends in emissions

In the context of the development of the national GHG inventory, monitoring emission trends is a key tool for analysing changes in emissions over time, identifying the main sources of emissions, and evaluating the effectiveness of emission reduction measures, prescribed through strategic documents. By analysing emission data from different sectors and categories, it is possible to monitor the impact of specific measures on GHG emissions, and to understand the main factors contributing to the increase or decrease of emissions. This trend overview covers relevant GHGs (CO_2, CH_4, N_2O, HFCs, PFCs) and all sectors: energy, industrial processes and product use (IPU), agriculture, forestry and land use (AFOLU), waste, as well as all emission precursors (NOx, CO, NMVOC, SO2). In the last reporting period, the emissions of all these gases were analysed, with a detailed presentation of their changes compared to previous years, and the determination of the main factors that influenced these changes. Through the analysis of emissions at the level of sectors and categories, and by type of gas, a specific pattern has been observed that indicates the key sources of emissions and areas that require special attention in the future planning of emission reduction policies, which will be presented in the next chapter.

Charts 2 and 3 show the trends in GHG emissions in the period 1990 – 2022, with and without sinks. Observed throughout the period 1990–2022, emissions without sinks show a significant decline in the early 1990s, mainly due to a decrease in industrial activity and changes in the energy sector during the war and post-war period. Since the mid-1990s, there has been a gradual increase in emissions, which stabilises in the period 2000-2005. After 2005, emissions show an oscillating trend, but are on the rise compared to the period of the early 2000s. Total GHG emissions without sinks in the period 2014–2022 ranged from 26,676.38 Gg CO_2-eq in 2014 to a maximum of 30,376.09 Gg CO_2-eq in 2017. After 2017, there was a slight decrease, with the exception of 2021 when emissions rose again to 29,237.61 Gg CO_2 - eq.

In 2022, emissions without sinks amounted to 28,031.44 Gg CO_2 - eq, which is an increase of 5.08% compared to 2014, and a decrease of 17.66% compared to 1990. Emissions from sinks in 2022 amounted to 21,102.73 Gg CO_2-eq, which represents an increase of 4.91% compared to 2014 and a decrease of 20.72% compared to 1990.

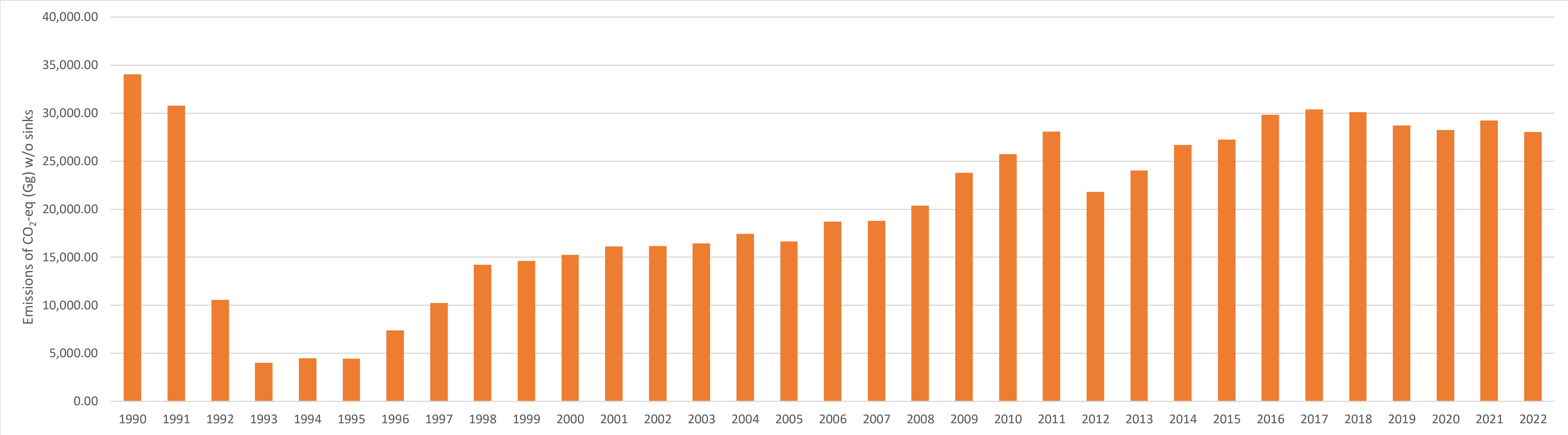

Chart 2: Trends in CO_2 emissions – eq without sinks in the period 1990 - 2022

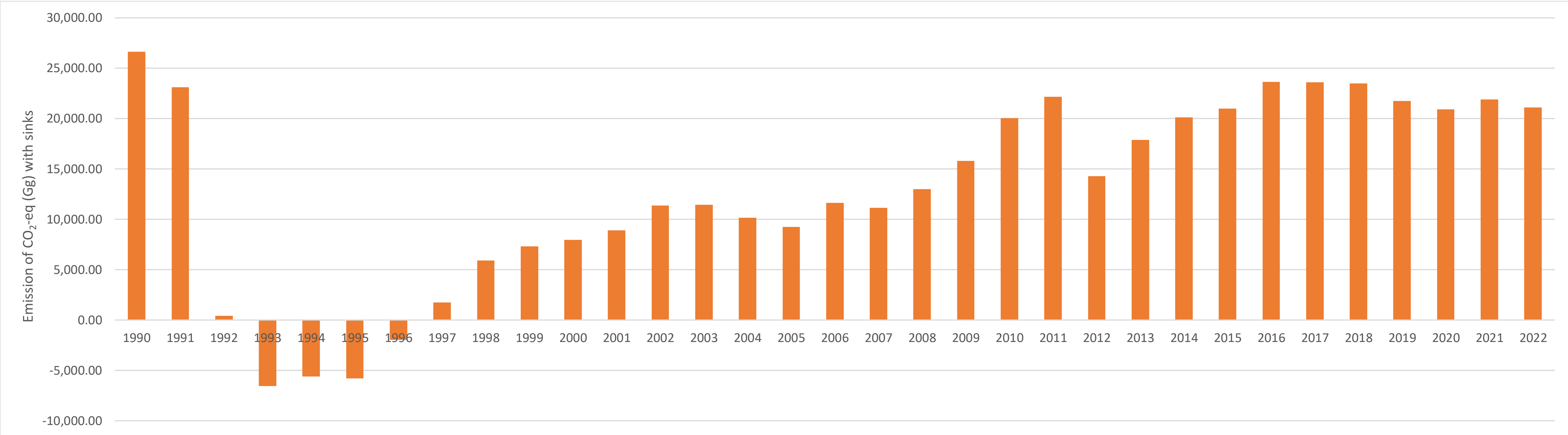

Chart 3: Trends in CO_2 emissions – eq with sinks in the period 1990 - 2022

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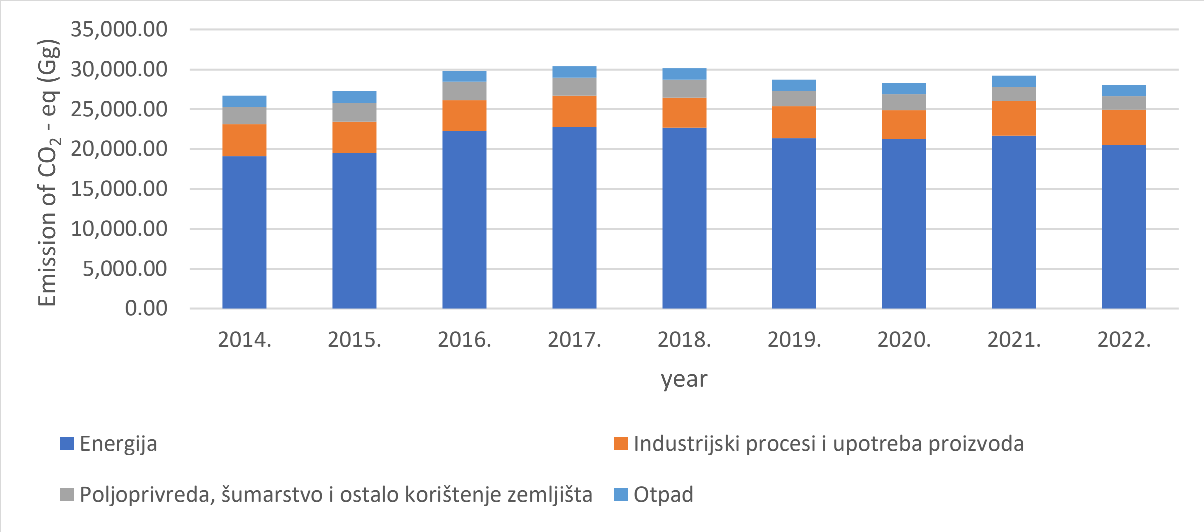
The following chart presents the CO_2-eq emission trends by sink-free sectors in the period 2014 – 2022. In 2014, the energy sector accounted for 72% of total emissions, the highest percentage of all sectors. It is followed by the industrial processes and product use sector with 15%, the agriculture, forestry and other land use sector with 8% and waste with 5%. In 2022, a similar distribution of emissions by sector was recorded as in 2014. The energy sector accounted for 73%, the industrial processes and product use sector for 16%, the agriculture, forestry and other land use sector for 6% and waste for 5%.



(LEGEND: Energija – Energy; Industrijski procesi i upotreba proizvoda – Industrial processes and product use; Poljoprivreda, šumarstvo i ostalo korištenje zemljišta – Agriculture, forestry and other land use; Otpad – Waste.)

Chart 4: CO_2-eq emission trends by sink-free sectors 2014-2022

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1.3.1 Emissions trends by sectors

Total GHG emissions in BiH, including the land use, land use change and forestry (LULUCF) sector, have shown some changes in recent years, as a result of various factors such as changes in energy consumption, industrial production, agriculture and forest management. The following is an analysis of the emissions trend by sector for the period 2014-2022, with emissions presented in CO_2-eq (with and without sinks).

Table 2: Overview of emissions trends with sinks by sectors for the period 2014-2022 (Gg CO_2-eq)

Sector	2014	2015	2016	2017	2018	2019	2020	2021	2022
Energy	19,080.37	19,517.47	22,289.45	22,750.94	22,718.31	21,355.36	21,284.91	21,714.00	20,504.47
Industrial Processes and Product Use	4,006.62	3,908.25	3,808.94	3,933.79	3,694.90	3,984.39	3,588.89	4,290.30	4,406.31
Agriculture	2,205.47	2,385.20	2,389.67	2,302.55	2,265.27	1,944.56	2,014.01	1,767.71	1,673.97
LULUCF	-6,560.84	-6,238.25	-6,178.34	-6,760.72	-6,593.76	-6,975.76	-7,322.79	-7,332.42	-6,92871
Waste	1,383.92	1,436.95	1,347.42	1,388,.81	1,415.54	1,422.55	1,366.82	1,465.61	1,446.69
Total with sinks	20,115.54	21,009.62	23,657.16	23,615.37	23,500.26	21,731.10	20,931.83	21,905.19	21,102.73

Total emissions from sinks, shown in the table above, in 2014 amounted to 20,115.54 Gg CO_2-eq In 2022, GHG emissions from sinks amounted to 21,102.73 Gg CO_2-eq, which indicates an increase in emissions by 4%. In 2016, the percentage change indicates an increase in emissions by 15%, and a similar trend appears in 2017 where the percentage change indicates an increase in emissions by 15%. In 2016, the percentage of change, in addition to indicating the largest increase in emissions for this period, has the highest absolute value compared to other years.

Table 3: Overview of sink-free emission trends by sectors for the period 2014-2022 (Gg CO_2-eq)

Sector	2014	2015	2016	2017	2018	2019	2020	2021	2022
Energy	19,080.37	19,517.47	22,289.45	22,750.94	22,718.31	21,355.36	21,284.91	21,714.00	20,504.47
Industrial Processes and Product Use	4,006.62	3,908.25	3,808.94	3,933.79	3,694.90	3,984.39	3,588.89	4,290.30	4,406.31
Agriculture	2,205.47	2,385.20	2,389.67	2,302.55	2,265.27	1,944.56	2,014.01	1,767.71	1,673.97
Waste	1,383.92	1,436.95	1,347.42	1,388.81	1,415.54	1,422.55	1,366.82	1,465.61	1,446.69
Total without sinks	26,676.38	27,247.87	29,835.49	30,376.09	30,094.02	28,706.86	28,254.62	29,237.61	28,031.44

When sinks are excluded from the trend overview, total emissions for 2014 amount to 26,676.38 Gg CO_2-eq. In 2022, sink-free GHG emissions amounted to 28,031.44 Gg CO_2-eq, which is 5% higher than in 2014. In 2016, 2017 and 2018, they have the highest percentages of change, amounting to 10%, 12% and 11% respectively. In these years, the largest increase in emissions is recorded.

Below is a comparison of the share of individual sectors in total emissions (w/o sinks) for 2014 and 2022.

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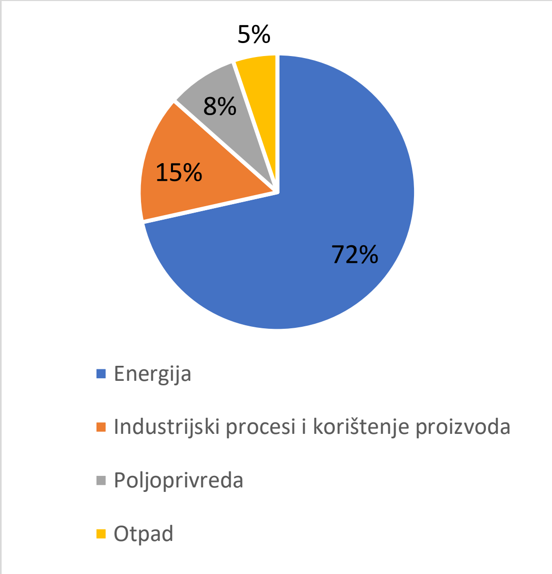

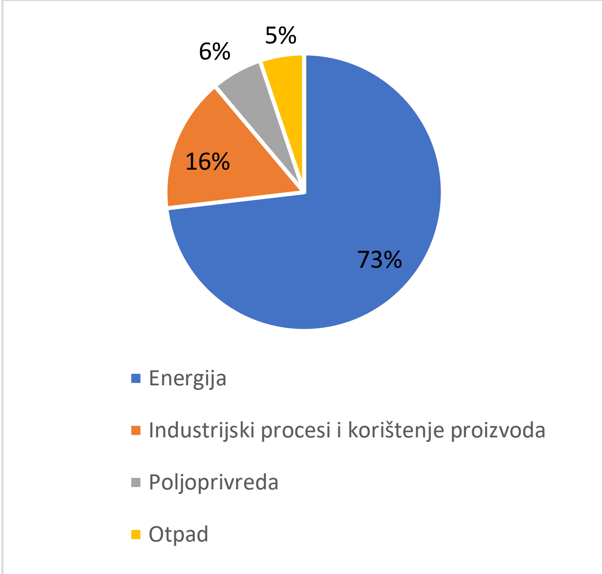

(LEGEND: Energija – Energy; Industrijski proizvodi i korištenje proizvoda – Industrial processes and product use; Poljoprivreda – Agriculture; Otpad – Waste.)

Chart 5: Comparison of the share of individual sectors in total emissions (w/o sinks) for 2014 and 2022

From the previous comparison, it can be seen that in both observed years, the energy sector dominates total emissions (72% in 2014 and 73% in 2022), while the share of industrial processes and product use increased from 15% to 16%. The share of agriculture decreased slightly (from 8% to 6%), while the share of waste remained stable at 5%.

1.3.2 Gas Emission Trends

In the calculation of the greenhouse gas inventory for the period 2019-2022, CO_2, CH_4, N_2O and PFCs, HFCs (from the sector of industrial processes and product use) are included. For the period 2014 – 2018, the calculation of CO_2, CH_4, N_2O and PFCs was performed. Emissions of these gases are shown in the following table.

Table 4: Overview of emissions per gases for the period 2014 - 2022 (Gg CO2-eq)

GHG	Emissions (Gg CO2-eq)								
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
CO_2:	15,153	15,641	18,299	18,132	18,046	16,642	15,954	16,936	16,117
CH_4	3,525	3,838	3,840	4,058	3,917	3,750	3,737	3,447	3,308
N_2O	1,045	1,177	1,200	1,051	1,144	923	941	917	834
HFCs	NO	NO	NO	NO	NO	214	299	335	428
PFCs	392	353	318	375	393	202	0,00	269	415

CO_2 emissions in 2014 amounted to 15,153 Gg. During the observed period, emissions fluctuated, with a slight increase until 2016 (18,299 Gg CO_2), followed by a decrease by 2020 (15,954 Gg CO_2). In 2022, emissions amounted to 16,117 Gg CO_2, which is approximately 6% more than in 2014.

CH_4 emissions in 2014 amounted to 3,525 Gg CO_2-eq. After an increase until 2017 (4,058 Gg CO_2-eq), the values declined slightly. In 2022, emissions amounted to 3,308 Gg CO_2-eq, which is about 6% less than in 2014.

N_2O emissions in 2014 amounted to 1,045 Gg CO_2-eq. Throughout the period, emissions remained stable, with slight fluctuations, and in 2022 they amounted to 834 Gg CO_2-eq, which represents a decrease of about 20% compared to 2014.

HFCs emissions are not calculated for the period 2014-2018. Since 2019, emissions have increased, from 214 Gg CO_2-eq in 2019 to 428 Gg CO_2-eq in 2022, doubling compared to the first recorded value in 2019.

PFCs emissions in 2014 amounted to 392 Gg CO_2-eq. After oscillations and decreases to 269 Gg CO_2-eq in 2021, a significant increase was recorded, so in 2022 they amounted to 415 Gg CO_2-eq, which is about 6% more than in 2014.

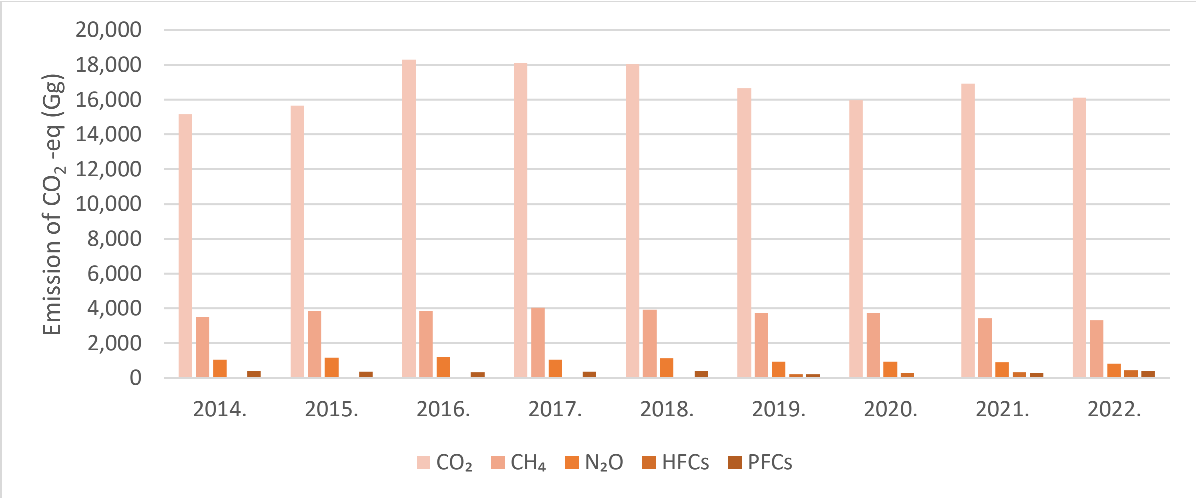

Chart 6: Overview of gas emission trends for the period 2014 – 2022

The chart above shows the trends in CO_2, CH_4, N_2O, HFCs and PFCs emissions in the period 2014-2022. CO_2 is the dominant gas in total emissions, while CH_4 and N_2O are present in much smaller quantities, with slight fluctuations and a decline in value by 2022. HFCs emissions were not counted until 2019, and in the period from 2019 to 2022 they recorded a significant increase. PFCs fluctuate over the period, and in 2022 they are approximately 6% higher than in 2014.

1.3.3 Precursor emission trends

The trend of precursor emissions is analysed below:

- Nitrogen oxides (NOx),
- Carbon – Monoxide (CO),
- Non-methane volatile organic compounds (NMVOCs) and
- Sulfur dioxide (SO2).

The calculation of precursor emissions was performed for categories 1.A.1 Energy/energy industries, 1.A.2 Industry and construction, 1.B.1 Fugitive emissions from solid fuels, 2.C.1 Iron and steel production, 2.C.3 Aluminium production, 2.H.1 Paper and pulp industry, 2.H.2 Food and beverage industry and 4.A Solid waste disposal. An overview of the trend of indirect emissions for the period 2014 – 2022 is shown in the following table and the accompanying Chart.

Table 5: Precursor emission trends for the period 2014 - 2022

Gas	Emission (gg)								
	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO	80.97	36.38	34.72	36.32	36.19	29.27	18.68	33.79	38.51
NOx	42.57	40.87	49.13	50.28	50.64	48.35	48.51	50.77	48.40
NMVOCs	32.15	21.55	23.80	23.06	10.50	24.71	24.84	24.41	24.49

SO2	188.53	177.32	212.62	217.97	219.72	204.62	208.48	205.55	193.66

CO emissions in 2014 amounted to 80.97 Gg. In the period from 2014 to 2022, a general trend of decreasing emissions of this gas was recorded. The lowest value was recorded in 2020 and amounted to 18.68 Gg, which represents a decrease of about 77% compared to 2014. Although emissions increased slightly in the following years, in 2022 CO emissions amounted to 38.51 Gg, which is approximately 52% less than in 2014.

NOx emissions in 2014 amounted to 42.57 Gg. During the following years, slight fluctuations were recorded, with the largest increase in 2017, when emissions amounted to 50.28 Gg, which is about 18% more than in 2014. In 2022, NOx emissions were 48.40 Gg, an increase of about 14% compared to 2014.

NMVOCs emissions amounted to 32.15 Gg in 2014. During the analyzed period, emissions generally declined, with the lowest value in 2018, when they fell to 10.50 Gg, a decrease of about 67% compared to the initial year. In 2022, emissions amounted to 24.49 Gg, which represents a decrease of approximately 24% compared to 2014.

SO_2 emissions amounted to 188.53 Gg in 2014. After a slight increase and fluctuations in the following years, emissions in 2022 amounted to 193.66 Gg. This means that total emissions of this gas in 2022 were higher by about 3% compared to 2014, although a temporary decrease was recorded during certain years (e.g. 2015).

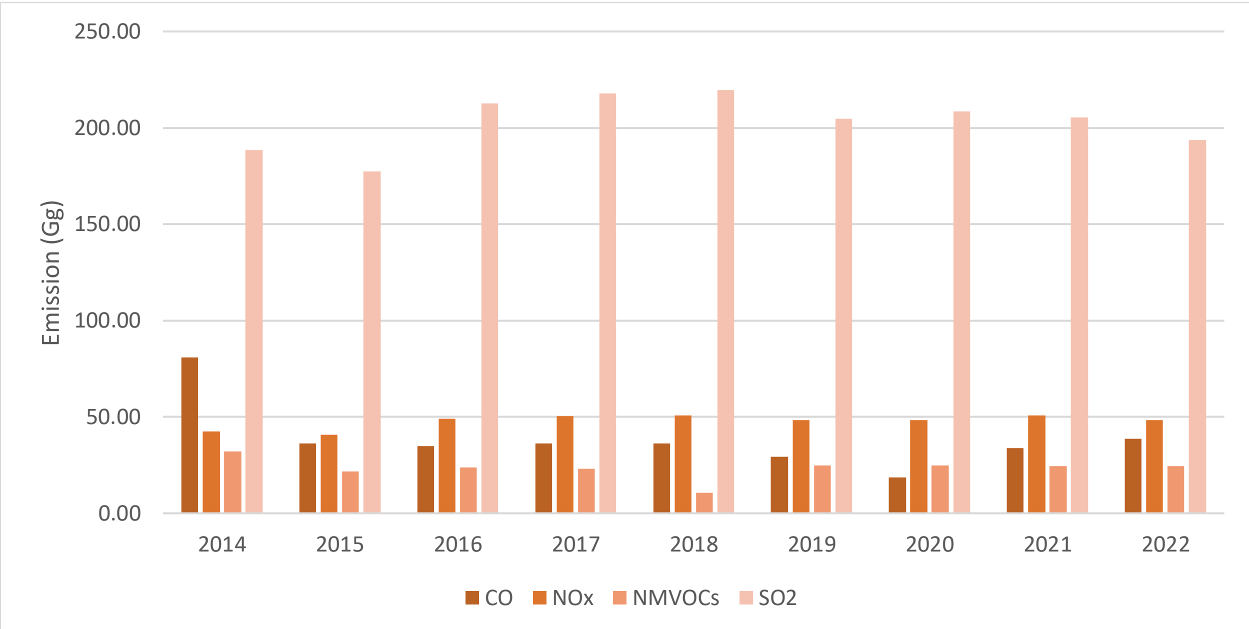

Chart 7: Overview of precursor trends for the period 2014-2022

The chart shows the trends in emissions of pollutant precursors (CO, NOx, NMVOCs and SO_2) in the period from 2014 to 2022, expressed in Gg. It is noted that SO_2 had by far the largest share among the pollutants shown throughout the period, with a marked increase from 2015 to 2018, followed by a slight decrease and stabilisation. This trend most likely indicates the increased use of fossil fuels with a high sulfur content during this period. The chart shows a reduction in CO emissions from 2014 to 2020, which may be due to improvements in combustion technologies and a reduction in traffic, after which there is a resurgence of growth. NOx recorded a gradual increase from 2014 to 2021, with a

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slight decline in 2022. This indicates an increase in activity in the transport and industrial sectors. Emissions of NMVOCs have been relatively stable throughout the period, with a slight increase, suggesting constant sources such as fuel evaporation and industrial processes.

Overall, the chart shows that emissions of most precursors have stabilised slightly or declined in recent years, which may be an indication of the initial effects of emission reduction measures, but still points to the need for additional efforts, especially in reducing SO_2 emissions.

1.4 Analysis of key categories

The analysis of key categories of greenhouse gas emissions in BiH was conducted in accordance with IPCC Approach 1, in order to identify the main sources of emissions expressed in CO_2 equivalent (CO_2 - eq). This analysis included both Level Assessment and Trend Assessment analyses and was conducted for 2022 in relation to the base year of the NDC (2014) and not in relation to 1990, which is in line with the flexibilities that developing countries have under the MPGs guidelines. Analysis by level and analysis by trend were conducted in IPCC Inventory Software, version 2.95, for the level of disaggregation of the data shown in the tables below. It is recommended to improve the detail of the presentation in the following reports, so that within individual key categories of a higher level it is clearly shown how much contribution individual subcategories have (e.g. within category 1.A.1).

1.4.1 Level Assessment

Level Assessment identifies the emission sources that make up the largest proportion of total emissions in a given year, i.e. categorizes the sources that together account for 95% of total emissions. This analysis focuses on a static overview of emissions, regardless of how emissions change over time. Key categories are determined based on their share of total emissions, and the aim is to identify the largest sources of emissions based on data for that year. As already stated, the Level Assessment was done according to Approach 1, for the base years 2014 and 2022, with and without LULUCF.

Below is an overview of the key categories (Level Assessment), with and without LULUCF, for 2014 and 2022.

Table 6: Analysis of key categories (Level Assessment) with sinks for 2014

IPCC mark	IPCC Category	Gas	2014 Ex,t(Gg CO_2-eq)	Percentage	Total cumulative
1.A.1	Energy/Energy Industries – Solid Fuels	CO2	11,413.40	34.34%	34.34%
3.B.1.a	Forest land not changing the category	CO2	6,396.86	19.25%	53.59%
1.A.3.b	Road transport – liquid fuels	CO2	3,002.47	9.03%	62.62%
2.C.1	Iron and steel production	CO2	2,619.35	7.88%	70.50%
1.A.2	Industry and construction – solid fuels	CO2	1,437.40	4.32%	74.82%
3.A.1	Enteric fermentation	CH4	1,105.05	3.32%	78.15%
4.A	Disposal of solid waste	CH4	949.40	2.86%	81.01%
1.B.1.a	Coal Mining and Handling	CH4	840.88	2.53%	83.54%

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1.A.4	Other sectors – solid fuels	CO2	691.31	2.08%	85.62%
3.C.4	Direct N2O emissions from the ground	N2O	596.43	1.79%	87.41%
1.A.1	Energy/Energy Industry - Liquid Fuels	CO2	461.15	1.39%	88.80%
4.D	Wastewater treatment and discharge	CH4	434.52	1.31%	90.10%
1.A.4	Other sectors - Liquid fuels	CO2	396.25	1.19%	91.30%
2.C.3	Aluminum production	PFCs	391.74	1.18%	92.48%
2.A.1	Cement production	CO2	315.93	0.95%	93.43%
2.A.2	Limestone production	CO2	293.60	0.88%	94.31%
1.A.2	Industry and construction – liquid fuels	CO2	249.88	0.75%	95.06%

Table 7: Level Assessment without sinks for 2014

IPCC mark	IPCC Category	Gas	2014 Ex,t(Gg CO_2-eq)	Percentage	Total cumulative
1.A.1	Energy/Energy Industries – Solid Fuels	CO2	11,413.40	42.52%	42.52%
1.A.3.b	Road transport – liquid fuels	CO2	3,002.47	11.19%	53.71%
2.C.1	Iron and steel production	CO2	2,619.35	9.76%	63.47%
1.A.2	Industry and construction – solid fuels	CO2	1,437.40	5.36%	68.82%
3.A.1	Enteric fermentation	CH4	1,105.05	4.12%	72.94%
4.A	Disposal of solid waste	CH4	949.40	3.54%	76.48%
1.B.1.a	Coal Mining and Handling	CH4	840.88	3.13%	79.61%
1.A.4	Other sectors – solid fuels	CO2	691.31	2.58%	82.19%
3.C.4	Direct N2O emissions from the ground	N2O	596.43	2.22%	84.41%
1.A.1	Energy/Energy Industries – Liquid Mr.	CO2	461.15	1.72%	86.13%
4.D	Wastewater treatment and discharge	CH4	434.52	1.62%	87.75%
1.A.4	Other sectors - Liquid fuels	CO2	396.25	1.48%	89.22%
2.C.3	Aluminum production	PFCs	391.74	1.46%	90.68%
2.A.1	Cement production	CO2	315.93	1.18%	91.86%
2.A.2	Limestone production	CO2	293.60	1.09%	92.95%
1.A.2	Industry and construction – liquid fuels	CO2	249.88	0.93%	93.88%
2.C.3	Aluminum production	CO2	223.10	0.83%	94.72%
3.C.5	Indirect N2O emissions from the ground	N2O	197.57	0.74%	95.45%

Table 8: Level Assessment with sinks for 2022

IPCC mark	IPCC Category	Gas	2022 Ex,t(Gg CO_2-eq)	Percentage	Total cumulative
1.A.1	Energy/Energy Industries	CO2	11,930.84	34.13%	34.13%
3.B.1.a	Forest land that does not change the category	CO2	6,443.57	18.43%	52.56%
1.A.3.b	Road transport – liquid fuels	CO2	4,028.82	11.52%	64.08%
2.C.1	Iron and steel production	CO2	2,031.61	5.81%	69.89%
1.A.2	Industry and construction – solid fuels	CO2	1,789.31	5.12%	75.01%
1.B.1.a	Coal Mining and Handling	CH4	859.88	2.46%	77.47%
3.A.1	Enteric fermentation	CH4	853.94	2.44%	79.91%
4.A	Disposal of solid waste	CH4	853.75	2.44%	82.36%

2.A.2	Limestone production	CO2	627.36	1.79%	84.15%
4.D	Wastewater treatment and discharge	CH4	512.45	1.47%	85.62%
3.D.1	Products made from felled wood	CO2	479.09	1.37%	86.99%
2.A.1	Cement Production	CO2	448.32	1.28%	88.27%
2.F.1	Refrigeration & Air Conditioning	HFCs, PFCs	429.04	1.23%	89.50%
2.C.3	Aluminum production	PFCs	414.82	1.19%	90.68%
1.A.4	Other sectors – solid fuels	CO2	412.71	1.18%	91.86%
3.C.4	Direct N2O emissions from the ground	N2O	399.77	1.14%	93.01%
1.A.2	Industry and construction – liquid fuels	CO2	361.96	1.04%	94.04%
1.A.4	Other sectors - Liquid fuels	CO2	272.65	0.78%	94.82%
2.C.3	Aluminum production	CO2	236.25	0.68%	95.50%

Table 9: Analysis of key categories (Level Assessment) without sinks for 2022

IPCC mark	IPCC Category	Gas	2022 Ex,t(Gg CO_2-eq)	Percentage	Total cumulative
1.A.1	Energy/Energy Industries - Solid Fuels	CO2	11,930.84	42.55%	42.55%
1.A.3.b	Road transport – liquid fuels	CO2	4,028.82	14.37%	56.92%
2.C.1	Iron and steel production	CO2	2,031.61	7.25%	64.17%
1.A.2	Industry and construction – solid fuels	CO2	1,789.31	6.38%	70.55%
1.B.1.a	Coal Mining and Handling	CH4	859.88	3.07%	73.62%
3.A.1	Enteric fermentation	CH4	853.94	3.05%	76.66%
4.A	Disposal of solid waste	CH4	853.75	3.05%	79.71%
2.A.2	Limestone production	CO2	627.36	2.24%	81.95%
4.D	Wastewater treatment and discharge	CH4	512.45	1.83%	83.77%
2.A.1	Cement Production	CO2	448.32	1.60%	85.37%
2.F.1	Refrigeration & Air Conditioning	HFCs, PFCs	429.04	1.53%	86.90%
2.C.3	Aluminum production	PFCs	414.82	1.48%	88.38%
1.A.4	Other sectors – solid fuels	CO2	412.71	1.47%	89.85%
3.C.4	Direct N2O emissions from the ground	N2O	399.77	1.43%	91.28%
1.A.2	Industry and construction – liquid fuels	CO2	361.96	1.29%	92.57%
1.A.4	Other sectors - Liquid fuels	CO2	272.65	0.97%	93.54%
2.C.3	Aluminum production	CO2	236.25	0.84%	9439%
1.A.2	Industry and construction – gaseous fuels	CO2	19970	0.71%	95.10%

The results of the Level Assessment for 2014 and 2022, observed with and without the LULUCF sector, show that the largest sources of emissions in both periods are related to energy, road transport and industrial processes, especially iron and steel production. Enteric fermentation and waste disposal also have a significant share in emissions. The inclusion of LULUCF shows a reduction in net emissions due to sinks from forestlandsand wood products, but the order of the main categories does not change significantly between the two observed periods.

1.4.2 Trend Assessment

Trend Assessment focuses on changes in emissions over time, not just their current value. This analysis identifies categories whose emission trend is significantly different from the general trend of inventory emissions, which may not be recognized through level analysis. Thus, analysis by trend takes into account changes in emissions over time and can reveal emission sources that have an upward or decreasing trend, which could not be observed by analyzing by emission levels alone.

Below is an overview of the Trend Assessment, with and without LULUCF for the period 2014-2022.

Table 10: Trend Assessment with sinks for the period 2014 – 2022

IPCC mark	IPCC Category	Gas	2014 Ex,0 (Gg CO_2 Eq)	2022 Ex,t (Gg CO_2 Eq)	Percentage	Total cummulative
1.A.3.b	Road transport – liquid fuels	CO2	3,002.47	4,028.82	15.67%	15.67%
2.C.1	Iron and steel production	CO2	2,619.35	2,031.61	12.77%	28.44%
2.F.1	Refrigeration & Air Conditioning	HFCs, PFCs	0.00	429.04	7.65%	36.09%
3.B.1.a	Forest land not changing the category	CO2	6,396.86	6,443.57	6.43%	42.52%
3.D.1	Products made from felled wood	CO2	157.92	479.09	5.86%	48.38%
1.A.1	Energy/Energy Industries – Liquid Fuels	CO2	461.15	158.67	5.80%	54.18%
2.A.2	Limestone production	CO2	293.60	627.36	5.69%	59.87%
1.A.4	Other sectors – solid fuels	CO2	691.31	412.71	5.57%	65.44%
3.A.1	Enteric fermentation	CH4	1,105.05	853.94	5.44%	70.89%
1.A.2	Industry and construction – solid fuels	CO2	1,437.40	1,789.31	5.02%	75.90%
3.C.4	Direct N2O emissions from the ground	N2O	596.43	399.77	4.03%	79.93%
1.A.4	Other sectors - Liquid fuels	CO2	396.25	272.65	2.55%	82.48%
4.A	Disposal of solid waste	CH4	949.40	853.75	2.54%	85.02%
2.A.1	Cement production	CO2	315.93	448.32	2.08%	87.10%
1.A.2	Industry and construction – liquid fuels	CO2	249.88	361.96	1.78%	88.88%
4.D	Wastewater treatment and discharge	N2O	0.00	80.50	1.44%	90.32%
3.C.5	Indirect N2O emissions from the ground.	N2O	197.57	129.65	1.38%	91.70%
3.C.1	Fires	CH4	2.68	61.35	1.04%	92.74%
4.D	Wastewater treatment and discharge	CH4	434.52	512.45	1.01%	93.75%
1.A.4	Other sectors – gaseous fuels	CO2	116.13	164.92	0.77%	94.52%
1.A.1	Energy/Energy Industries – Solid Fuels	CO2	11,413.4	11,930.8	0.76%	95.28%

Table 11: Trend Assessment without sinks for the period 2014 – 2022

IPCC mark	IPCC Category	Gas	2014 Ex,0 (Gg CO_2 Eq)	2022 Ex,t (Gg CO_2 Eq)	Percentage	Total cummulative
1.A.3.b	Road transport – liquid fuels	CO2	3,002.47	4,028.82	17.87%	17.87%
2.C.1	Iron and steel production	CO2	2,619.35	2,031.61	14.56%	32.43%

2.F.1	Refrigeration & Air Conditioning	HFCs, PFCs	0.00	429.04	8.72%	41,15%
1.A.1	Energy/Energy Industries – Liquid Fuels	CO2	461.15	158.67	6.61%	47.76%
2.A.2	Limestone production	CO2	293.60	627.36	6.49%	54.25%
1.A.4	Other sectors – solid fuels	CO2	691.31	412.71	6.35%	60.60%
3.A.1	Enteric fermentation	CH4	1,105.05	853.94	6.21%	66.81%
1.A.2	Industry and construction – Solid fuels	CO2	1,437.40	1,789.31	5.72%	72.53%
3.C.4	Direct N2O emissions from the ground	N2O	596.43	399.77	4.59%	77.12%
1.A.4	Other sectors - Liquid fuels	CO2	396.25	272.65	2.91%	80.03%
4.A	Disposal of solid waste	CH4	949.40	853.75	2.89%	82.92%
2.A.1	Cement production	CO2	315.93	448.32	2.38%	85.30%
1.A.2	Industry and construction – liquid fuels	CO2	249.88	361.96	2.03%	87.33%
4.D	Wastewater treatment and discharge	N2O	0.00	80.50	1.64%	88.96%
3.C.5	Indirect N2O emissions from the ground.	N2O	197.57	129.65	1.58%	90.54%
3.C.1	Fires	CH4	2.68	61.35	1.19%	91.73%
4.D	Wastewater treatment and discharge	CH4	434.52	512.45	1.15%	92.88%
1.A.4	Other sectors - gaseous fuels	CO2	116.13	164.92	0.88%	93.76%
1.A.1	Energy/Energy Industries – Solid Fuels	CO2	11,413.40	11,930.84	0.87%	94.62%
3.A.2	Fertilizer management	CH4	145.47	111.31	0.84	95.46

In terms of the emissions trend between 2014 and 2022, observed with and without LULUCF, the analysis shows that the key categories encompass similar emission sources, with road transport, iron and steel production, and emissions from energy accounting for the largest contributors to overall emissions, while the inclusion of sinks reduces net emissions from forest lands and wood products. Between 2014 and 2022, the largest increase in emissions was recorded in the road transport category (liquid fuels), with an increase of around 1,026 Gg CO_2-eq, making this sector the largest single contributor to total emissions. Emissions from the energy/liquid fuel energy sector decreased, as did emissions from enteric fermentation and certain industrial processes, while certain categories such as solid waste disposal and direct N_2O emissions from soil showed a slight decrease.

1.5 Uncertainty Analysis

The uncertainty analysis was conducted using IPCC Inventory Software version 2.95, in accordance with the methodology set out in the 2006 IPCC Guidelines and 2019 amendments. The uncertainty analysis was done in relation to 2014, i.e. the reference year from the NDC, with and without LULUCF, which is in line with the flexibilities of developing countries. Approach 1 was used, which involves estimating the uncertainties for each individual emission source, and combining them to obtain the overall uncertainty of the inventory. For each category, the uncertainty of the input data and emission factors is determined. The uncertainty assessment was made by combining expert opinion and recommended emission ranges in accordance with IPCC guidelines.

The Approach 1 – Error propagation was used and it implies a correlation between emission factors in the reference year and the current year, while activity data (input data) are considered independent between these years. This approach allows the calculation of the uncertainty of the emission trend using the following formula:

$$U_T = \sqrt{\sum i\ (U^2{}_{Te,i} + U^2{}_{Ta,i})}$$

Whereas:

UT - uncertainty in the trend of total emissions,

UTe,i - trend uncertainty caused by the uncertainty of the emission factors for the category(s) and

UTa,i - trend uncertainty caused by the uncertainty of the activity data for the category/gas.

This method allows for the quantification of the total uncertainty of emissions using standard error propagation rules, thus ensuring consistency in the analysis of uncertainty in the emission inventory.

The overall uncertainty in the 2022 emissions inventory is 5.86%, while the uncertainty of the emissions trend is 6.59%. These results indicate a moderate level of uncertainty, which is acceptable for the current level of accuracy. The results of the uncertainty calculations by category are presented in detail in Attachment II of the report.

For each emission category, a detailed uncertainty analysis was carried out in the report, in order to identify specific areas with higher levels of uncertainty and where improvements in data collection or methodology application are possible. This analysis makes it possible to focus further necessary improvements and reduce uncertainty in emission estimates. The results of the uncertainty analysis (with and without LULUCF) are presented in Attachment II.

1.6 Performed inventory improvements

In the process of creating the greenhouse gas inventory for the period 2019 – 2022, with recalculation for the period 2014 – 2018, a number of improvements were made to ensure compliance with international standards and improve accuracy of reporting.

- The structure of the Reporting and Monitoring Guidelines (MPGs) adopted at the United Nations Climate Change Conference - Paris Agreement in 2018 (CMA 2018) was monitored, which enabled consistency in the development and reporting according to the global guidelines. These guidelines provide a key framework for monitoring, reporting and verifying GHG emissions, ensuring compliance with the requirements of international standards, thus improving the transparency and reliability of data.
- A unique database has been prepared in IPCC software v 2.95, with data for the period from 2014 (reference year in NDC) to 2022. This step is critical to the long-term consistency of reporting and ensuring compliance with the requirements of the Paris Agreement, as well as for future revision and updating of inventory based on new data and requirements.
- Archiving all relevant information, by submitting QA/QC questionnaires, databases of used data, as well as software database to UNDP.

- The sectoral and reference approaches are clearly presented to ensure the accuracy of sector-specific data, taking into account the specific characteristics and needs of each sector for the calculation of emissions according to the IPCC methodology. In this way, precise monitoring of emissions is possible, taking into account all relevant changes and specificities by sector.
- Reporting on indirect greenhouse gas emissions (NMVOC, CO, NOx, SO2) is included in the document. Also, the reporting of PFC emissions from aluminium production has been improved.
- Engagement of an external quality assurance (QA) expert enabled additional verification and verification of data, which improved the accuracy and reliability of all reports.
- For the agriculture sector, emissions for the period from 2010 to 2018 were recalculated, which improved the accuracy of data for this sector, taking into account new approaches in the methodology.
- Calculation of the inventory from the agricultural sector according to the last categorization in accordance with the IPCC 2006 methodology and amendments from 2019, after which a recalculation was made until 2010.
- Implementation of updated input data on the annual amount of applied mineral fertilizer taken from the FAO database. In this part, due to changes in the input data of the animal population and methodology, a recalculation was made for the period 2010-2022.
- Calculation of CO_2 emissions from urea resulting from N in the implementation of mineral fertilizers,
- Budget of HFCs executed.

1.7 Plan for future inventory improvements

Suggestions for improving the inventory preparation process, described in this chapter, are the result of:

- Expertise, knowledge and experience of the expert team in charge of creating the inventory,
- Implemented capacity building activities through the involvement of all relevant institutions responsible for environmental protection, energy and energy efficiency,
- Conducted meetings, interviews and surveys with the FBiH and RS Hydrometeorological Institutes.

Using the above, the following was prepared:

- Proposals for improvement of the overall inventory preparation process, based on the improvement of institutional arrangements, data collection processes and sublimation of emission data at the state level, and
- Proposals to improve inventory calculation taking into account the specific requirements of each sector.

1.7.1 Improvement of the inventory preparation process

Proposals for improving the inventory preparation process are defined on the basis of:

- Review and identification of the main challenges that BiH faces in the process of creating inventory,
- Preparation of proposals for improving the inventory process,
- Collecting opinions, suggestions and proposals of institutions responsible for environmental and energy protection and

- Conducted meetings, interviews and surveys with the FBiH and RS Hydrometeorological Institutes.

BiH, as a Non-Annex I country, faces a number of challenges in the process of preparing the inventory:

- Preparation of the greenhouse gas inventory is performed within the projects financed by international financial institutions, with a noted lack of experts in authorised institutions for the preparation of inventory,
- Institutional arrangements and coordination of institutions in the process of collecting, processing and submitting data,
- Lack of a standardised methodology for data collection, incomplete or inconsistent data, and limited access to relevant data;
- Lack of harmonised databases with data from both entities and BDs on activities, emission factors and emissions for the period since 1990,
- Inconsistency between existing data and data necessary for calculation according to the IPCC methodology,
- Lack of legislation on the type and scope of data collected in BiH.

The lack of a standardised methodology for data collection, incomplete or inconsistent data, and limited access to relevant data are problems that significantly hamper the accuracy and consistency of inventory. These challenges can lead to inaccurate emission estimates and make it difficult to produce reliable reports. Also, the lack of harmonised databases covering data on emissions, activities and emission factors for the period since 1990 is a significant aggravating circumstance for showing the complete and consistent trend of emissions.

To overcome these challenges, it is necessary to introduce standardised data collection methodologies that will enable consistency and alignment with international practices. In addition, it is necessary to continuously work on harmonizing the data collected, analyzed and presented in statistical reports (at the BiH and entity levels), with the data needed for the calculation of greenhouse gas inventories according to the IPCC guidelines from 2006, taking into account the improvements from 2019 (Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories). It is necessary to improve the legislative framework and oblige entity and cantonal ministries to provide data in line with laws and regulations.

Also, it is necessary to create harmonized databases between the entities, with the aim of enabling the simpler consolidation of data on emissions in BiH, which would enable easier analysis and reporting. Improving institutional arrangements and coordination among relevant institutions is also crucial for efficient data collection and exchange, and it is especially important to comply with legislation that would define the type and scope of data collected in BiH.

In accordance with the RS Law on Air Protection, the RS Hydrometeorological Institute is in charge of preparing the GHG inventory for the RS, while, in accordance with the Law on Air Protection of the FBiH of September 2024, the FBiH Hydrometeorological Institute is in charge of preparing the GHG inventory for the FBiH, which, upon the adoption of bylaws and rulebooks, will start making the inventory. In this regard, it is necessary to ensure the existence of a joint body in BiH, for the consolidation of entity inventories into an inventory for BiH, which will include emissions from both entities, with the addition of emissions for the area of Brčko District (BD BiH). In addition, it is important to strengthen the capacities of institutions (hydrometeorological institutes) through additional training and employment of experts, in order to ensure the sustainability and quality of the inventory on a long-term basis. In order to improve the quality of inventory, it is recommended to participate in trainings and projects such as, among other things, RIPAP and CBIT projects. Some of the units that should be included in the training are data collection and analysis, improvement of inter-institutional cooperation and the use of software tools for calculating emissions.

In order to define the initial state and improve the consistency and completeness of the time series, it is necessary, through recalculation by 1990, to determine the zero/initial state according to the latest methodology. In this inventory, the flexibility of presenting data from 2014 as a base year in the NDC was used, and a recalculation was made for the period 2014 – 2018. For all sectors, especially for the LULUCF sector, additional methods of data collection should be introduced, as well as the implementation of expert analyses that will improve the data used for the creation of the inventory, and new methods of data collection should be found.

The introduction of mandatory regular meetings between institutions, strengthening the capacity of institutions through education and additional resources, and forming a Technical Working Group composed of representatives of the competent hydrometeorological institutes of the RS and FBiH, as well as representatives of the BD BiH responsible for the preparation of the inventory that will oversee reporting, could improve coordination between the institutions participating in the creation of the inventory. It is necessary to appoint persons in front of the institutions who will submit and verify the data, which is defined by the RS Law on Air Protection (Article 50, RS Official Gazette Nos. 124/11, 46/17) and the FbiH Law on Air Protection (Article 44, FbiH Official Gazette No. 72/24). Also, it is necessary to strengthen the awareness of institutions about the importance of inventory, about the importance of using inventory data for NDCs and about the importance of providing data in the manner required by those who create the inventory.

For the successful preparation of the GHG inventory, it is necessary to improve the process of its development by strengthening the capacities of institutions, including financial and human resources. The key problems related to the financing of this process are the lack of budget for research, data collection and analysis. The best way to secure stable funding is to increase the budget for this area. Applying for international projects and funds and introducing mandatory contributions from the high-emitting sector would help to secure stable financing.
Better digitisation and standardisation of data and greater participation of academic and research institutions would improve the quality and availability of data.
Greater investment in education and awareness raising on climate change could improve policies and measures to reduce emissions. Introduction of stricter regulatory frameworks and control mechanisms for polluters, as well as financial and technical incentives for the transition to OiE, would contribute to further reducing emissions.

1.7.2 Improvement of inventory calculation by sectors

As part of the GHG inventory process, experts from relevant sectors analyzed current methods of data collection and emission calculations, and proposed concrete improvements that would contribute to the accuracy, consistency and efficiency of emissions reporting. The proposals, which are summarized in the following table, are aimed at improving each of the sectors included in the emission calculation according to the guidelines of the IPCC methodology, in order to ensure compliance with international standards and improve the quality and precision of the data used in the inventory process.

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Table 12: Recommendations to improve sectoral reporting

Sector	Recommendations for improvement
Energy	• Improvement of data delivery by operators and submission of data required for Tier 2 • Harmonization of background data from statistical reports • Submission of data on total consumption and type of energy products used in industrial power plants with data on which industry they belong to • Preparation of a list of closed mines • Implementation of recalculation for the period from 1990 to 2014
Transport	• Improving the consistency and completeness of the time series for the collected energy balance data for the rail sectors (1.A.3.c) • Consideration of railway transport through a separate category in statistical reports for the calculation of emissions from railway transport, because according to the current categorization it is included in the total traffic • Transition to Tier 2 emissions calculation at least for road transport • Implementation of recalculation for the period from 1990 to 2014
Industrial Processes and Product Use	• Use of data from other statistical sources (EUROSTAT, FAO) • Involve more experts with different expertise in the field of industry • The Need for continuous data collection with a concerted approach • Improving the consistency and completeness of data collection • Implementation of recalculation for the period from 1990 to 2014 • Calculation of F-gas emissions
Waste	• Necessity of continuous data collection and constantly involved institutions • Re-checking and improving access to data collection and calculation • Implementation of recalculation for the period from 1990 to 2014
Agriculture	• Harmonization of values by categories and subcategories from entity statistical institutes with the Agency for Statistics of BiH before publishing data • Keeping records on the number of mules and donkeys, for which there are currently no data • Development of National Factors for Fertilizer Management Systems • Keeping records of the number and size of lagoons where manure is deposited and the amount of liquid manure/seed, which is deposited on arable land (bare or sown land as organic fertilization), as well as the application of best practices that prevent leakage, i.e. contribute to higher GHG emissions • Keeping records of actually applied mineral fertilizers based on the balance of fertilizers sold from agricultural pharmacies or surveys of farmers or agronomists employed on large farms (intensive fruit growing, etc.) • Adapting data collection methods to the needs of IPCC Software • Intensify research on Tier 2 data in livestock feeding practices, manure management, fertiliser use in agriculture to encourage the implementation of best practices and reduce emissions from the sector • Implementation of recalculation for the period from 1990 to 2010 • Data collection and calcification calculation • Calculation of emissions from fires on agricultural and grassland • Calculation of other indirect emissions from agriculture
Forestry	• Improving collection of data on the percentage of burned areas by type of area • Calculation of burned areas from the area of BD BiH • Organization of training by international experts and additional strengthening of HR capacities for conducting inventory • Calculation of sinks resulting from land-use change

	• Implementation of recalculation for the period from 1990 to 2014

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2 Circumstances, Institutional Arrangement and Cross-Sectoral Activities in Bosnia and Herzegovina

2.1 Circumstances and Institutional Arrangement

BiH is a sovereign state with a decentralised political and administrative structure, consisting of two entities: RS and FBiH, and BD BiH.

In BiH, the obligation to prepare the GHG inventory is regulated by laws at the entity level. In the FBiH, Article 44 of the Law on Air Protection (Official Gazette of the Federation of BiH, No. 72/24), establishes the GHG inventory, which is kept by the FBiH Hydrometeorological Institute. Ministries and other federal administrative bodies, as well as public companies, are obliged to submit the necessary data to the Institute free of charge by the end of December of the current year for the previous calendar year. The Law on Air Protection was adopted in the FBiH in September 2024, and is currently in the process of preparing bylaws and regulations that will describe in detail the methodology and process of creating an inventory. In the FBiH, the GHG inventory has not yet been officially made for a single year.

In the Republika Srpska, the obligation to make a GHG inventory is defined by the Law on Air Protection (Official Gazette of the Republika Srpska, Nos. 124/11, 46/17). The competent institution for the preparation of the GHG inventory for the Republika Srpska is the RS Hydrometeorological Institute. In accordance with the said Law, the RS authorities and organizations, operators and authorized legal entities are obliged to timely and free of charge submit to the Institute the data necessary for the preparation of the GHG inventory, as well as other data necessary for the management of the air quality information system. This legal obligation allows for the collection of data from different sectors and emission sources, thus ensuring the comprehensiveness and accuracy of the inventory. For purposes of calculating emissions, the IPCC methodology prescribed by the Convention shall be used. The RS Hydrometeorological Institute publishes a report on the GHG inventory every year. In the RS, there are still no legislative documents on the methodology and process of making inventories. In accordance with the aforementioned law, the Institute is the Reference Center for Air Quality, Air Emissions and Climate Change Mitigation, which plays a key role in the exchange of data in accordance with international obligations. This exchange is carried out with the prior consent of the Ministry of Spatial Planning, Construction and Ecology of the Republika Srpska. In BD BiH, there is no clearly defined institutional competence for the development of GHG inventory, so data are collected *ad hoc* within technical projects, most often through direct communication with the departments for communal and spatial affairs.
At the BiH level, the MVTEO BiH is responsible for policy making and coordination of activities in international relations related to the environment and energy. However, specific environmental and energy issues are the responsibility of the entity governments. The Ministry of Spatial Planning, Construction and Ecology acts as the focal point of BiH according to the UNFCCC. In the FBiH, the Ministry of Environment and Tourism is responsible for these issues, while in BD BiH, the Department of Communal Affairs is responsible.

2.1.1 Focal point of BiH towards the UNFCCC

The Council of Ministers of Bosnia and Herzegovina, at its 66th session held on May 16, 2002, adopted the proposals and issued a conclusion by which it adopted the proposal of the organisational arrangement and bodies for the coordination of international environmental agreements (conventions) in BiH. The Ministry of Spatial Planning, Construction and Ecology of the Republika Srpska coordinates the implementation activities of the UNFCCC.

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2.1.2 Inventory Preparation Process in BiH

In the FBiH, according to the Law on Air Protection, the FBiH Hydrometeorological Institute is in charge of preparing the inventory, while in the RS, the same task is assigned to the RS Hydrometeorological Institute. At the entity level, the relevant legal documents prescribing the procedure for reporting and collecting data have not yet been adopted.

Until now, the creation of an inventory in BiH for purposes of reporting according to the Convention has been carried out through the engagement of experts who are not employed in the competent institutions, i.e. they are contracted through the implementing agency – UNDP BiH. In addition to the expert team, an expert in quality assurance and quality control (QA/QC) is also hired to create the inventory, who is in charge of reviewing the data used, methodology and calculation results, and identifying and minimizing potential errors in the inventory. QA/QC activities are carried out in parallel with the creation of the inventory, in accordance with IPCC guidelines and good international practices

In absence of a formally established institutional mechanism at the BiH level, the development of an inventory of GHG emissions in BiH relies on a clearly defined operational approach. Below are the key steps that are performed in the development of the inventory in BiH, from initial consultations with relevant actors to the finalization of emission calculations and presentation of results. This process involves several phases of interconnected activities of the expert team, the institutions in charge of data delivery, with the control of QA/QC experts.

1. **Introductory workshop with stakeholders**

As the first step in the inventory development process, the Implementation Unit organizes a workshop with relevant institutions and sectors with the aim of presenting the inventory methodology, the time (dynamic) work plan, as well as the expert team in charge of inventory preparation. This phase serves to establish cross-sectoral communication and coordination.

2. **Preparation and distribution of questionnaires for data collection**

The expert team prepares sectoral questionnaires for the collection of certain data in accordance with the IPCC methodology and submits them to the entity hydrometeorological institutes, which collect data in accordance with their competencies.

3. **Data collection and delivery**

Entity hydrometeorological institutes (FHMZ and RHMZ) collect data in accordance with their competencies, and submit them to the expert team in a predefined format and deadline. In addition, the expert team collects the remaining necessary data, processes it and calculates the emissions.

4. **Data processing and calculation of emissions**

The expert team performs validation and processing in IPCC software (the latest available version at the time of inventory preparation), applying the IPCC 2006 and 2019 Refinement guidelines. On the basis of the above, CRT tables are made and an inventory document for BiH (NID) is prepared.

5. **QA/QC – Quality Assurance and Quality Control**

Throughout the process, a QA/QC expert conducts checks on the accuracy, consistency and completeness of the data, methodology and calculation results. Within the framework of the document, a proposal for a future QA/QC plan is made, given in Attachment III.1.

6. **Presentation of the draft to stakeholders**

Upon completion of the technical draft, a consultative workshop with stakeholders is organized to present the preliminary results and collect comments, suggestions and additional information.

7. **Capacity building and institutional support**

Throughout the process, activities are performed to strengthen the capacity of institutions in charge of data submission and sectoral cooperation, with the aim of improving the quality, regularity and institutional memory of GHG inventories.

8. **Submission of the final document and CRT table**

After the adopted suggestions have been collected during the presentation of the draft, the final greenhouse gas inventory document is prepared, together with CRT tables, and submitted to the implementation unit, which further forwards the documentation to the UNFCCC focal point (Ministry of Spatial Planning, Construction and Ecology of the Republika Srpska).

2.1.3 Archiving information

According to Decision 24/CP.19, at the 19th United Nations Climate Change Conference (UNFCCC) the archiving is prescribed for:

- Disaggregated emission factors and activity data, used for the calculation of emissions,
- Documentation of how these factors and data were generated and aggregated for inventory preparation,
- Internal documentation of QA/QC procedures,
- External and internal overviews and documentation on the annual key categories and the identification of key categories; and
- Planned inventory improvements.

The expert team in charge of compiling the greenhouse gas inventory submits the archived information to the implementing agency, which shares it with the UNFCCC focal point.

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2.1.4 Process of Official Adoption and Approval of Inventory

The process of official adoption of the greenhouse gas inventory in BiH follows clearly defined steps to ensure transparency and compliance with international obligations. The process of official adoption and approval of the inventory includes the engagement of:

- Consulting companies (expert team) in charge of creating inventory,
- Implementing Agencies – UNDP BiH,
- Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina (MVTEO),
- entity governments, the government of BD BiH,
- Council of Ministers,
- National focal points for reporting under the UNFCCC.

After the preparation of the national emission inventory, the consulting company hired for the preparation submits the report to the UNDP BiH Implementation Agency, which distributes it to the MVTEO BiH. The MVTEO BiH submits a report to the competent ministries of the FBiH, RS and BD BiH entities for an opinion, which is adopted by the entity governments after harmonization and submitted to the Council of Ministers for adoption.

After adoption by the Council of Ministers, the Ministry of Spatial Planning, Construction and Ecology of the Republika Srpska, as BiH's focal point for the UNFCCC, sends the official version of the document for UNFCCC review. After that, the document goes through a process of revision by international UNFCCC experts.

2.2 Inventory Methodology

The inventory for the period from 2014 to 2022 used the methodology set out in the 2006 UNFCCC guidelines, taking into account the improvements from 2019[1]. The calculation of indirect emissions was made using the guidelines of the EMPE/EEA methodology. A Tier 1 approach was used, which is based on general emission factors and methodologies, where GHG emissions were estimated using the formula:

$$Emission = AD * EF$$

Whereas:

- Emission = CO_2 emissions,
- AD = Activity data, and
- EFa = Emission factor.

Emissions were documented and archived using IPCC Inventory software (v 2.95). Emissions are estimated for each sector based on data collected from the sources mentioned in the previous section. In accordance with the guidelines, carbon sinks are also estimated and included in the inventory assessment.
In order to ensure consistency of the GHG inventory, a recalculation of the time series was performed, for the period 2014-2018. It is also recommended that a complete recalculation be made for the previous period (1990-2014).

[1] Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

In accordance with the requirements of the BTR, all calculations made are explained in the textual part of the report, including the inputs used, their sources and the operations used, ensuring clarity and transparency.

2.2.1 Determination of key categories

After the calculations of GHG emissions were made, the identification of key categories was carried out in accordance with the IPCC 2006 guidelines. A key category analysis was conducted for the GHG inventory to identify the main sources of GHG emissions, so the sources available for inventory preparation were prioritized to improve GHG emission estimates for these major sources. The analysis of the key categories was carried out for CO_2 equivalent (CO_2-eq) emissions.

The analyses were perforemd at the level of categories defined by the IPCC (in accordance with available data), using CO_2-eq emissions and global warming potential AR5 GWPs (100 year time horizon). The level assessment was then prepared by identifying key categories through the so-called "level assessment" and "trend assessment" (with and without LULUCF). Key categories are those that, when added together in descending order of magnitude, contribute up to 95% of the total cumulative level (100%).

2.2.2 Preparing the QA/QC plan

In accordance with the planned work methodology and IPCC guidelines from 2006, internal and external QA/QC procedures are carried out within the preparation of the GHG inventory for BiH. The aim of these procedures is to ensure the accuracy, completeness and consistency of data and calculations, which contributes to the credibility and reliability of the report.

Internal QA/QC procedures are performed by the Support and Management Consulting Team, which consists of the Team Leader, Project Coordinator and QA Manager. These procedures include continuous verification of data and budgets within the team, and documentation of all QA-related activities through prepared questionnaires by QA/QC experts, which are attached to the document.

External QA/QC procedures are performed by an independent expert hired by the Implementing Agency (UNDP), who performs independent audits and quality analyses, ensuring objectivity and additional confirmation of the accuracy of the inventory.

QC involves a system of routine technical activities aimed at assessing and maintaining data quality during inventory preparation. These activities are performed by the staff in charge of compiling the inventory, and the QC system is designed to:

- Ensure routine and consistent checks on the integrity, correctness and completeness of data,
- Identifies and addresses errors and omissions by comparing the collected data with historical data, determined emission factors, and implementing corrective actions in case of discrepancies.
- Documents and archives data and records all quality control activities.

QC activities include:

- Verification of accuracy of data entry and calculations through internal audit of the entered values in the IPCC software,
- Control the use of approved and standardized methods for the calculation of emissions and sinks in accordance with the IPCC guidelines.

- Comparing data between years to identify discrepancies or illogic items, with explanations thereof,
- Review of input data and data sources by team members to check consistency,
- Archiving all key information and background used for calculations, including notes, input files, and correspondence, to ensure transparency and the possibility of future checks.

QA refers to planned and systematic activities that are performed to ensure that inventory processes are correct and consistent over time. These activities include:

- Independent review and verification of data by external experts,
- Verification and validation of the methods and input data used,
- Periodic audits and assessments of the quality control system,
- Preparation of detailed reports on the conducted QA/QC activities and their results,
- Identification of key weaknesses and suggestions for their elimination.

External experts perform a final quality review, ensuring that the inventory is prepared in accordance with scientific knowledge, available data and international guidelines. This process contributes to increasing the credibility of the data and enables its reliable use in the development of policies and strategies to reduce greenhouse gas emissions.
The following chart shows the scheme of QA/QC procedures and parties involved in the preparation of the greenhouse gas inventory for BiH.

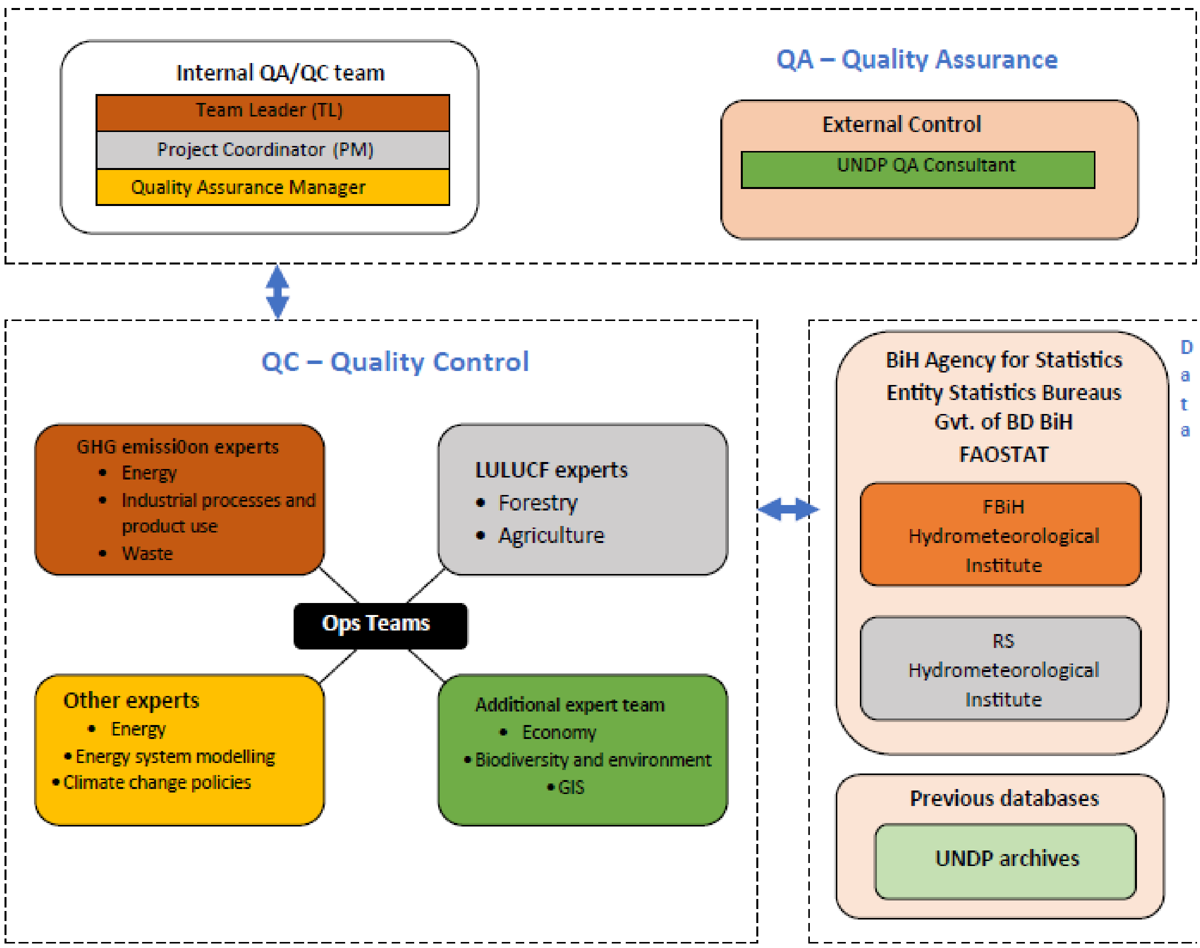

Chart 8: Scheme of QA/QC procedures and stakeholders

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The QA/QC system is a key segment of quality management within the preparation of the GHG inventory and ensures that the data is accurate, complete and consistent, thus enabling informed decisions based on reliable data on greenhouse gas emissions and sinks in BiH.

2.2.3 Conducting uncertainty analysis

Estimating calculation uncertainty is one of the key parts of the emissions inventory. Uncertainty information does not diminish the value of the calculation, but rather helps to prioritize steps to improve the accuracy of the calculation and facilitates the choice of methodological options. There are several reasons why actual emissions and sinks differ from the values obtained by calculation within the inventory. Some sources of uncertainty can provide well-defined and easily characterized estimates of the range of possible errors, while others are difficult to define precisely. The total estimated uncertainty of emissions from individual sources is the result of a combination of individual uncertainties in the emission estimate, including:

- Uncertainty related to emission factors and
- Uncertainty related to activity data.

CO_2 emissions resulting from fuel combustion depend on the amount of fuel used (energy balance), its energy value, carbon emission factors (default values from the IPCC manual), and the proportion of oxidized carbon (default values from the IPCC manual).

A qualitative uncertainty analysis was performed for each of the sectors, using the recommendations from the IPCC guidelines.

2.3 Data completeness analysis

Previous emission inventories for BiH covered the period starting in 1990. During the preparation of this inventory, the expert team recalculated the data for the period 2014 - 2018, harmonizing them with the new data for the period 2019 - 2022. Based on this, and with implementation of available flexibility within MPGs, it was decided to use the period 2014 – 2022 as the baseline time series for this reporting cycle, in order to enable comparability of the presented and analysed data.

Where the input data allows, trends covering the period since 1990 are also presented, with the aim of preserving continuity and transparency of long-term changes in emissions. In accordance with the above, an integrated database for the period 2014–2022 has been entered in the IPCC Inventory Software (v 2.95). Given that the calculation of emissions for the period prior to 2014 was made using different methodological guidelines – IPCC Guidelines for National Greenhouse Gas Inventories (1996) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories – there was an inconsistency in the approach and the impossibility of direct comparison with the data for the period after 2014, which were recalculated in accordance with the recommendations of the 2019 Refinement to the 2006 IPCC Guidelines. This situation leads to a violation of the TCCCA (Transparency, Consistency, Comparability, Completeness and Accuracy) principles.

In order to establish a completely consistent and methodologically uniform time series since 1990, in the future it will be necessary to perform additional harmonization and creation of a single database for the entire period 1990–2022. In addition, the completeness analysis showed that there is a lack of emissions data for the transport sector for the period 1991-2001.

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When it comes to geographic coverage, it is important to note that through the preparation of the GHG inventory for the period 2019-2022, as well as for the recalculation of 2014-2018, data were collected from the entire country (two entities and BD BiH).

2.4 Analysis of the applied Flexibilities in Inventory Preparation

The flexibilities related to the GHG inventory contained in MPGs, which were used in the preparation of the GHG inventory of BiH for the period 2019-2022, including the recalculation for 2014-2022, are shown in the following table.

Table 13: Overview of flexibilities applied (Decision 18/CMA.1)

Flexibility	Description	Implementation
Para. 57 - Flexibility in terms of time series reporting	Countries may report data covering, at a minimum, the reference year/period for their NDC under Article 4 of the Paris Agreement and, in addition, a consistent annual time series from at least 2020 onwards.	In accordance with the aforementioned flexibility, the inventory report of BiH will use 2014 as the base year. The analysis of key categories and the analysis of uncertainty are done in relation to the year that is the reference year in the NDC – 2014.
Para. 48 – Flexibility in relation to emissions reporting	They shall declare at least three gases (CO_2, CH_4 and N_2O), as well as any of the additional four gases (HFCs, PFCs, SF6 and NF3) included in the NDCs of the Parties pursuant to Article 4 of the Paris Agreement; they are included in activties according to Article 6 of the Paris Agreement or have been previously reported.	In the Greenhouse Gas Inventory of BiH, emissions of the following gases have been calculated: CO_2, CH_4 and N_2O, HFCs and PFCs.
Para. 34 – Flexibility in the development of a QA/QC plan	Developing countries are encouraged to develop a QA/QC plan in line with IPCC guidelines	So far, the GHG inventory in BiH has not included a QA/QC plan. The expert team prepared a QA/QC plan that was followed during the development of the inventory for BiH for the period 2019-2022. The same form of QA/QC plan can be used for future reporting (Attachment III.I of the report)
Para. 57(b) – Flexibility in relation to reporting data for years x-2	Parties that are unable to provide complete data for year x-2 may use data for year x-3 as the last reporting year, with a rationale.	Given the challenges in data collection and processing, the GHG inventory for BiH for the first BTR covers the period up to 2022 (x–3), with an explanation of methodological and institutional limitations.

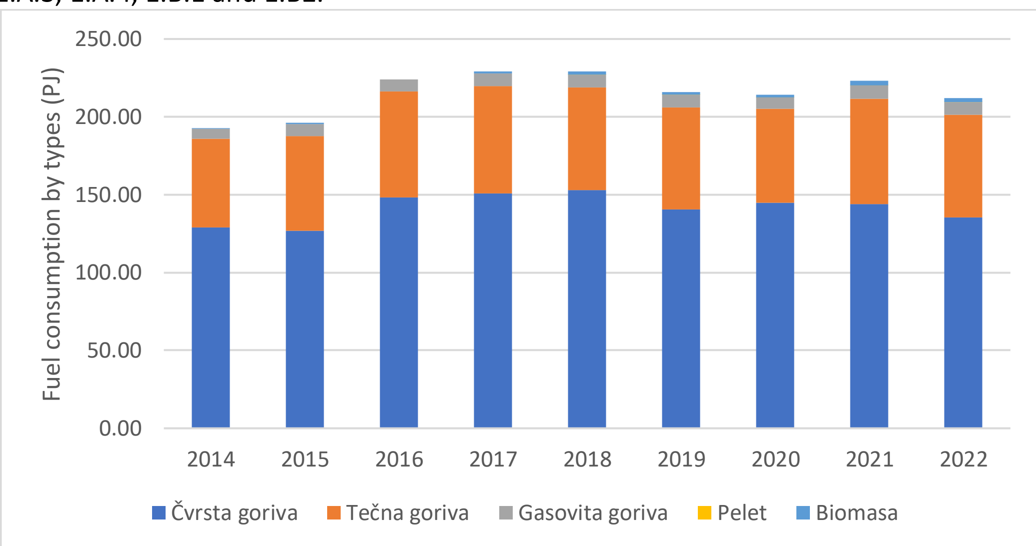
3 Energy (CRT sector 1)

3.1 Basic information about the sector

Energy is the dominant sector in BiH when it comes to CO_2 emissions. The contribution to emissions ranges from 72 to 75%. This sector covers all activities that involve the consumption of fossil fuels for energy purposes, as well as fugitive emissions that occur during the production, transmission, processing, storage and distribution of fossil fuels. The energy sector implies energy consumption in the following sub-sectors, in accordance with the IPCC 2006 methodology:

- **1.A.1:** Energy industries, including thermal power plants, cogeneration - combined heat and power, district heating (heating plants), oil and oil refining;
- **1.A.2:** Manufacturing industries,
- **1.A.3:** Transport,
- **1.A.4:** Other sectors, including domestic heating, public facilities and fuel consumption in agriculture, forestry, etc.
- **1.A.5:** Not specified,
- **1.B.1:** Fugitive emissions from solid fuels,
- **1.b.2:** Fugitive emissions from oil and natural gas;
- **1.B.3:** Other emissions from energy production,
- **1.C.1:** CO_2 transport,
- **1.C.2**: Injection and storage,
- **1.C.3:** Other

This report covers emissions from activities in the energy sector classified under subsectors 1.A.1, 1.A.2, 1.A.3, 1.A.4, 1.B.1 and 1.B2.



(LEGEND: Čvrsta gorive – Solid fuels; Tečna goriva – Liquid fuels; *Gasovita goriva* – Gaseous fuels; *Pellets* – Biomasa – Biomass.)

Chart 9: Fuel consumption by type in the CRT 1 Energy sector in the period 2014 – 2022

The chart provides an overview of fuel consumption by type in the energy sector in the period 2014-2022. The largest share in consumption is held by solid fuels, where coal-lignite predominates (preferably the energy sector), followed by liquid fuels (mostly the transport sector), gaseous fuels

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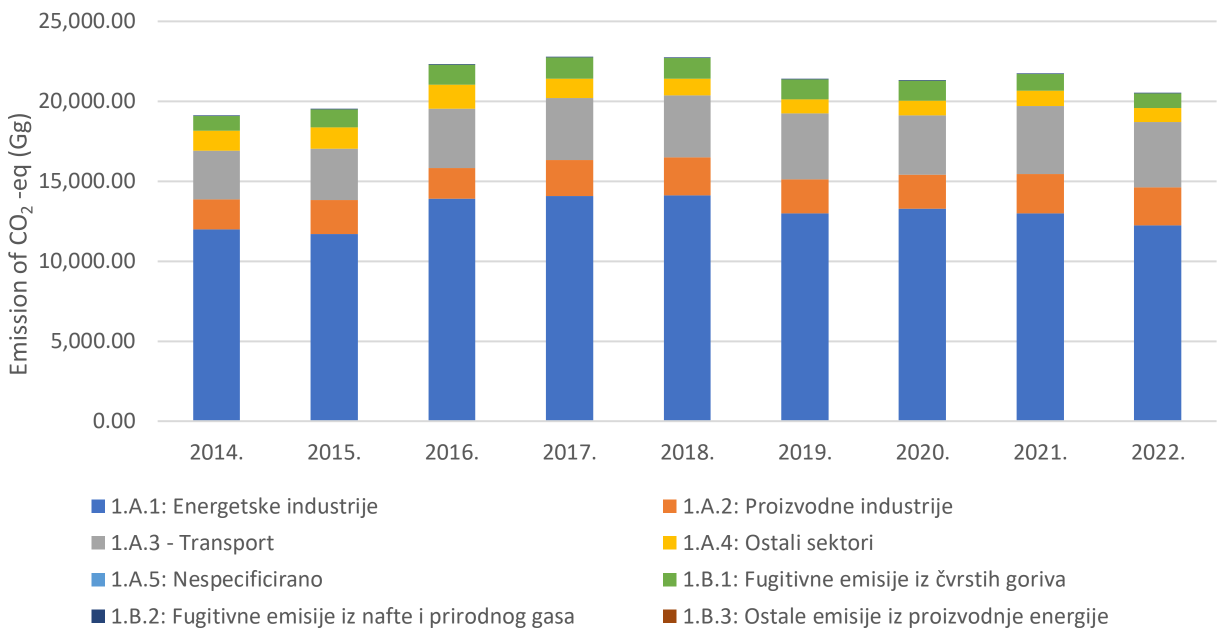
and negligible small shares of biomass and pellets. The source of data on fuel consumption is the Agency for Statistics of BiH and entity statisticc bureaus.

The following chart provides an overview of GHG emissions expressed as CO_2-eq in the Energy sector for the period 2014-2022.



(LEGEND: Energetske industrije – Energy industries; Transport – Transport; Nespecificirano – Unspecified; Fugitivne emisije iz nafte i prirodnog gasa - Fugitive emissions from oil and natural gas; Proizvodne industrije – Manufacturing industries; Ostali sektori – Other sectors; Fugitivne emisije iz čvrstih goriva – Fugitive emissions from solid fuels; Ostale emisije iz proizvodnje energije – Other emissions from energy production.)

Chart 10: CO_2-eq emissions of all categories in the CRT 1 Energy sector in the period 2014 – 2022

The energy subsector (1.A.1) contributes the most to total emissions from the Energy sector, accounting for 63% of the total emissions of the entire sector in 2014 and 60% in 2022. In the observed period 2014 - 2022, there was a noticeable increase in the share of emissions from the manufacturing industry and transport, while the share of emissions from other sectors, as well as fugitive emissions from fuels, is slightly decreasing.

In 2022, CO_2-eq emissions in the energy sector amounted to 20,504.47 Gg CO_2-eq, which is 22.97% lower compared to 26,619.47 Gg in 1990. This decrease is attributed to the decline in industrial production, as well as structural changes in the industry.

3.2 Fuel Combustion (CRT 1A)

The fuel combustion subsector of the IPCC 2006 guidelines covers emissions from the direct combustion of fossil fuels and biomass for power generation, heating, industrial processes, transport and other uses. The main categories include:

- 1.A.1: Energy industries, including thermal power plants, cogeneration-combined production of electricity and thermal energy, district heating (heating plants), oil and oil refining;
- 1.A.2: Manufacturing industries,
- 1.A.3: Transport,
- 1.A.4: Other sectors, including domestic heating, public facilities and fuel consumption in agriculture, forestry, etc.
- 1.A.5: Not specified.

Category 1.A Fuel combustion activities accounted for 95.18% of greenhouse gas emissions in 2014, and 95.53% in 2022 in category 1 Energy. Category 1A accounts for 68.08% of total GHG emissions in 2014 and 69.88% in 2022. Within Category 1A, a number of key subcategories have been identified. Consumption of solid fuels in the energy industries (1.A.1) was the key category in 2014 and 2022 according to the analysis by level, and in 2022 according to the analysis by trend. In industry and construction (1.A.2), the consumption of solid and liquid fuels was recognized as key categories according to the analysis by level in 2014 and 2022, while the consumption of gaseous fuels was key according to the analysis by level only in 2022. Road transport – liquid fuels (1.A.3.b) was the key category both by level in 2014 and 2022 and by trend in 2022. In other sectors (1.A.4), the consumption of liquid and solid fuels was recognized as key categories in 2014 and 2022, while emissions from gaseous fuels were key only according to the trend analysis.

3.3 Comparison of sectoral and reference approaches

The estimate of emissions for the period 2019-2022 is based on data on fossil fuel consumption from annual energy balances for individual fuels published in the bulletins of the Agency for Statistics of BiH. For the sectoral approach, based on the collected data, emissions were estimated using IPCC 2006 Software, in accordance with the IPCC 2006 methodology (Tier 1). The IPCC 2006 methodology allows to ensure the principles of transparency, completeness, consistency, comparability and accuracy of calculations. The methodology requires the assessment of the uncertainty of the calculation and the verification of input data and results, in order to increase the quality, accuracy and improvement of the reliability of the calculation/estimate.

The estimation of emissions using the reference approach was carried out using the data of the total fuel balance at the level of BiH. It is an internal method of verifying the emission estimate, i.e. checking the matching with the results obtained using the sectoral approach. On the basis of detailed data on production (only in the case of primary fuels), imports, exports and stocks for individual fuels, the total amount of a particular fuel available for consumption was calculated, the consumption of which is recorded through a sectoral approach. For all fuels except coal and lignite, the lower heat outputs given by the methodology were used. Given that there was data on lower thermal capacities for the coal used in thermal power plants, a weighted value based on weighted values for the period 2014-2022 was used in the reference approach.

Table 14: Comparison of reference and sectoral approach

Year	Fuel	Reference approach CO_2-eq emissions (Gg)	Sectoral approach CO_2-eq emissions (Gg)	Difference (%)
2014	Liquid fuels	4,322.29	4,109.5	5.17
	Solid fuels	14,413.99	13,542.10	6.44
	Gaseous fuels	357.02	359.72	-0.75
	Total	**19,093.30**	**18,011.58**	**6.01**
2015	Liquid fuels	4,496.65	4,423.58	1.65
	Solid fuels	14,446.53	13,344.35	8.26
	Gaseous fuels	415.73	449.37	-7.48
	Total	**19,358.92**	**18,217.30**	**6.27**
2016	Liquid fuels	5,106.34	4,974.13	2.66
	Solid fuels	16,269.80	15,442.38	5.36
	Gaseous fuels	439.21	447.03	-1.75

	Total	**21,815.35**	**20,863.54**	**4.56**
2017	Liquid fuels	5,100.92	5,016.92	1.67
	Solid fuels	17,003.94	15,714.90	8.20
	Gaseous fuels	474.99	471.34	0.77
	Total	**22,579.84**	**21,203.16**	**6.49**
2018	Liquid fuels	4,907.15	4,778.13	2.70
	Solid fuels	17,362.66	15,962.39	8.78
	Gaseous fuels	473.37	470.11	0.69
	Total	**22,743.17**	**21,212.06**	**7.21**
2019	Liquid fuels	4,908.07	4,785.22	2.57
	Solid fuels	15,929.54	14,717.17	8.24
	Gaseous fuels	446.18	426.10	4.71
	Total	**21,283.79**	**19,929.91**	**6.79**
2020	Liquid fuels	4,492.96	4,416.09	1.74
	Solid fuels	16,812.09	15,037.55	11.80
	Gaseous fuels	407.77	410.68	-0.71
	Total	**21,712.83**	**19,866.30**	**9.29**
2021	Liquid fuels	5,071.07	4,961.80	2.20
	Solid fuels	16,327.79	15,045.00	11.29
	Gaseous fuels	491.43	479.00	2.59
	Total	**22,305.48**	**20,487.66**	**8.87**
2022	Liquid fuels	4,954.57	4,822.10	2.74
	Solid fuels	15,964.21	14,132.86	12.96
	Gaseous fuels	478.98	464.65	3.08
	Total	**21,397.76**	**19,419.85**	**10.19**

It is clear from the table above that the total emissions calculated using the reference approach are consistently higher than the emissions obtained by the sectoral approach, in all years of the analyzed period (2014-2022). The difference between these two approaches varies from year to year, ranging from around 4.5% (2016) to over 10% (2022), when the largest overall discrepancies (10.19%) were recorded.

The largest differences occur in the estimation of emissions from solid fuels, especially in the years 2020, 2021 and 2022. In these years, the gap between the reference and sectoral approaches for solid fuels is more than 11%. The reason for this difference probably lies in the fact that the reference approach used data on the amount of anthracite/hard coal consumed, while in the sectoral approach emissions were calculated on the basis of the amount of coke produced, according to the Tier 1 methodology. For liquid and gaseous fuels, the differences are significantly smaller and generally remain below 3%, indicating a higher level of consistency between actual consumption in sectors and balance sheet records.

According to a report by the International Energy Agency (IEA), fuel combustion emissions for BiH in 2022 amounted to 20.6 Mt CO_2, or 20,600 Gg CO_2.[2] By comparing the stated emission values with emissions from the sectoral approach, it is evident that the difference in emissions of the national emission inventory for BiH and emissions according to IEA data is 6%, which indicates a relatively good harmonization of the input data used and the calculation method in both reports.

[2] Retrieved from https://www.iea.org/countries/bosnia-and-herzegovina/emissions#what-are-the-main-sources-of-co2-emissions-in-bosnia-and-herzegovina on 02.04.2025.

3.3.1 International bunker fuel emissions

According to the 2006 IPCC Guidelines, International Bunker Fuel Emissions refers to GHG emissions from the combustion of fuels used in international air and sea transport. These emissions are excluded from the national total emissions, and are reported separately from the national totals because they are attributed to international transport and not to a country's domestic emissions inventory.

Taking into account international aviation, emissions come from fuel that is refueled at airports in BiH for international flights. The main sources of data are airlines, airports (Sarajevo, Banja Luka, Tuzla, Mostar) and competent civil aviation authorities. Fuel used for international flights (JET A-1) must be excluded from the total aviation fuel consumption.

Given that BiH has a very limited sea coast (Neum) and does not have a large international maritime trade, emissions from international shipping are minimal or negligible. On the other hand, there may be some fuel consumption for international river flows (Sava transport), so it would be useful to obtain data from shipping companies and harbour master's offices.

The following chart shows the trend of CO_2 emissions from international aviation for the period 2014-2022. The data indicate a gradual increase in aviation emissions, with a particularly pronounced increase in 2022, which may indicate the recovery of international air traffic after pandemic restrictions and an increase in the number of flights from BiH to abroad.

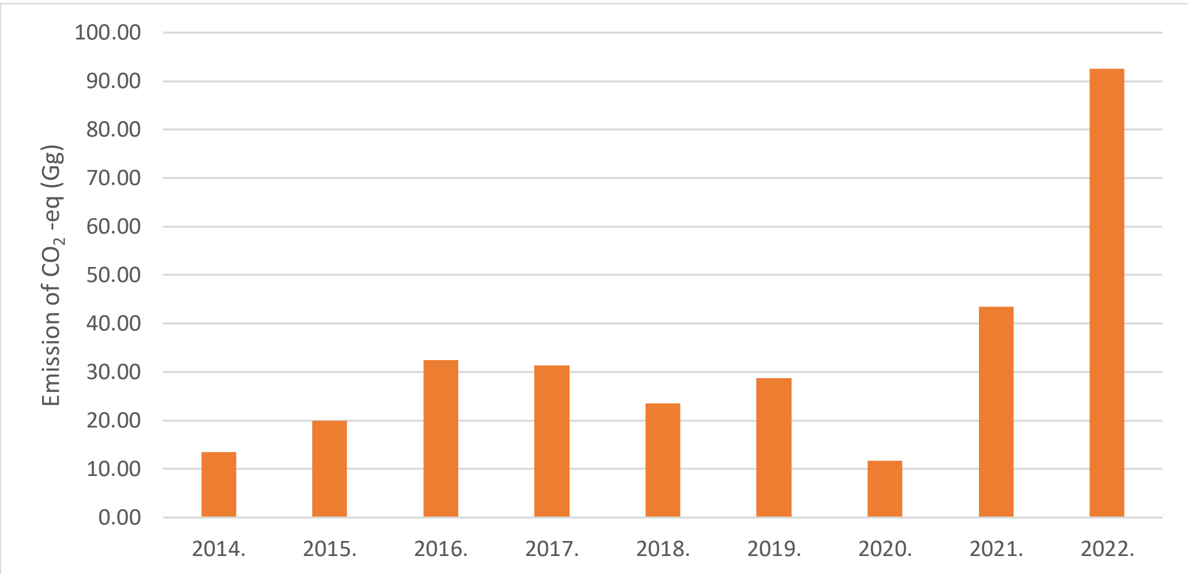


Chart 11: CO_2 - eq emissions from international bunkers/aviation in sector 1.A.3 Transport in the period 2014 – 2022

3.3.2 Use of fuel for non-energy purposes

In accordance with the changes in the IPCC 2006 methodology compared to the IPCC 1996, where total emissions from the use of fossil fuels were estimated and then the part related to long-term stored carbon was subtracted, according to the IPCC 2006 guidelines, the use of fuels for non-energy purposes is reported in the IPPU sector. [3]

Fossil fuels can be used for various purposes such as combustion for energy needs or as a feedstock, intermediate or reducing agent (non-energy use). During operation, emissions can occur both in the combustion phase and during industrial processes. However, it is not always possible to report these two types of emissions separately.

In the GHG inventory of BiH, energy and non-energy consumption of solid fuels (coal, coke and fuel derivatives) is understood in the production of iron and steel, and given that blast furnace gas is completely burned in the iron and steel industry, these emissions are shown in subcategory 2.C.1, and emissions related to the consumption of lubricants are reported in subcategory 2.D.1.

The consumption of gaseous fuels for non-energy purposes has not been recorded in BiH.

3.3.3 Energy/energy industries (CRT 1.A.1)

Basic information about the category

Category 1.A.1 Energy industry accounts for 62.50% of GHG category 1.A emissions in 2014 and 62.50% in 2022. In total GHG emissions, this category participates with 68.08% in 2014 and 69.88% in 2022. Category 1.A.1 – Energy/Energy Industries is the key category in the analysis by level for 2014 and 2022, and is also recognized as the key category according to the analysis by trend. Consumption of solid fuels in the energy sector was a key category in 2014 and 2022 according to the analysis by level, and in 2022 it was also identified as a key category according to the analysis by trend. Consumption of liquid fuels was the key category in 2014, according to the analysis by level, but also according to the analysis by trend.

The energy industries that are included in the inventory in BiH include:

- Production of electricity and heat (CRT 1.A.1.a),
- Petroleum refining (CRT 1.A.1.b) and
- Production of solid fuels and other energy (CRT 1.A.1.c).

The chart below provides an overview of CO_2-eq emissions from the energy sector for the period 2014 – 2022.

[3] Whereas the IPCC 1996 Guidelines for the energy sector estimated total potential emissions from fossil-fuel use and then subtracted the portion of the carbon that ended up stored in long-lived products, the IPCC 2006 eq. Guidelines include all non-fuel uses in the IPPU sector (IPCC 2006, Volume 2, page 2.38).

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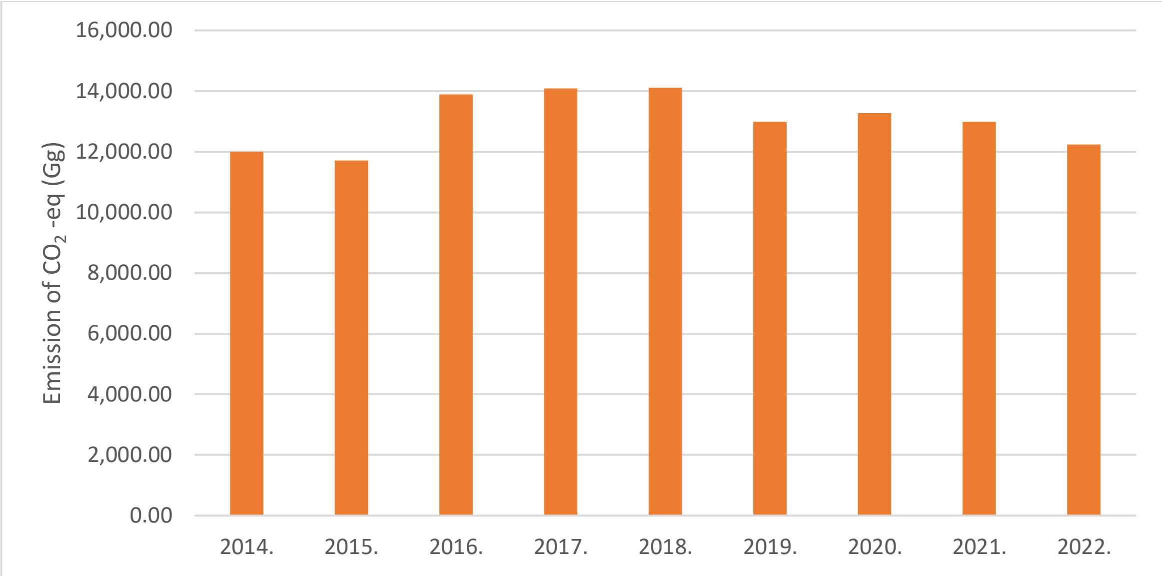
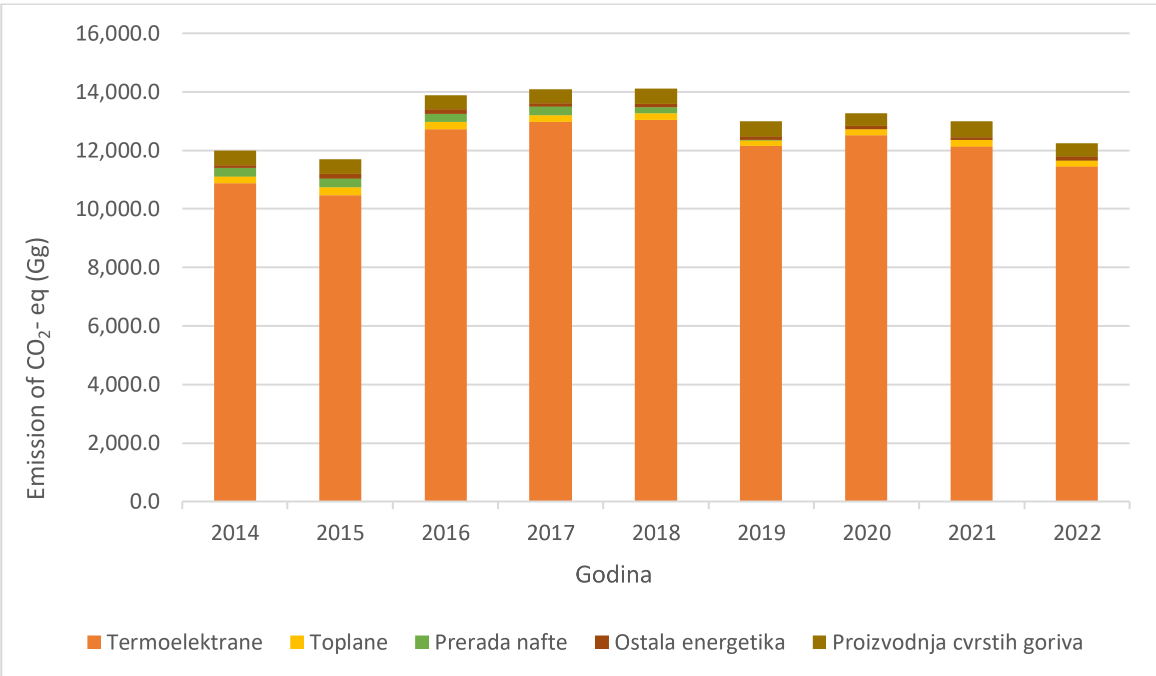


Chart 12: CO_2 - eq emissions in the CRT 1.A.1 Energy sector in the period 2014 – 2022

The previous chart shows that emissions are relatively stable over the observed period, with a slight increase from 2015 to 2018, followed by a gradual decline, with the lowest values recorded in 2022. CO_2-eq emissions from the energy sector in 2022 amounted to 12,243.94 Gg, which represents an increase of 2.06% compared to 2014, when emissions amounted to 11,996.78 Gg.

The following chart shows the share of individual categories in total emissions from the energy sector.

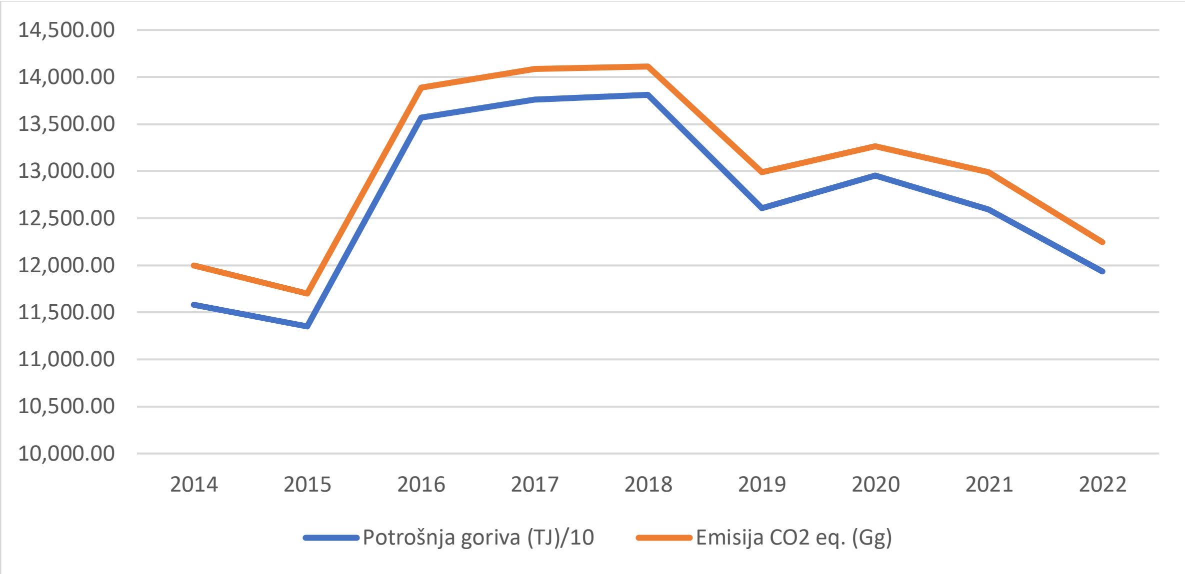


(LEGEND: Termoelektrane – Thermal power plants; Tople – Heating plants; Prerade nafte – Oil processing; Ostala energetika – Other energy; Proizvodnja čvrstih goriva – Production of solid fuels.)

Chart 13: CO_2 - eq emissions of all categories in the CRT 1.A.1 Energy sector in the period 2014 – 2022

It is evident that thermal power plants contribute the most (from 89-94%) to emissions from the energy sector. The share of emissions from the production of solid fuels is about 4%, and from oil refining and heating plants between 0 and 2%, depending on the year.

The trend of emissions in the period 2014-2022 from the energy sector follows the fuel consumption shown in the following diagram. Fuel consumption values are taken from the energy balance of BiH.



(LEGEND: Potrošnja goriva – Fuel consumption; Emisija CO2– Emission of CO2.)

Chart 14: Trend of fuel consumption and CO_2 emissions - eq in the sector CRT 1.A.1 Energy in the period 2014-2022.

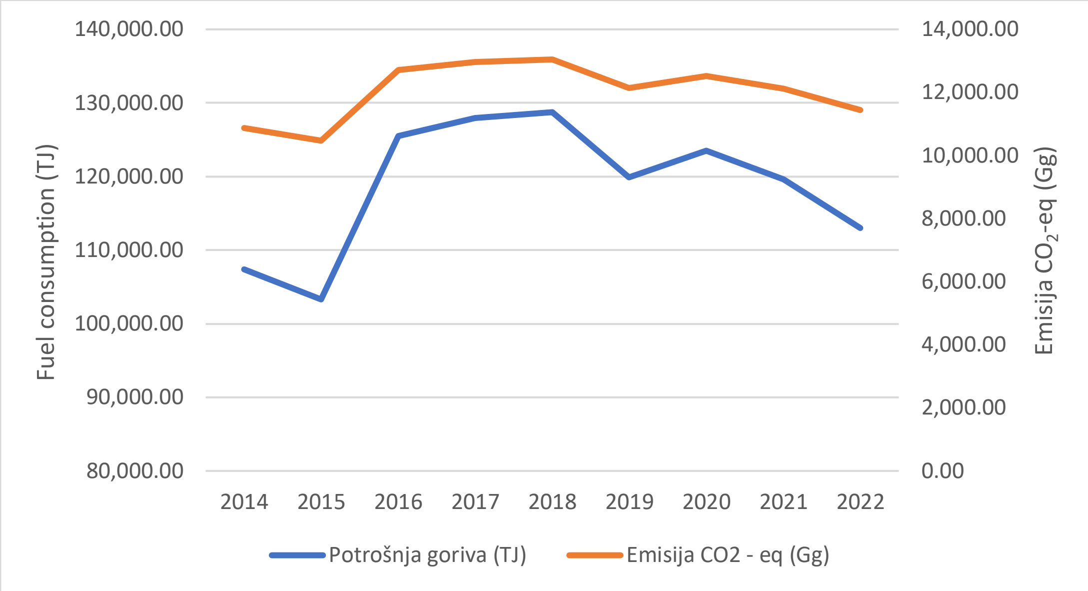
Coal consumption is primarily related to thermal power plants and the manufacturing industry, while liquid fuels are most represented in the manufacturing industry, households and public institutions, and gaseous fuels are mostly used in the manufacturing industry and heating plants.

(a) Generation of electricity and heat (CRT 1.A.1a)

Basic information about the category

In BiH, this category includes coal-fired power plants (primarily lignite), which are the main source of electricity, and heating plants that supply district heating systems. Five thermal power plants are in operation in BiH, two in FBiH (TPP Tuzla and TPP Kakanj) and three in RS (TPP Gacko, TPP Ugljevik and TPP Stanari). TPP Stanari is the youngest thermal power plant, which entered operation in 2016, which is clearly visible in the sharp increase in emissions in 2016 compared to 2015. Heating plants in BiH use lignite, fuel oil, natural gas, pellets and wood chips.

Emissions are estimated on the basis of fuel consumption data from energy balances. Below are the emissions from CRT category 1.A.1.a, together with fuel consumption from thermal power plants and heating plants (TJ/year).



(LEGEND: Potrošnja goriva – Fuel consumption; Emisija CO2– Emission of CO2.)

Chart 15: Trend of fuel consumption and CO_2 -eq emissions in the CRT sector 1.A.1.a Generation of electricity and heat in the period 2014 – 2022

The previous chart shows that emissions are highest in the period 2016-2018, which also corresponds to the peak fuel consumption in the same years. After 2018, a moderate decline in both consumption and emissions was recorded, with slight fluctuations, and the lowest values were recorded in 2022. In the total emissions from CRT category 1.A.1.a Generation of electricity and heat, emissions from fuel combustion in thermal power plants participate with 97-99%, depending on the year, while emissions from fuel combustion in heating plants account for a smaller part of total emissions.

Methodological approach

Thermal power plants in BiH use lignite, brown coal and liquid fuels (a smaller part, 0.5% as support and stabilization of combustion). Due to its thermal power, which is at the level of lignite, brown coal is classified as lignite. Data on coal consumption in thermal power plants (in Gg) are taken from the press release of the Agency for Statistics of BiH - Energy Statistics (Electricity and Heat) for each year.

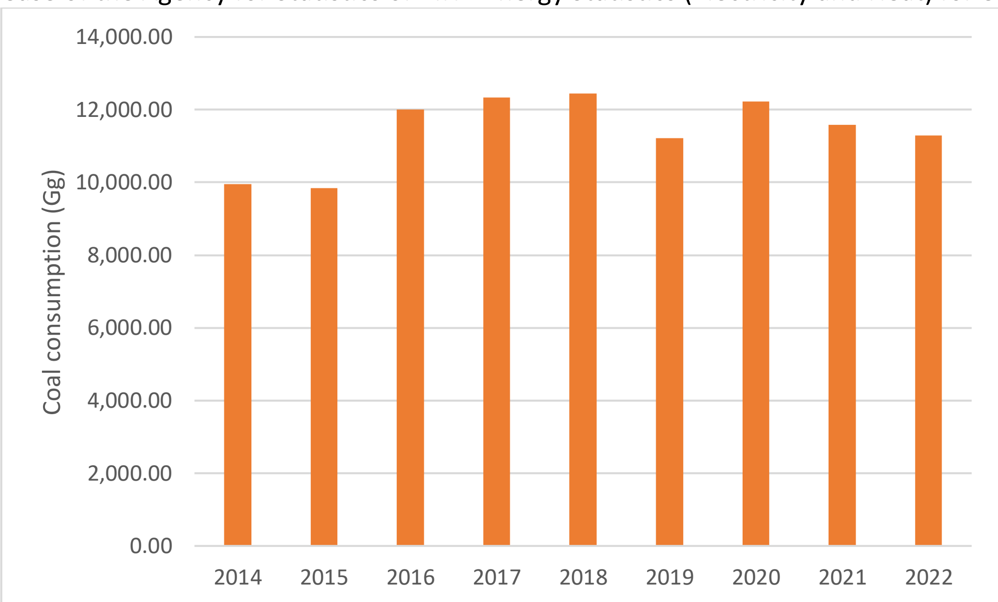


Chart 16: Coal consumption in thermal power plants (Gg/year) in the period 2014 – 2022

For the calculation of coal consumption in thermal units (TJ), data on lower heat output obtained from thermal power plant operators through a questionnaire were used. Data on coal consumption and lower heat output for each coal were collected from thermal power plants. On the basis of these data, the weighted values of the lower heat outputs for each year were calculated (Table 15).

Table 15: Weighted values of lower thermal capacities (TJ/Gg) of coal from thermal power plants

Year	Hd, TJ/Gg
2014	10.76
2015	10.46
2016	10.41
2017	10.34
2018	10.32
2019	10.65
2020	10.08
2021	10.29
2022	9.97

Since the data on the carbon content of coal were not available for every coal and all thermal power plants in BiH, the default value of the carbon content in lignite, which is 27.6 kg/GJ, was used. The hypothesized carbon oxidation factor is 1. Due to the incompleteness of the above data, it was not possible to move to a higher level of complexity of the emission calculation using the national emission factor, and the lowest level of complexity (Tier 1) was applied for the emission assessment. Default values of emission coefficients were used, in accordance with the IPCC 2006 methodology (Volume 2, Table 2.2)

Liquid fuel (fuel oil and fuel oil) is used in thermal power plants for ignition and combustion support in boilers. The following chart provides an overview of the consumption of liquid fuel in thermal power plants. It is evident that the quantities of liquid fuel are about 1000 times less than the amount of coal, and accordingly the difference in emission factors for solid and liquid fuels, the emission due to the combustion of liquid fuel in power plants is negligible compared to the emission from the combustion of coal.

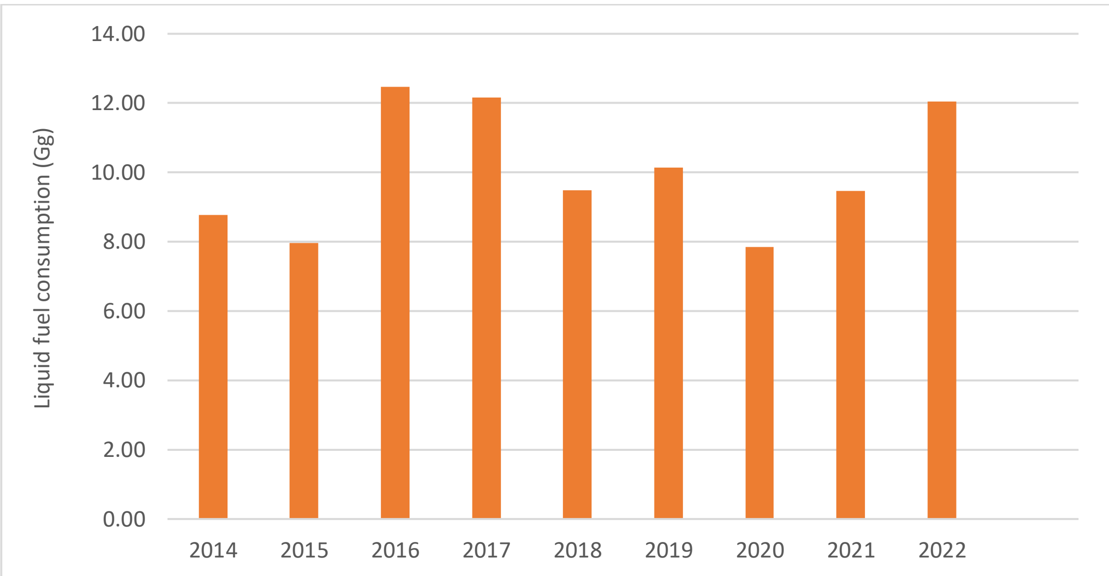
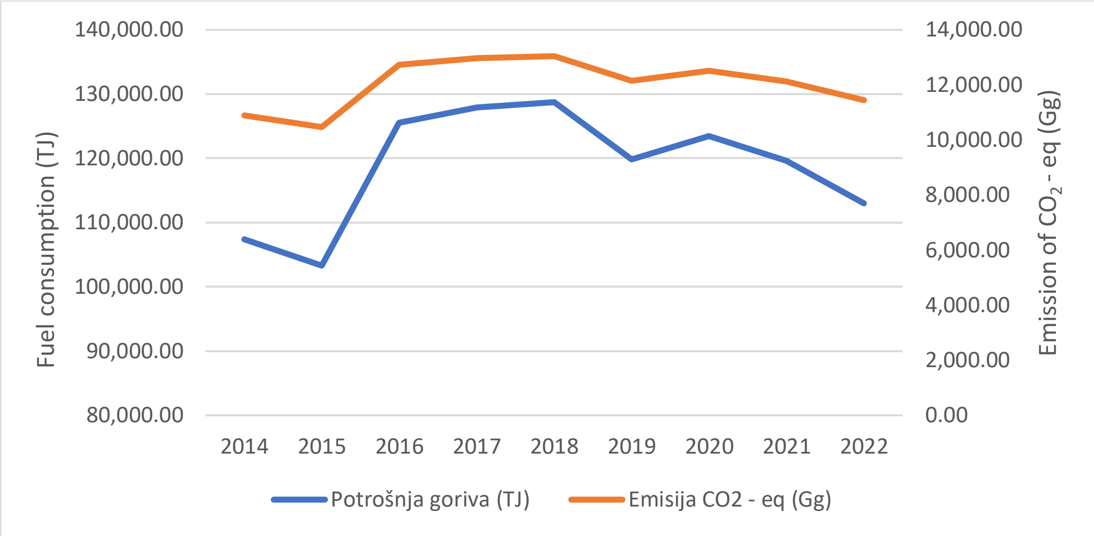


Chart 17: Consumption of liquid fuel in thermal power plants in the period 2014 – 2022

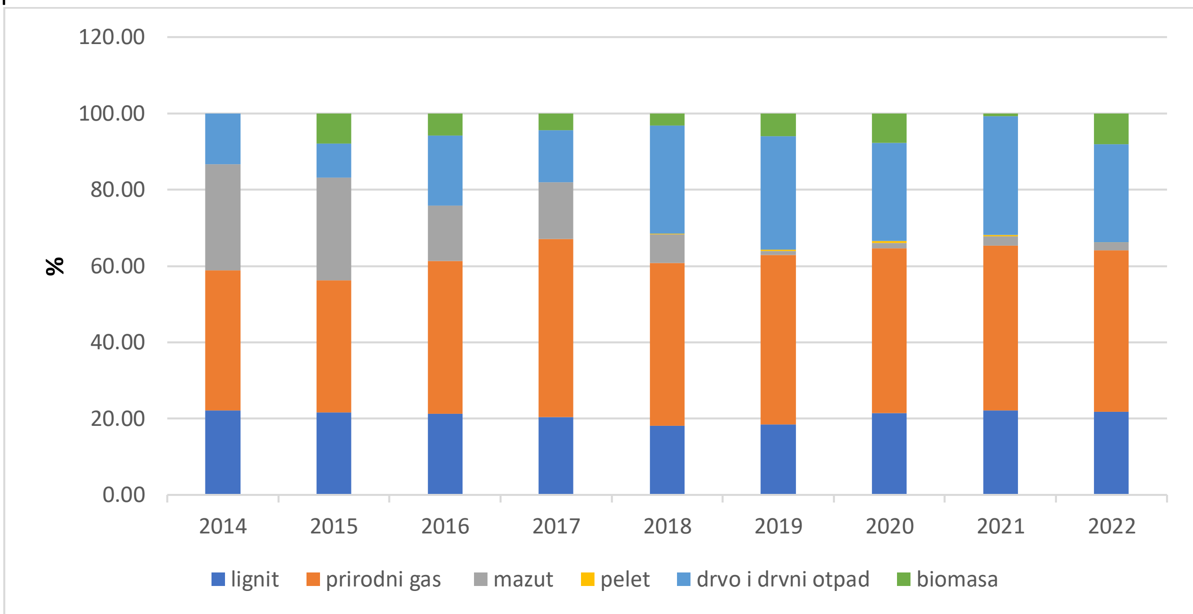
For the calculation of GHG emissions from the combustion of liquid fuels in thermal power plants, the default values of emission coefficients were used, in accordance with the IPCC 2006 methodology (Volume 2, Table 2.2).
Below are the CO_2-eq emissions from fuel combustion in thermal power plants, which are proportional to the amount of energy products consumed and the lower thermal capacity.



(LEGEND: Potrošnja goriva – Fuel consumption; Emisija CO2– Emission of CO2.)

Chart 18: Trend of fuel consumption and CO_2-eq emissions in thermal power plants in the period 2014 – 2022

Heating plants in BiH use lignite, fuel oil, natural gas, pellets and biomass. Data on energy consumption in heating plants are taken from the press release of the Agency for Statistics of BiH - Energy Statistics. The following diagram shows the share of individual energy sources in the consumption of heating plants.



(LEGEND: Lignit - Lignite; Prirodni gas – Natural gas; Mazut – Fuel oil; Pelet – Pellet; *Wood & Wood scrap material*; Biomasa – Biomass.)

Chart 19: Share of consumption of certain energy products in heating plants in the period 2014 – 2022

Natural gas has the largest share in fuel consumption in heating plants, and pellets have the lowest. The consumption of pellets in heating plants began in 2018, and biomass in 2015. Since 2018, the share of fuel oil has been decreasing, and the share of biomass has been increasing.

For the calculation of GHG emissions from fuel combustion in heating plants, data on lower heat output for coal obtained from heating plant operators through a questionnaire were used. On the basis of these data, the weighted values of the lower heat output of coal for each year were calculated, shown in the following table.

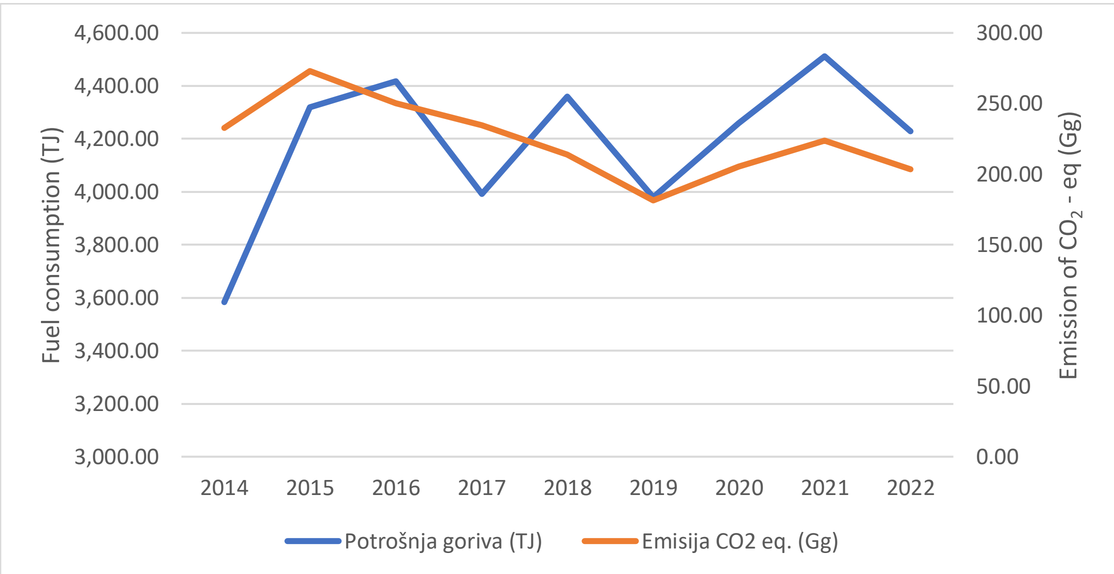
Table 16: Weighted values of lower heat output (TJ/Gg) of coal from heating plants

Year	Hd, TJ/Gg
2014	11.43
2015	11.53
2016	11.47
2017	9.68
2018	10.06
2019	10.20
2020	12.20
2021	12.25
2022	12.15

Since 2017, according to the data of the Agency for Statistics of BiH - Energy Statistics (Electricity and Heat), firewood has been used for the production of electricity and heat in cogeneration plants (CHP) (combined production of electricity and heat). For the lower heat output and emission coefficient, the default values from the IPCC 2006 Volume 2 methodology (Tables 1.2 and 2.2, Hd = 15.60 TJ/Gg, Ef = 112 t/TJ) were used.

For the calculation of GHG emissions from the combustion of liquid fuels in heating plants, the default values of emission coefficients were used, in accordance with the IPCC 2006 methodology (Volume 2, Table 2.2).

Below are the CO_2-eq emissions from fuel combustion in heating plants (Gg/year), which are proportional to fuel consumption.



(LEGEND: Potrošnja goriva – Fuel consumption; Emisija CO2– Emission of CO2.)

Chart 20: Trend in fuel consumption and CO_2-eq emissions from combustion in heating plants

Below are the CO_2, CH_4 and N_2O emissions for the period 2014 – 2022 from the energy sector.

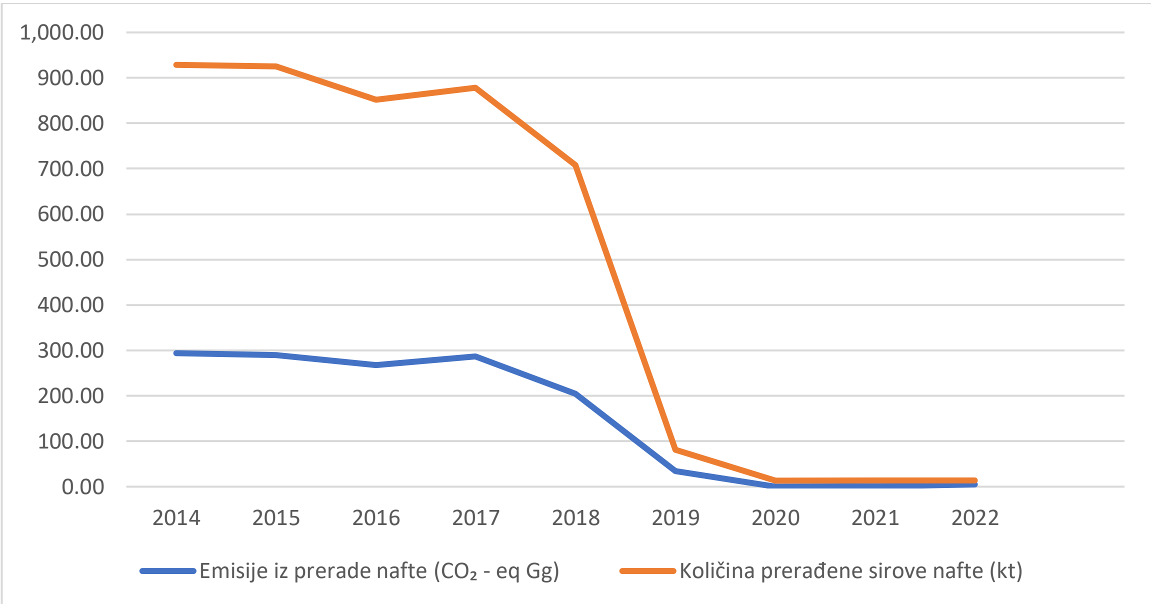
Table 17: GHG emissions from the energy sector

Year	CO_2 - eq (Gg)	Net CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)
2014	11,996.78	11,948.44	0.14	0.17
2015	11,701.29	11,654.59	0.14	0.16
2016	13,890.83	13,833.46	0.18	0.20
2017	14,084.64	14,026.47	0.18	0.20
2018	14,113.83	14,054.36	0.20	0.20
2019	12,989.05	12,931.35	0.27	0.19
2020	13,268.68	13,210.42	0.25	0.19
2021	12,987.45	12,929.38	0.28	0.19
2022	12,243.94	12,189.78	0.25	0.18

(b) Petroleum refining/processing (CRT 1.A.1b)

Basic information

An oil refinery processes crude oil. As previously stated, the share of emissions from oil refining in the energy sector is negligible and ranges up to max. 2.48% in 2015. In the period from 2014 to 2019, emissions from the refinery range between 33 and 294 Gg, while after 2019 emissions drop drastically, which is a consequence of the reduced capacity of the refinery (at a minimum) and the resulting reduced amount of processed crude oil.



(LEGEND: Emisije iz preparde nafte – Emissions from oil refining; Količina prepađene sirove nafte – Quantity of refined crude oil.)

Chart 21: Amount of crude oil processed and CO_2 - eq emissions from the refinery

Methodological approach

The calculation of CO_2-eq emissions was made on the basis of data from the balance of liquid fuels of the RS Statistics Bureau (since BiH has only one refinery located in the territory of the Republika Srpska). Data on the consumption of LPG, fuel oil and other petroleum products are included. For the lower heat outputs and emission factors, the default values from the IPCC 2006 methodology (Volume 2, Tables 1.2 and 2.2) were used.

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(c) Production of solid fuels and other energy (CRT 1.A.1c)

Basic information

This category includes GHG emissions from the production of solid fuels (e.g. lignite) and other energy activities that do not fall into the categories of electricity and heat production. The consumption of anthracite for the production of coke is not counted in CRT 1.A.1.c, as these quantities are already included in sub-category 2.C.1, but emissions from coke production are reported under this subcategory. Also, emissions associated with coal production are included in fugitive emissions from solid fuels (1.B.1.b).

Methodological approach

Subcategory 1.A.1.c.ii estimates the GHG emissions for self-generation from coal mines based on the consumption of liquid and solid fuels in the mines. The calculation was based on the default values of the lower heat output from the IPCC 2006 methodology (Volume 2, Table 1.2: coal 11.90 TJ/Gg, diesel 43.00 TJ/Gg).

(d) Uncertainty analysis and data consistency

The uncertainty factors for the input data and the emission factor for categories 1.A.1 are presented below. According to IPCC 2006, Volume 2, page 2. The emissions are shown for the period 2014 – 2022.

Table 18: Uncertainty analysis for CRT category 1.A.1

Energy	Uncertainty, %		
	CO_2	CH_4	N_2O
Input data	1%	1%	1%
Emission factor	7%	100%	100%
Combined uncertainty	1.6%	0.02%	0.2%

3.3.4 Industry and construction (CRT 1.A.2)

(a) Basic information about the category

The industry and construction sector includes emissions from fuel combustion in various industries, such as:

- Iron and steel (CRT 1.A.2.a),
- Non-ferrous metals (CRT 1.A.2.b),
- Chemicals (CRT 1.A.2.c),
- Pulp, paper and printing (CRT 1.A.2.d),
- Food, beverage and tobacco processing (CRT 1.A.2.e),
- Non-metallic minerals (CRT 1.A.2.f)
- Machinery (CRT 1.A.2.g)
- Transport equipment (CRT 1.A.2.h)
- Mining and quarrying (CRT 1.A.2.i)
- Timber and timber products (CRT 1.A.2.j)
- Civil engineering (CRT 1.A.2.k)

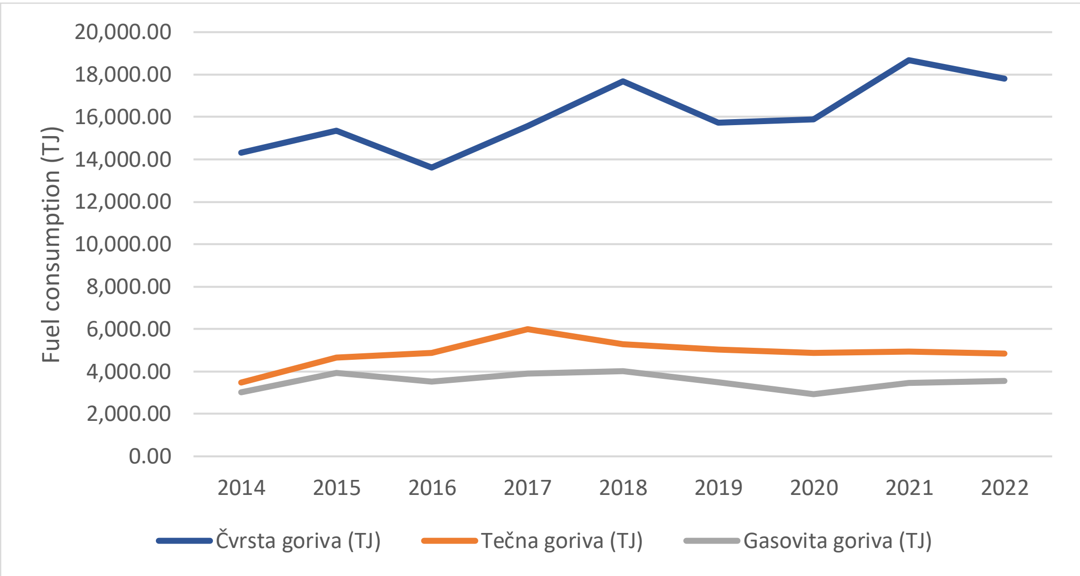
- Textiles and leather (CRT 1.A.2.l)
- Unspecified (CRT 1.A.2.m)

In BiH, there are seven categories of economic activities that are run as self-producers (they produce electricity for their own needs), as follows:

- Food, beverage and tobacco processing,
- Coke products,
- Non-ferrous metals,
- Production of other inorganic basic chemicals,
- Iron, steel, ferroalloys,
- Wood and wood products and
- Products made of paper and cardboard.

The industrial and construction sector relies heavily on solid fuels. The following chart shows the consumption of different types of fuels in the industry and construction sector (CRT 1.A.2) in BiH for the period 2014–2022.

Category 1.A.2 Industry and construction accounts for 10.28% of GHG category 1A emissions in 2014 and 12.07% in 2022. In total GHG emissions, this category participates with 7.00% in 2014 and 8.43% in 2022. This category was the key in terms of consumption of solid and liquid fuels in 2014 and 2022 according to the level analysis, and was also identified as the key category according to the trend analysis. The use of gaseous fuels in this category was a key category in 2022 alone, according to a level-by-level analysis.



(LEGEND: Čvrsta gorive – Solid fuels; Tečna goriva – Liquid fuels; Gasovita goriva – Gaseous fuels.)

Chart 22: Consumption of certain types of fuels in the sector CRT 1.A.2 Industry and construction in the period 2014-2022

From the previous chart, it can be seen that solid fuels have a dominant share in total consumption, with fluctuations during the observed period and peak consumption in 2018 and 2021. Liquid fuels recorded a slight increase until 2017, followed by a gradual decline and stabilization. Gaseous fuels have the smallest share, with slight changes and moderate growth in recent years. This trend points

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to the sector's strong dependence on solid fuels, with limited moves towards diversifying the energy mix.

With the aim of showing the share of individual types of fuels in the total consumption of the industrial sector, an overview of the consumption of individual types of fuels within the CRT 1.A.2 category – Industry and construction during 2022 is presented below.

Table 19: Consumption of solid, liquid and gaseous fuels in certain industries within CRT 1.A.2 in 2022 (TJ/year)

CRT Category	Solid fuels	Liquid fuels	Gaseous fuels
1.A.2.a - Iron and steel	2,062	25	1,003
1.A.2.b - Non-ferrous metals	2,673	167	1,502
1.A.2.c - Chemicals	4	73	111
1.A.2.d - Pulp, paper and printing	2	456	3
1.A.2.e - Processing of food, beverages and tobacco	57	648	379
1.A.2.f - Non-metallic minerals	3,278	895	79
1.A.2.g - Machinery	2	162	1
1.A.2.h - Transport equipment	40	410	28
1.A.2.i - Mining and quarrying	33	619	10
1.A.2.j - Timber and timber products	0	154	
1.A.2.k - Construction	0	884	
1.A.2.l - Textiles and leather	41	108	47
1.A.2.m - Unspecified	9,623	240	406

Based on the presented data, it can be concluded that subcategory 1.A.2.m – Unspecified industry is the largest consumer of solid fuels, with over 9,600 TJ, which indicates a significant share of self-producers of energy whose precise sectoral classification was not possible. In addition, the sectors of non-metallic minerals (1.A.2.f), non-ferrous metals (1.A.2.b) and iron and steel (1.A.2.a) also recorded high consumption of solid fuels, which is expected given the energy-intensive processes characteristic of these industries.

As regards to liquid fuels, the highest consumption is recorded in non-metallic minerals (1.A.2.f), the construction sector (1.A.2.k), food, beverage and tobacco processing (1.A.2.e) and mining and quarrying (1.A.2.i), indicating a wider use of diesel fuel in machinery and equipment used in these activities.

In gaseous fuels, the largest consumers are non-ferrous metals (1.A.2.b), iron and steel (1.A.2.a), indicating a gradual diversification of the energy mix in these industries and a shift from solid to cleaner energy sources, such as natural gas.

These data confirm the significant differences in the structure of fuel consumption among industrial sub-sectors, as well as the need to improve the quality of sectoral data, in particular for self-generators in order to map emissions more accurately and plan the decarbonisation of industry more efficiently.

The following chart shows CO_2-eq emissions from CRT category 1.A.2 Industry and construction in the period 2014 – 2022.

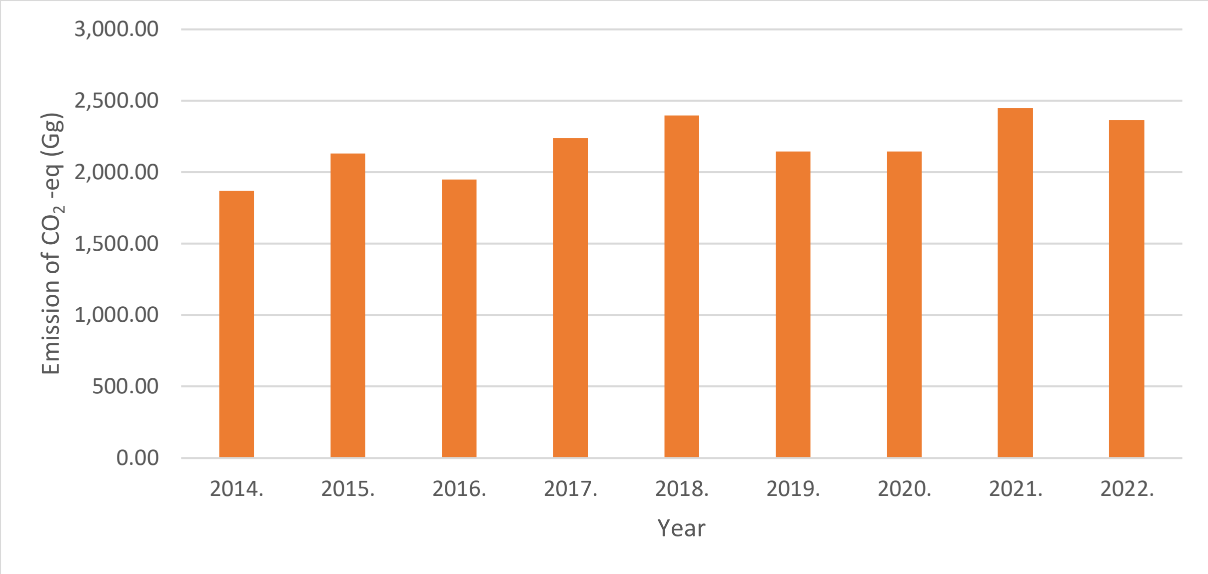

Chart 23: CO_2 - eq emissions in sector 1.A.2 Industry and construction in the period 2014 – 2022

Emissions from sector 1.A.2 have a variable trend in the period 2014-2022, with the lowest value recorded during 2016 when it amounted to 1,947.28 Gg CO_2-eq, and the highest during 2021 when it amounted to 2,448.20 Gg CO_2-eq.

Out of the subcategories of category 1.A.2, the most significant in terms of contribution to total emissions is the subcategory of unspecified industry, which, depending on the year, accounts for 43-53% of the emissions of this category. Unspecified industries also include the previously mentioned so-called self-producers.

(b) Methodological approach

Data for the estimation of emissions from the industry and construction sectors are taken from the fuel and energy balance published in the statistical bulletins of the Agency for Statistics of BiH. The assessment was carried out using the Tier 1 complexity level, using the default values of emission factors and lower heat outputs in accordance with the IPCC 2006 methodology (Volume 2, Table 1.2 and Table 2.3).

Fuel consumption related to autoproducers is reported under CRT 1.A.2. However, due to the lack of officially available data on the distribution of fuel consumption by type and industry (economic activities), it was not possible to make an accurate estimate of emissions at the level of individual subsectors of industry. Accordingly, the total emissions from fuel consumption of auto-manufacturers are allocated under sub-category 1.A.2.m — Unspecified industry.
Below are the CO_2, CH_4 and N_2O emissions for the period 2014 – 2022 from the industrial and construction sectors.

Table 20: GHG emissions from the industrial and construction sectors

Year	CO_2 - eq (Gg)	Net CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)
2014	1,867.56	1,856.99	0.16	0.02
2015	2,129.47	2,120.46	0.08	0.03
2016	1,947.28	1,936.81	0.15	0.02
2017	2,239.69	2,227.67	0.17	0.03
2018	2,397.00	2,383.70	0.19	0.03
2019	2,145.36	2,134.42	0.14	0.03

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2020	2,143.08	2,131.15	0.17	0.03
2021	2,448.20	2,432.59	0.23	0.03
2022	2,365.24	2,350.98	0.21	0.03

(c) Uncertainty analysis and data consistency

The uncertainty factors for the input data and the emission factor for categories 1.A.2 are presented below. According to IPCC 2006, Volume 2, Chapter 2. The emissions are shown for the period 2014 – 2022.

Table 21: Uncertainty Analysis for CRT 1.A.2

Industry & Construction	**Uncertainty, %**		
	CO_2	**CH_4**	**N_2O**
Input data	2%	2%	2%
Emission factor	7%	100%	100%
Combined uncertainty	0.5%	0.006%	0.01%

3.3.5 Transport (CRT 1.A.3)

(a) Basic information about the category

Category 1.A.3 Transport accounts for 16.87% of GHG emissions of category 1.A in 2014 and 20.95% in 2022. In total GHG emissions, this category participates with 11.48% in 2014 and 14.64% in 2022. Consumption of liquid fuels in road transport (1.A.3.b) was a key category in 2014 and 2022 according to the analysis by level, and in 2022 it was also identified as a key category according to the analysis by trend. The total length of the road network in BiH in 2022 was 8,850 km. Looking at the categorization, there are 231 km of motorways, 4,274 km of main roads, 4,345 km of regional roads. All data are taken from the Thematic Bulletin "Traffic 2023" issued by the Agency for Statistics of BiH.

Table 22: Length of the road network in BiH

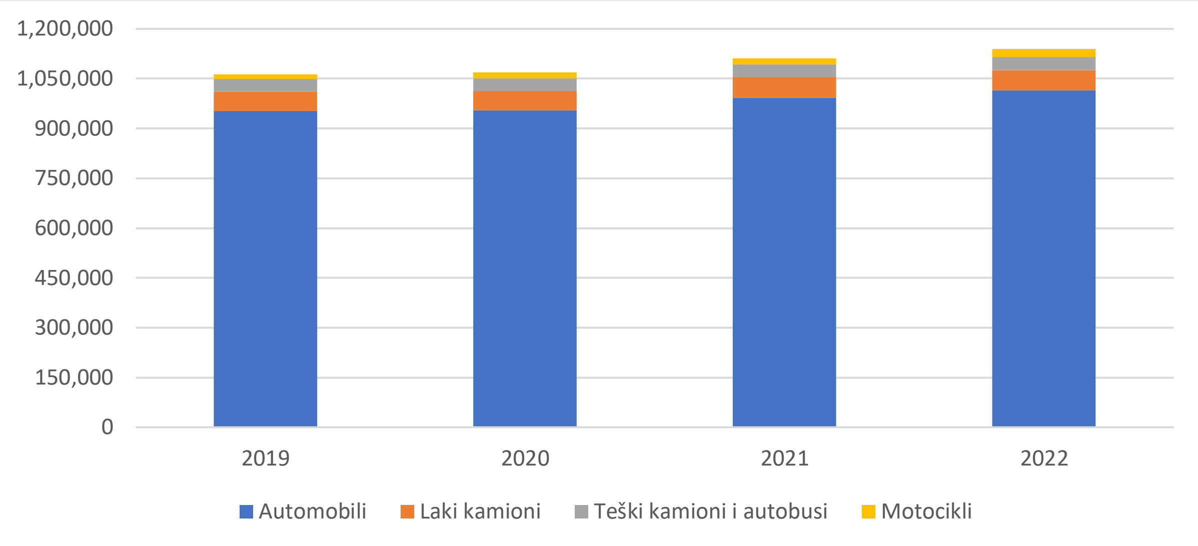
Type of trip/year	**Length, km**								
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Highways	127	127	163	172	198	198	218	218	231
Main roads	3,779	3,779	3,870	3,870	4,787	4,039	4,237	4,256	4,274
Regional roads	4,827	4,826	4,761	4,734	5,173	4,496	4,655	4,822	4,345
Total	**8,733**	**8,732**	**8,794**	**8,776**	**10,158**	**8,733**	**9,110**	**9,296**	**8,850**

The number of registered vehicles in BiH continued the long-standing trend of increasing the number of vehicles. The territorial distribution of the number of vehicles in BiH is reflected in the representation of vehicles in the FBiH, where 59.72% of the total number of registered vehicles are registered, 37% in the RS and 3.28% in the BD BiH.

Table 23: Number of registered vehicles in BiH

Category	**Number of vehicles**			
	2019	**2020**	**2021**	**2022**
Cars	951,577	953,750	993,609	1,014,317
Light trucks	58,431	58,905	60,408	61,483
Heavy trucks and buses	38,356	37,833	39,025	40,121

Motorcycles	14,751	17,591	18,899	22,473
TOTAL	**1,063,115**	**1,068,079**	**1,111,941**	**1,138,394**



(LEGEND: Automobili – cars; Laki kamioni – light trucks; Teški kamioni i autobusi – heavy trucks and buses; Motocikli – Motorcycles.)

Chart 24: Number of registered vehicles in BiH by category in the period 2019 – 2022

Air traffic data shows that there are 27 officially registered airports in BiH. However, only 4 airports are registered for international traffic, namely Sarajevo, Banja Luka, Mostar and Tuzla.

BiH has a very short coastline in Neum and does not have regulated adequate access to international waters, and therefore no seaport. River transport is present in the Port of Brčko.

The transport sector is divided into subcategories for a more accurate and transparent calculation of emissions from different sources such as aviation, road transport, railways, etc.

Table 24: Subcategories in the transport sector

IPCC Code	Description	Availability			Not available (NO)
		Estimated	Not Rated (NO)	Included elsewhere (IE)	
1.A.3.a.i	Domestic Aviation (Civil)	✓			
1.A.3.b	Road transport				
1.A.3.b.i	Vehicles	✓			
1.A.3.b.ii	Light trucks	✓			
1.A.3.b.iii	Heavy trucks and buses	✓			
1.A.3.b.iv	Motorcycles	✓			
1.A.3.b.v	Evaporative emissions from vehicles		✓		
1.A.3.b.vi	Urea-based catalysts		✓		
1.A.3.c	Railways			✓	

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1.A.3.d	Domestic water navigation				√
1.A.3.e	Other modes of transport				
1.A.3.e.i	Pipeline transport				√
1.A.3.e.ii	Other				√

(b) Methodological approach

The methodology used to calculate emissions from the transport sector is according to the IPCC 2006 guidelines. A Tier 1 approach was used to calculate emissions from the transport sector, which calculates CO_2 emissions by multiplying the estimated fuel sold by a given CO_2 emission factor.

In energy statistics, the production, transformation and consumption of solid, liquid, gaseous and renewable fuels are reported in physical units, e.g. in tonnes or cubic metres. To convert this data into energy units, in this case terajoules, caloric values are required. To estimate the emissions resulting from the combustion of fossil fuels, the net calorific values (NCV) according to the 2006 IPCC guidelines were used. To estimate emissions resulting from the combustion of fossil fuels, the default carbon content according to the IPCC guidelines from 2006 was used.

Table 25: Display of NCV and CC fuels used in the transport sector

Fuel	**Net Calorific Default Values (NCV)**	**Carbon Content (CC) Setpoints**	**Default oxidized carbon content**
	TJ/Gg	**kg/GJ**	**%**
LIQUID FUELS (Crude oil and petroleum products)			
Petrol	44.30	18.90	100
Kerosene	44.10	19.50	100
Diesel	43.00	20.20	100
LPG	47.30	17.20	100

The calculation of emissions from the transport sector requires data on fuel consumption in the sub-categories of the sector converted into units of measure for energy. The first step towards calculation is data collection. The Tier 1 approach was used for this calculation because there is no data available from the competent institutions on the carbon content of fuels sold on our market. For this reason, the default factors available in the IPCC 2006 methodology were used.

The table shows the input data on fuel consumption in the transport sector, which are taken from the official publications of the Agency for Statistics of BiH.

Table 26: Total fuel consumption

Fuel type	Sector	Tons								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
Liquefied petroleum gas (TNP)	Transport	36,008	36,957	45,974	58,212	53,266	51,790	60,574	60,985	53,170
Unleaded motor gasoline	Transport	188,324	192,762	198,247	188,221	177,657	170,125	138,813	164,566	152,526
Diesel and heating oil	Transport	727,125	761,451	909,954	957,382	963,051	1,054,505	956,718	1,101,426	1,067,724
Kresoene	Transport	4,261	6,271	10,222	9,864	7,391	9,029	3,687	13,682	29,140

The final fuel consumption by subcategories was calculated using the COPERT V software and the average value of fuel consumption for the entire period expressed as a percentage of total consumption was used.

Table 27: Fuel consumption by subcategories

Category and fuel		Tons								
		2014	2015	2016	2017	2018	2019	2020	2021	2022
Cars	Diesel (64% of total consumption)	465,360	487,329	582,371	612,724	616,353	674,883	612,300	704,913	683,343
	Gasoline (95% of total consumption)	178,908	183,124	188,335	178,810	168,774	161,619	131,872	156,338	144,900
	LPG (100% of total consumption)	36,008	36,957	45,974	58,212	53,266	51,790	60,574	60,985	53,170
Light trucks	Diesel (9% of total consumption)	65,441	68,531	81,896	86,164	86,675	94,905	86,105	99,128	96,095
	Gasoline (3% of total consumption)	5,650	5,783	5,947	5,647	5,330	5,104	4,164	4,937	4,576
Heavy trucks and buses	Diesel (27% of total consumption)	196,324	205,592	245,688	258,493	260,024	284,716	258,314	297,385	288,285
Motocycles	Gasoline (2% of total consumption)	3,767	3,855	3,965	3,764	3,553	3,403	2,776	3,291	3,051

In the statistical reports of the FBiH Bureau of Statistics and the Agency for Statistics of BiH, data on fuel consumption in railway transport are not available, but data on total fuel consumption in traffic. The assumption is that all diesel consumed for rail transport, already included in diesel fuel in total traffic, and this data is shown for road transport.

An overview of GHG emissions from fuel combustion in CRT category 1.A.3 Transport is given in the following charts and tables.

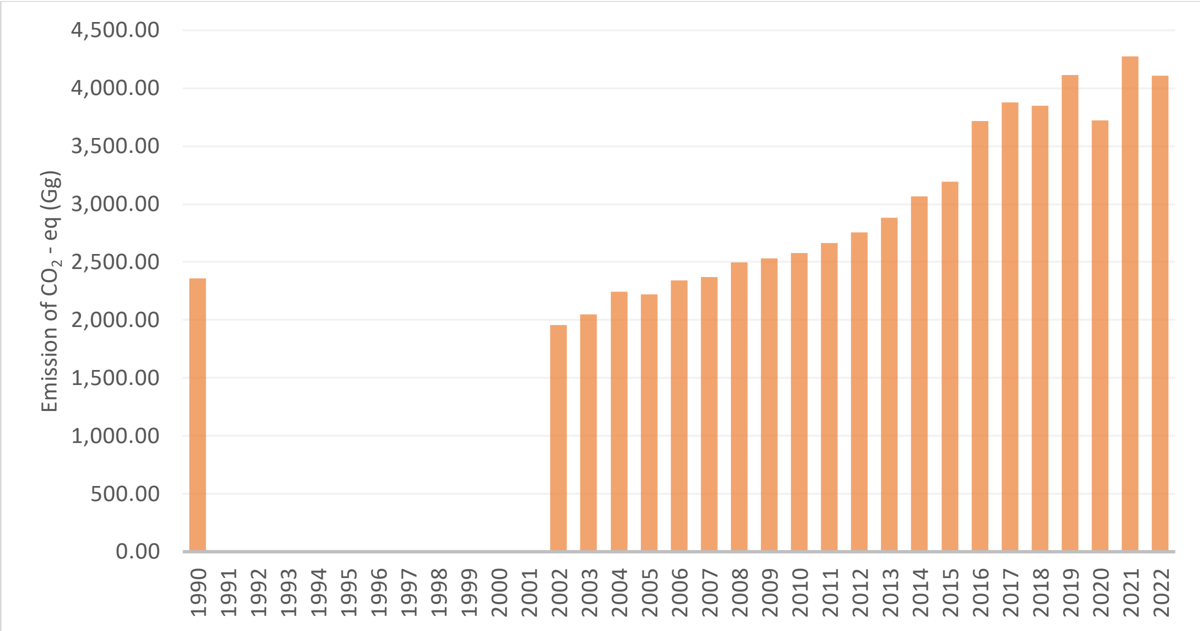
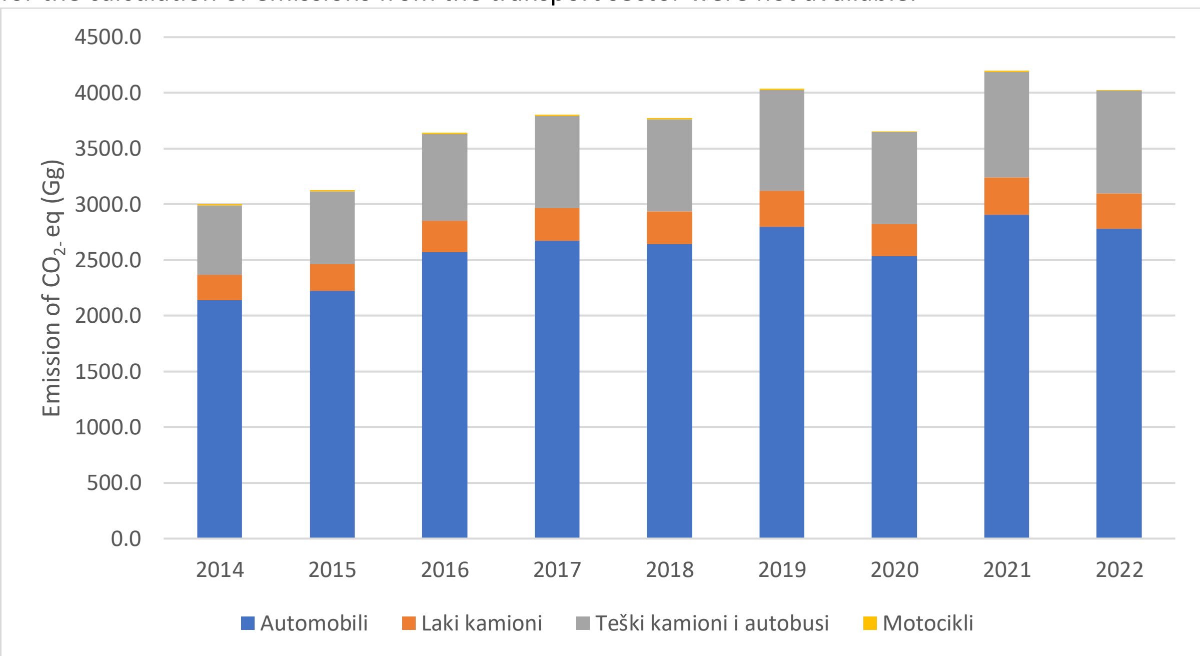


Chart 25: Emission of CO_2 - eq in the sector CRT 1.A.3 Transport in the period 1990 – 2022.

The chart shows the period from 1991 to 2001, where there is no data on emissions from the transport sector. In this period, due to the war (1992-1995), and after that period, the data necessary for the calculation of emissions from the transport sector were not available.



(LEGEND: Automobili – cars; Laki kamioni – light trucks; Teški kamioni i autobusi – heavy trucks and buses; Motocikli – Motorcycles.)

Chart 26: Emission of CO_2 - eq in the sector CTR 1.A.3 Transport in the period 2014 – 2022.

The charts show that emissions in 2020 are slightly lower than emissions in other years in the period 2016 – 2022. The number of vehicles is constantly growing, and the consumption of diesel and gasoline is lower in 2020, with the increased use of LPG, which is one of the causes of this trend. The decrease of emissions in 2020 was expected also due to the Covid-19 pandemic.

Below are the CO_2, CH_4 and N_2O emissions for the period 2014 – 2022.

Table 28: GHG emissions from the transport sector

Year	CO_2-eq	Net CO_2	CH_4	N_2O	International aviation CO_2
1.A.3	**Gg**	**Gg**	**Gg**	**Gg**	**Gg**
2014	3,064.77	3,002.47	0.436	0.189	13.43
2015	3,192.91	3,128.29	0.450	0.196	19.77
2016	3,718.56	3,645.19	0.507	0.223	32.225
2017	3,877.55	3,802.07	0.540	0.228	31.103
2018	3,846.96	3,772.94	0.514	0.225	23.305
2019	4,114.24	4,036.79	0.517	0.238	28.473
2020	3,724.79	3,655.31	0.492	0.21	11.604
2021	4,276.53	4,196.69	0.546	0.244	43.141
2022	4,104.82	4,029.00	0.504	0.234	91.883

In addition to GHG emissions from the transport sector, emissions of pollutants CO, NOx, NMVOC and SO2 are calculated, which are shown in the table. For this calculation, the EMEP/EEA guidelines and emission factors provided in the "EMEP/EEA air pollutant emission inventory guidebook 2023" were used.

Table 29- Pollutant emissions from the transport sector

Year	CO	NOx	NMVOC	SO2
1.A.3	**Gg**	**Gg**	**Gg**	**Gg**
2014	14.6	13.28	2.34	0.000003
2015	15.1	13.88	2.41	0.000003
2016	16.9	15.4	2.92	0.000004
2017	17.3	16.17	2.98	0.000004
2018	16.3	16.18	2.82	0.000004
2019	16.3	17.59	2.81	0.000004
2020	14.7	15.97	2.53	0.000004
2021	16.7	18.36	2.88	0.000004
2022	15.5	17.74	2.67	0.000004

Table 30: Emission factor of pollutants

Category/Fuel		Emission factors of pollutants			
		CO (g/kg of fuel)	NMVOC (g/kg of fuel)	NOx (g/kg of fuel)	SO2 (g/g of fuel)
Cars	**Diesel**	2.41	0.51	11.77	0.000003
	Petrol	48.36	7.75	3.98	0.000005
	LPG	58.22	9.43	5.48	
Light trucks	**Diesel**	6.81	1.23	13.48	0.000003
	Petrol	118.70	7.42	5.93	0.000005
Heavy trucks and buses	**Diesel**	6.10	0.90	25.95	0.000003
Motorcycles	**Petrol**	244.88	92.74	7.23	0.000005

Air transport (CRT 1.A.3a)

Basic information about the category

Aviation emissions come from the combustion of jet fuel (jet kerosene and jet gasoline). Aircraft engine emissions roughly consist of about 70% CO_2, just under 30% H2O and less than 1% of NOx, CO, SOx, NMVOC, particulate matter and other trace components, including hazardous air pollutants. Modern gas turbines produce little or no N_2O emissions (IPCC, 1999). CH_4 can be emitted by idle gas turbines and older-tech engines, but recent data shows that modern engines emit little or no CH_4.

In BiH, the fuel consumption of domestic aviation (CRT 1.A.3.a) was not reported. For aviation, only international bunker emissions are estimated and excluded from the national total emissions.

Methodological approach

Data for using a higher Tier (2 or 3) approach is not available. It is necessary to provide more detailed data on the number and type of flights, the efficiency of aircraft engines, specific fuel data such as the type and proportion of carbon, power settings, the time spent in each phase of the flight, and the altitudes at which exhaust gases are emitted.

Road transport (CRT 1.A.3.b)

Basic information about the category

This category refers to GHG emissions from road transport. Road transport includes all types of passenger cars, light trucks, heavy trucks, buses and motorcycles. These mobile sources use different types of liquid and gaseous fuels, mainly gasoline and diesel, and emit significant amounts of GHG and air pollutants.

Road transport is the most developed mode of transport in BiH. In addition, the age of the vehicle fleet is a key problem in terms of energy efficiency, environmental protection, as well as traffic safety.

Emissions can be estimated either from the fuel consumed (represented by the fuel sold) or from the distance travelled by the vehicles. In general, the first approach (fuel sold) is suitable for CO_2, and the second (distance traveled by vehicle type and road type) is suitable for CH_4 and N_2O. Fuel consumption data in this category were used in our calculation. Category 1.A.3.b Road transport –

liquid fuels was the key category in 2014 and 2022 according to the analysis by level, and in 2022 it was also identified as the key category according to the analysis by trend.

Methodological approach

In this subcategory, there were no challenges in applying a methodology that did not change in the IPCC 2006 methodology compared to the previous IPCC 1996.

Rail transport (CRT 1.A.3c)

Basic information about the category

Railway locomotives are generally one of three types: diesel, electric or steam. Diesel locomotives generally use diesel engines in combination with an alternator or generator to generate the electricity needed to power their traction engines. Electric locomotives are powered by electricity generated in stationary power plants as well as other sources. The corresponding emissions are covered by the chapter on stationary combustion.

Data for this category are not available, and no calculation of emissions from this subcategory has been made. It is important to emphasize that no higher emissions are expected due to the fact that the electrification of the main road routes has been done.

Methodological approach

This sector is not covered by any statistical survey in our country. All input data is missing.

Uncertainty analysis and data consistency

CO_2, N_2O and CH_4 typically contribute around 97.2-3 and 1 percent of CO_2 equivalent emissions from the road transport sector. Therefore, although the uncertainties in the estimates of N_2O and CH_4 are much greater, CO_2 dominates emissions from road transport. Using locally estimated data will reduce uncertainties, especially in bottom-up estimates. The default CO_2 emission factors have an uncertainty of 2-5%, due to uncertainty in the composition of the fuel.

The uncertainty analysis considered the uncertainty in the input data used and the emission factors, as shown in the table below. The base year for estimating trending uncertainty is 2014. The emissions are shown for the period 2014 – 2022.

Table 31: Uncertainty analysis for CRT category 1.A.3

Transport sector	Uncertainty, %			Source
	CO_2	CH_4	N_2O	
Input data	5	10	10	IPCC vol.2. Chapter 3.6.1.7
Emission factor	3,068	244,69	209,93	IPCC vol.2. Chapter 3.6.1.7
Combined uncertainty	5,866	244,74	209,99	IPCC vol.2. Chapter 3.6.1.7

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3.3.6 Other sectors (CRT 1.A.4)

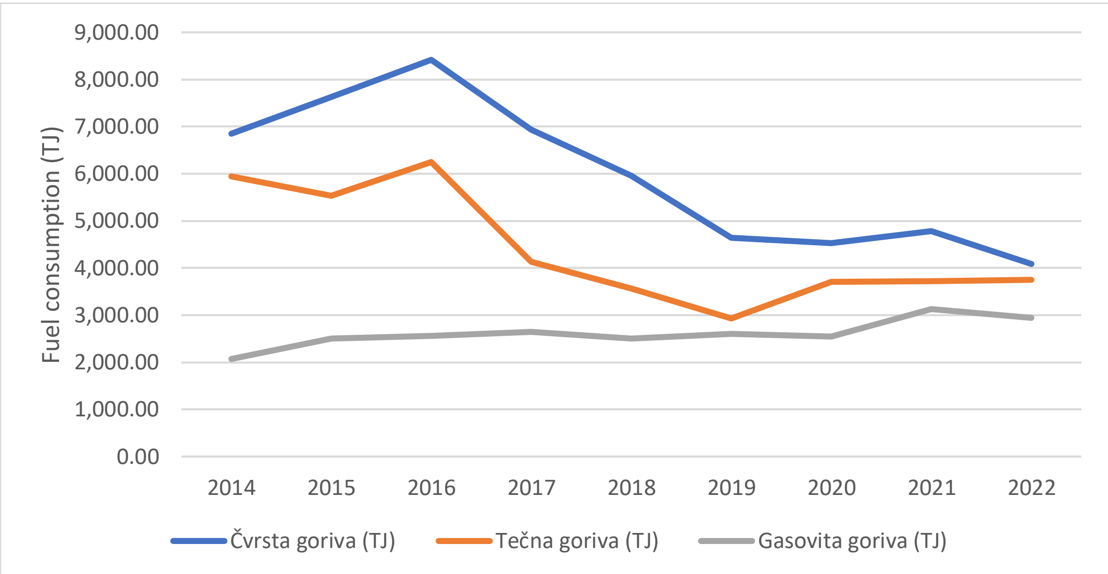
(a) Basic information about the category

Category 1.A.4 Other sectors accounted for 6.78% of category 1A greenhouse gas emissions in 2014 and 4.47% in 2022. In total greenhouse gas emissions, this category participates with 4.61% in 2014 and 3.12% in 2022. Consumption of liquid fuels was a key category in both 2014 and 2022 according to the analysis by level, and in 2022 it was also identified as a key category according to the analysis by trend. Solid fuel consumption was the key category in 2014 and 2022 according to the level analysis and was also recognized as the key category according to the trend analysis, while the consumption of gaseous fuels was not the key category in the level analysis for 2014 and 2022, but was recognized as the key category according to the trend analysis.

This category covers emissions from fuel combustion for other activities within the Energy sector:

- Emissions from public institutions (CRT 1.A.4.a),
- Emissions from residential buildings (CRT 1.A.4.b) and
- Emissions from agriculture, fisheries and forestry (CRT 1.A.4.c).

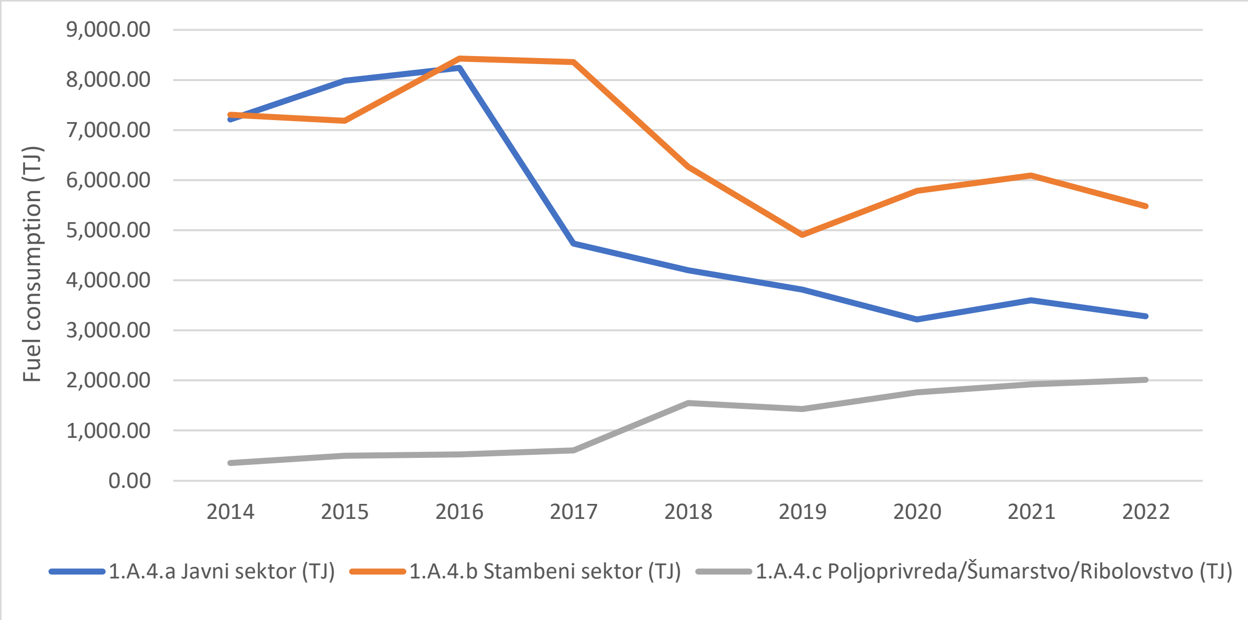
Data on fuel consumption are taken from the statistical balances of fuels at the level of BiH (Agency for Statistics of BiH). From CRT subcategory 1.A.4.c, only data on fuel consumed in agriculture are available. The consumption of individual fuel types in category 1.A.4 is shown below.



(LEGEND: Čvrsta goriva – solid fuels; Tečna goriva – Liquid fuels; Gasovita goriva – Gaseous fuels).

Chart 27: Consumption of certain types of fuels in the CRT sector 1.A.4 Other sectors in the period 2014-2022

From the previous chart it can be seen that the consumption of solid fuels is dominant in category 1.A.4. However, it is evident that after reaching the highest consumption value in 2016, the consumption of solid fuels decreases drastically until 2019, stagnates until 2020, and increases in 2021, after which it decreases again. The consumption of solid fuels in 2022 was 40.30% lower than the consumption in 2014. The consumption of liquid fuels also shows a variable growth trend in the observed period, with the maximum value recorded in 2016, when it amounted to 6,248.51 TJ. In 2022, the consumption of liquid fuels was 36.97% lower than in 2014. Gaseous fuels are the least used energy source in category 1.A.4, and in recent years they have shown an upward trend in consumption. Gaseous fuel consumption in 2022 was 42% higher than in 2014.



(LEGEND: Javni sektor – public sector; Stambeni sektor – Housing sector; Poljoprivreda,/šumarstvo/Ribolovstvo - *agriculture, fisheries and forestry.)*

Chart 28: Fuel consumption of all categories in CRT 1.A.4 Other sectors 2014-2022

Fuel consumption in the housing and public sectors (CRT 1.A.4.b and 1.A.4.a) shows a decreasing trend since 2016, with the housing sector having a higher consumption until 2018, after which the consumption of these two sectors converges, with higher consumption values from the housing sector. The public sector has seen a steady decline in fuel consumption for most of the observed period. On the other hand, consumption in the agriculture, forestry and fisheries sector (CRT 1.A.4.c) recorded a slight increase until 2020, after which consumption stabilized.
Below are the CO_2, CH_4 and N_2O emissions for the period 2014 – 2022 from other sectors.

Table 32: GHG emissions from other sectors

Year	CO_2 - eq (Gg)	Net CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)
2014	1,231.86	1,203.68	0.88	0.01
2015	1,342.24	1,313.96	0.87	0.01
2016	1,484.23	1,448.08	1.14	0.02
2017	1,193.08	1,146.94	1.53	0.01
2018	1,036.40	1,001.05	1.16	0.01
2019	853.93	827.35	0.87	0.01
2020	897.11	869.41	0.90	0.01
2021	958.15	928.99	0.95	0.01
2022	875.81	850.28	0.83	0.01

The highest emissions in sector 1.A.4 were recorded in 2016 and 2015, when they amounted to 1,484.23 Gg CO_2-eq and 1,342.86 Gg CO_2-eq, respectively, while after that a downward trend is visible, with the lowest emissions in 2019 (853.93 Gg CO_2-eq). Emissions partially increase in 2021 (compared to 2019 and 2020), but remain below the level of the first years of the observed period.

The following chart shows the share of individual industries in the total emissions from the CRT 1.A.4 category.

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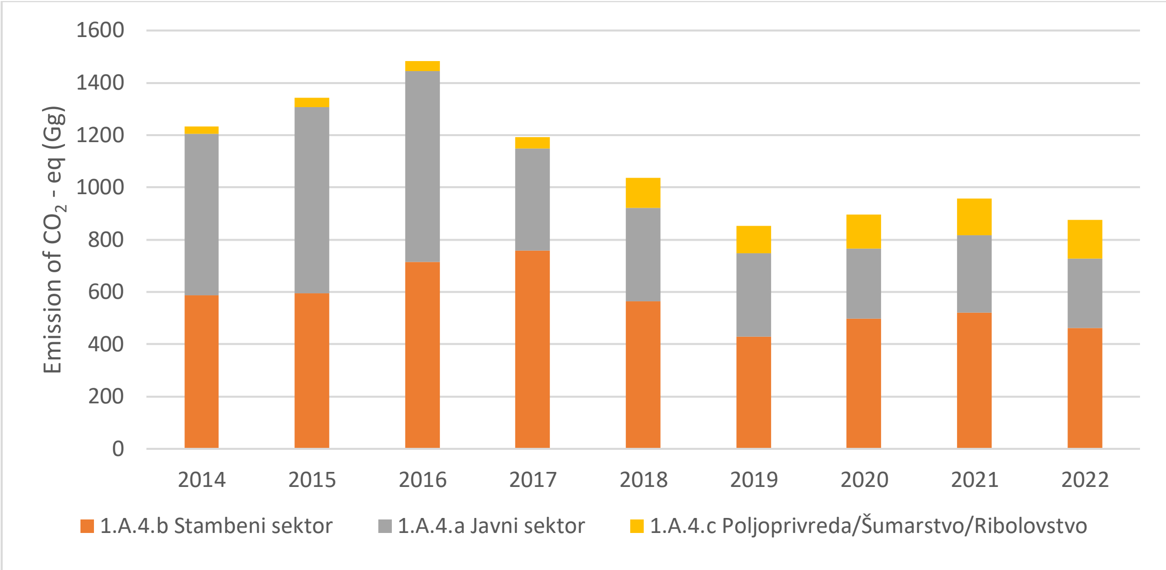

(LEGEND: Javni sektor – public sector; Stambeni sektor – Housing sector; Poljoprivreda,/šumarstvo/Ribolovstvo - *agriculture, fisheries and forestry.)*

Chart 29: CO_2-eq emissions of all categories in the CRT sector 1.A.4 Other sectors in the period 2014 – 2022

The previous graph shows that the housing and public sectors have a majority share in emissions of category 1.A.4, with higher values of emissions from the public sector recorded in 2014, 2015 and 2016, and during other years a larger total share in emissions was occupied by emissions from the housing sector.

In 2022, the public sector (1.A.4.a) accounted for 30% of total emissions from category 1.A.4, with emissions of 264.12 Gg CO_2-eq. Since 2014, when the public sector contribution was 50% (618.99 Gg CO_2-eq), emissions from this subsector have shown fluctuations, with the highest value in 2016 of 728.93 Gg CO_2-eq, accounting for 49% of total emissions from this category. Since 2016, there has been a decline in emissions from the public sector. The reason for this reduction in emissions is most likely to increase energy efficiency and improve the energy performance of buildings. Many public buildings (schools, hospitals, municipalities, etc.) have been involved in energy efficiency projects, often with international support, leading to lower emissions.

In 2022, the contribution of the housing sector (1.A.4.b) is 53%, which makes it the leading source of emissions within this category in that year. Since 2014, the value of emissions from the housing sector has shown a variable trend, accounting for 48% of total emissions from category 1.A.4 in 2014. The highest emissions in the housing sector were recorded in 2017 (759.46 Gg CO_2-eq), which accounted for 64% of total category 1.A.4 emissions. The largest decrease in emissions is observed from 2017 to 2019 (from 759.46 to 428.05 Gg CO_2-eq), after which there is a stabilization and minor fluctuations. This sharp decline is likely caused by an increase in pellet consumption after 2017 and a decline in coal demand.

Emissions from agriculture, forestry and fisheries (1.A.4.c) account for the smallest share of total emissions of category 1.A.4, but show a slight upward trend. In 2022, this subsector recorded emissions of 147.90 Gg CO_2-eq, accounting for 17% of total emissions. In 2014, the share was 2% (26.70 Gg CO_2-eq).

(b) Methodological approach

The values of emission factors given by the IPCC 2006 methodology (Volume 2, Table 2.4 for the calculation of emissions from public institutions and Table 2.5 for the calculation of emissions from households and agricultural activities) were used for the calculation of emissions.

(c) Uncertainty analysis and data consistency

The uncertainty factors for the input data and the emission factor for category 1.A.4 based on IPCC 2006, Volume 2, Chapter 2 are presented below. The emissions are shown for the period 2014 – 2022.

Table 33: Uncertainty Analysis for CRT Category 1.A.4

Other sectors	**Uncertainty, %**		
	CO_2	CH_4	N_2O
Input data	10%	10%	10%
Emission factor	7%	100%	100%
Combined uncertainty	0.5%	0.8%	0.15%

3.4 Fugitive emissions from solid and liquid fuels and natural gas and other emissions from energy production (CRT 1B)

Fugitive emissions refer to the unintentional release of greenhouse gases, primarily CH_4, during the extraction, handling, and transportation of fossil fuels, including coal and oil.

Category 1.B Fugitive emissions from fuels account for 3.44% of total GHG emissions in 2014 and 3.26% in 2022. This category participates in Category 1 emissions with 4.82% in 2014 and 4.46% in 2022. Category 1.B.1.a Coal mining and handling was the key category in both 2014 and 2022 according to the level analysis.

In BiH, fugitive emissions are associated with:

- Coal mining and handling: mining activities in underground and open-pit mines and post-mining emissions.
- Petroleum systems: refining and transportation of oil.

The CO_2-eq emissions of all categories in the CRT 1B sector are shown below

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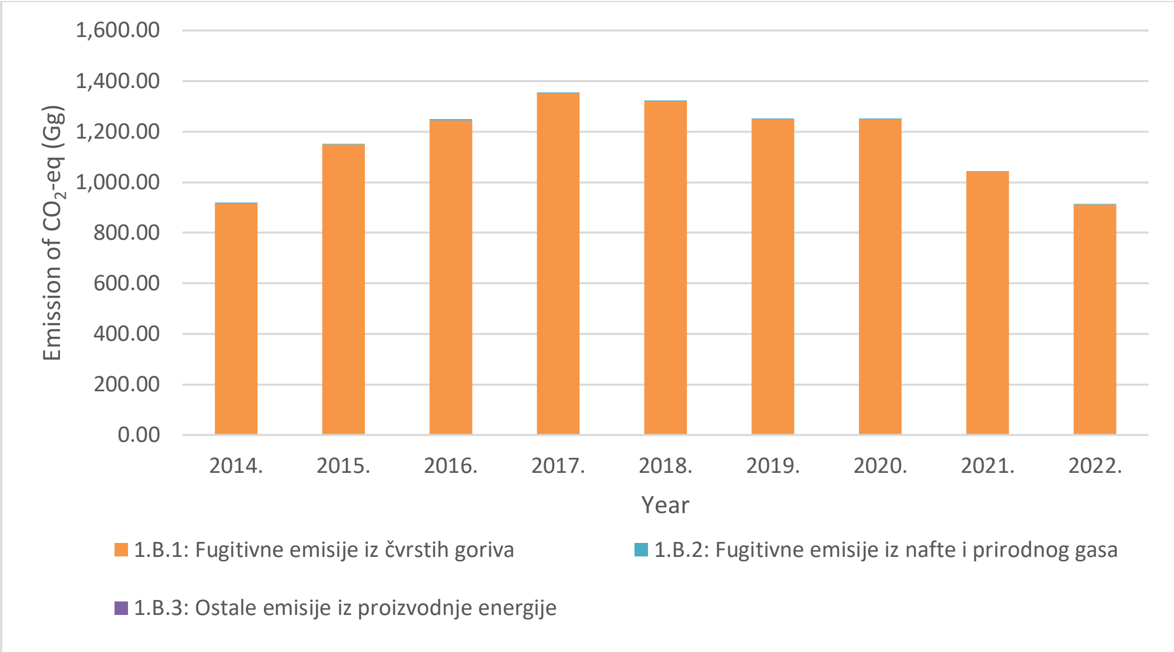


Chart 30: CO_2-eq emissions of all categories in the CRT 1.B sector Fugitive emissions from solid and liquid fuels and natural gas in the period 2014 – 2022

(LEGEND: Fugitivne emisije iz čvrstih goriva – Fugitive emissions from solid fuels; Fugitivne emisije iz nafte i prirodnog gasa – Fugitive emissions from oil and natural gas; Ostale emisije iz proizvodnje energije – Other emissions from energy production.)

The above chart shows that the total CO_2-eq emissions from CRT 1.B consist of emissions from other emissions from energy production (1.B.3), fugitive emissions from oil and natural gas (1.B.2) and fugitive emissions from solid fuels (1.B.1). Over the years, most of the total emissions in 1.B have been occupied by emissions from 1.B.1.

Fugitive emissions were estimated mostly on the basis of data on exploited quantities of solid fuel (coal), given that oil and natural gas are not exploited in BiH. Fugitive emissions from liquid fuels and natural gas are estimated for the transport and distribution activities of these energy sources, and make up a negligible part of total emissions.

3.4.1 Solid fuels (CRT 1.B.1)

(a) Basic information about the category

Category 1.B.1 Fugitive emissions from solid fuels accounted for 99.77% of emissions in 2014 of category 1B, while in 2022 it accounted for 99.70% of emissions. This category accounted for 3.43% of total greenhouse gas emissions in 2014 and 3.00% in 2022. Category 1.B.1.a Coal mining and handling was the key category in both 2014 and 2022 according to the level analysis.
In BiH, underground and surface coal mining is being performed. Underground mining is carried out only in the FBiH, while surface mining is carried out in both entities, RS and FBiH.
The input data for the calculation of emissions are the quantities of coal exploited in mines, which were obtained by the RS Statistics Bureau, and are presented below.

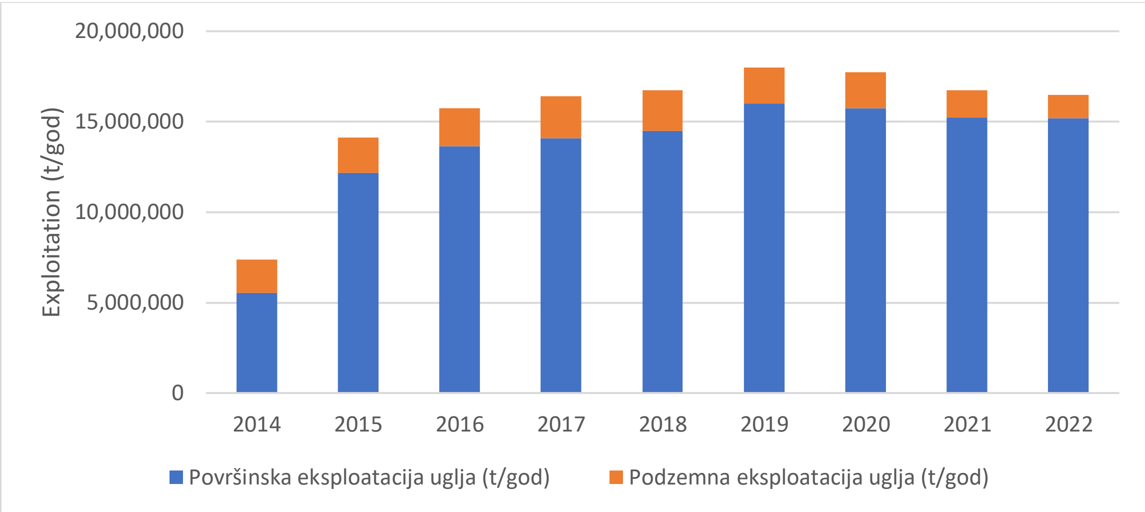
Table 34: Quantities of coal mined in mines in the period 2014 – 2022

Year	Open-pit coal mining (t/yr)	Underground coal mining (t/yr)	Total coal mining (t/yr)
2014	5,527,920	1,835,951	7,363,871

2015	12,172,292	1,964,468	14,136,760
2016	13,644,131	2,101,981	15,746,112
2017	14,083,709	2,329,872	16,413,581
2018	14,504,833	2,227,402	16,732,235
2019	16,010,546	1,963,172	17,973,718
2020	15,761,364	1,975,937	17,737,301
2021	15,241,532	1,512,933	16,754,465
2022	15,199,778	1,272,005	16,471,783

Coal mining fluctuated during the period 2014-2022, and has been declining since 2020.

Surface coal mining is the dominant form of coal mining and its share has been increasing over the years (from about 75% in 2014 to about 92% in 2022), as shown in the following chart.



(LEGENDA: Površinska eksploatacija uglja – Surface coal mining; Podzemna eksploatacija uglja – Underground coal mining.)

Chart 31: Coal mining in the sector 1.B.1 Solid fuels in the period 2014 - 2022

The emission estimate included emissions during and after coal mining. Emissions after the closure of the mine were not estimated, due to the lack of necessary data.

The following chart provides an overview of total emissions and CH4 emissions from coal mining by type in the period 2014-2022.

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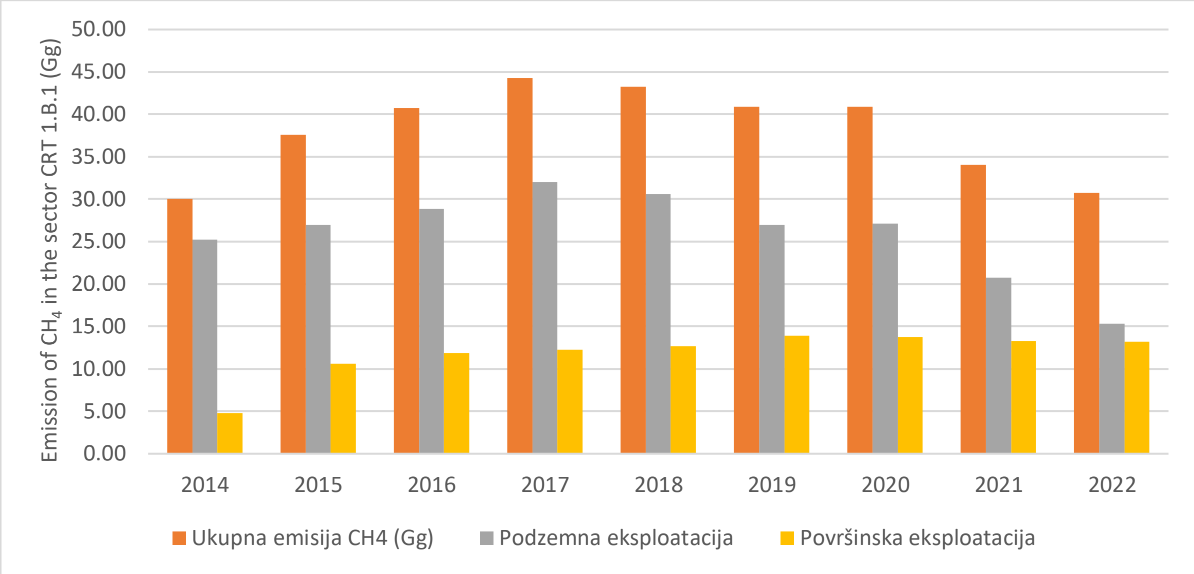

(LEGEND: Ukupnma emisija CH_4 – total emission of CH4; Podzemna eksploatacija – underground mining; Površinska eksploatacija – surface mining.)

Chart 32: CH_4 emissions by type of coal mining in CRT 1.B.1 Solid fuels in the period 2014-2022

Underground mining contributes the most to total emissions from exploitation in the observed period (84% in 2014 and 50% in 2022). In the period 2019-2022, emissions from mining have a downward trend (especially from underground mining). The value of CH_4 emissions in 2022 is 39.2% lower than in 2014.

(b) Methodological approach

CH_4 emissions were estimated, given that CH_4 is the main GHG produced during coal mining, especially in the case of underground mining. Data on the amount of coal mined (t/year) in surface and underground mining, obtained by the FBiH Ministry of Energy, Mining and Industry and the RS Statistics Bureau, shown in the table 34, were used for the calculation and the average default values of emission factors and conversion factors in accordance with the IPCC 2006 methodology (Volume 2).

Table 35 Emission and conversion factors used to estimate fugitive emissions from coal mining

Coal production	Emission factor m3/t	Conversion factor Hg/m3
Surface mining	1.20	0.67*10-6
After mining - Surface	0.10	0.67*10-6
Underground mining	18.00	0.67*10-6
After mining - Underground	2.50	0.67*10-6

Below are the fugitive CO_2, CH_4 and N_2O emissions from solid fuels for the period 2014 – 2022.

Table 36: GHG emissions from the solid fuels sector

Year	CO_2-eq (Gg)	Net CO_2 (Gg)	CH_4 (Gg)
2014	917.34	76.46	30.03
2015	1,148.40	96.05	37.58
2016	1,245.31	104.18	40.75
2017	1,352.60	113.11	44.27
2018	1,320.86	110.50	43.23
2019	1,250.19	104.73	40.91

2020	1,248.90	104.61	40.87
2021	1,040.87	87.32	34.06
2022	911.93	52.05	30.71

(c) Data Uncertainty and Consistency Analysis

The uncertainty factors for the input data and the emission factor for category 1.B.1 based on IPCC 2006, Volume 2, Chapter 2 are presented below. The emissions are shown for the period 2014 – 2022.

Table 37: Uncertainty analysis for CRT 1.B.1

Solid fuels	Uncertainty, %
	CH_4
Input data	5%
Emission factor	20%
Combined uncertainty	0.3%

3.4.2 Liquid fuels and natural gas (CRT 1.B.2)

(a) Basic information about the category

Category 1.B.2 Fugitive emissions from oil and natural gas accounted for 0.22% of emissions in 2014 and 0.29% of category 1.B. This category accounted for 0.007% of total greenhouse gas emissions in 2014 and 0.009% in 2022. This category was not among the key categories in 2019-2022.

In BiH, exploitation of oil and natural gas is being performed. Fugitive emissions from liquid fuels and natural gas are estimated for the transport and distribution activities of these energy sources. Import data for crude oil and natural gas was used from the press release of the Agency for Statistics of BiH "Energy Statistics", as presented below.

Table 38: Data on the annual quantities of imported oil and natural gas

Year	Oil imports (t/yr)	Import of natural gas (1,000 Sm3/year)
2014	951,377	186,556
2015	942,670	218,237
2016	929,098	226,927
2017	856,090	245,415
2018	694,710	247,012
2019	5,844	234,612
2020	12,130	213,379
2021	12,575	254,790
2022	18,563	247,635

Imports of crude oil and natural gas in BiH have taken place continuously during the observed period, with changes in volume affecting estimated emissions from transport and distribution. The biggest changes in the trend are visible in oil imports, where volumes have been declining significantly since 2019. The highest value of imports was recorded in 2014, when it amounted to 951,377 t/year, while the lowest value of imports was recorded during 2019, when it amounted to 5,844 t/year. Minor

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fluctuations are visible in natural gas imports, with the lowest value recorded in 2014 when it amounted to 86,556 Sm3/year, and the highest in 2021, when it amounted to 254,790 Sm3/year.

Below are emissions from CRT 1.B.2 Fugitive emissions from oil and natural gas.

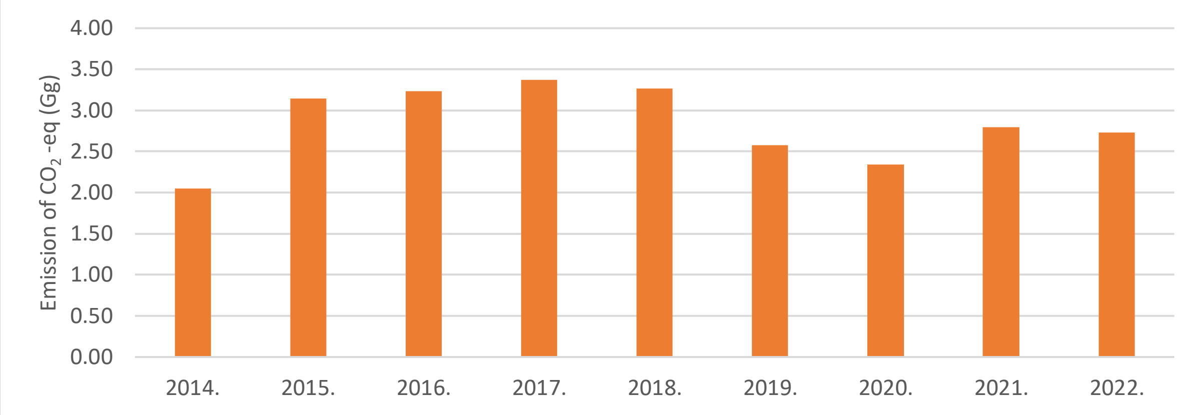

Chart 33: CO_2 - eq emissions in the CRT sector 1.B.2 Liquid fuels and natural gas in the period 2014 – 2022

The previous chart shows that emissions from the CRT 1.B.2 sector are variable over the observed period, with the highest value recorded in 2017 (3.37 Gg CO_2-eq) and the lowest recorded in 2014 (2.05 Gg CO_2-eq).

(b) Methodological approach

Data on imports of oil and natural gas from the press release of the Agency for Statistics of Bosnia and Herzegovina "Energy Statistics" were used for the calculation of emissions, as well as emission factors in accordance with the IPCC 2006 methodology (Volume 2, Chapter 4, Table 4.24). The density of oil used is 881 kg/m3. The calculation does not take into account emissions from flaring, since this method is not used in BiH.

(c) Data Uncertainty and Consistency Analysis

The uncertainty factors for the input data and the emission factor for category 1.B.2 based on IPCC 2006, Volume 2, Chapter 2 are presented below. The emissions are shown for the period 2014 – 2022.

Table 39: Uncertainty Analysis for CRT 1.B.2

Liquid Fuels and Natural Gas	**Uncertainty, %**		
	CO_2	**CH_4**	**N_2O**
Input data	10%	10%	10%
Emission factor	2%	100%	100%
Combined uncertainty	10.20%	100.50%	100.50

3.5 CO_2 transport and storage (CRT 1.C)

In BiH, transport and storage of CO_2 is being performed.

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4 Industrial Processes and Product Use (IPPU CRT 2)

4.1 Basic information about the sector

Category 2 Industrial Processes and Product Use accounted for 15.01% of total greenhouse gas emissions in 2014 and 15.72% in 2022. Several subcategories from the IPPU category have been recognized as a key category, primarily due to significant emissions from the production of iron and steel, aluminum, as well as from processes in the industry of mineral products such as cement and limestone.

The sector of industrial processes and product use includes GHG emissions that arise from the technological processes of production of raw materials and products. As part of the development of the inventory of GHG emissions in BiH, a consistent methodology has been set for the analysis of individual technological processes and the separation of emissions from fuel combustion (in heat and power production) and emissions from technological processes and industrial production. In this report, the 2019 amendment to the IPCC Guidelines for GHG inventories has been fully implemented.

The industrial processes and products sector includes the activities of industrial enterprises and GHG emissions that are not the result of fuel combustion, as well as the use of industrial products such as fluorinated gases and others. The following sectors are included in the inventory of GHG gases:

- Mineral industry (2.A), including cement and lime production,
- Chemical industry (2.b), including soda production,
- Metal industry (2.C), including the manufacture of iron and steel, ferroalloys, aluminium,
- Secondly, including the production of pulp and peppers and food and beverages (NMVOC, NOx and CO emissions).

Non-energy-related industrial activities produce a variety of GHG emissions. Emission sources are industrial production processes in which raw materials are chemically or physically transformed. In this transformation, many different greenhouse gases can be released, such as CO_2, CH_4, N_2O, and PFC. Some industrial sources also produce NOx, NMVOC, CO, and SO2.

Currently, the sector of industrial processes and product use includes the activities of industrial enterprises classified in the production of cement, lime, soda, iron and steel, ferroalloys, aluminum. The methodology used to calculate emissions is according to the IPCC 2006 guidelines, and the Tier 1 approach was used to calculate emissions from the industrial process sector and product use.

Table 40: Subcategories in the IPPU sector

IPCC code	Description	Availability			Not available (NO)
		Estimated	Not Rated (NO)	Included elsewhere (IE)	
2.A	Mineral industry	✓			
2.A.1	Cement	✓			
2.A.2	Lime	✓			
2.B	Chemical Industry	✓			

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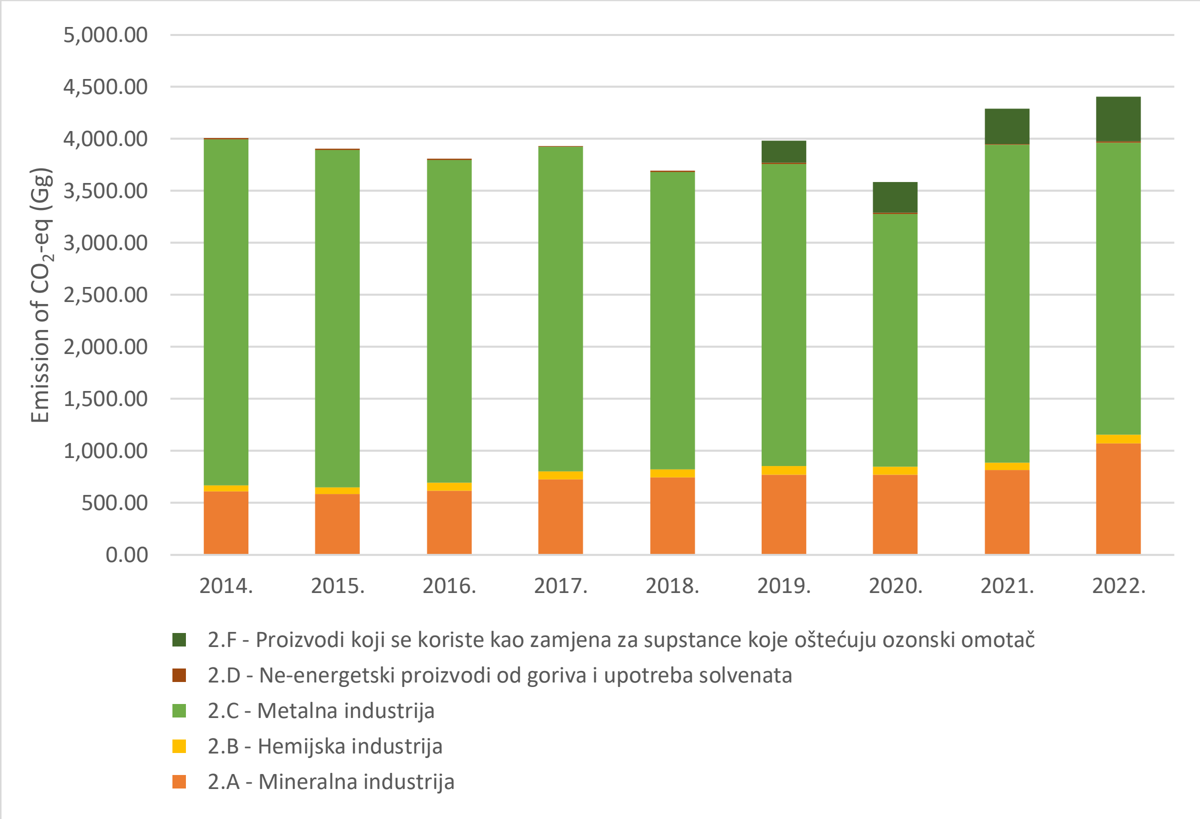
IPCC code	Description	Availability			Not available (NO)
		Estimated	Not Rated (NO)	Included elsewhere (IE)	
2.B.7	Soda	✓			
2.C	Metal Industry	✓			
2.C.1	Iron and steel	✓			
2.C.2	Ferroalloys	✓			
2.C.3	Aluminum	✓			
2.D	Non-energy fuel products and the use of solvents	✓			
2.E	Electronics Industry				✓
2.F	Products used as substitutes for substances that deplete the ozone layer	✓			
2.G	Other Production and Use		✓		
2.H	Other	✓			
2.H.1	Pulp and paper	✓			
2.H.2	Food & Drink	✓			

Overall trends from data received directly from emission sources (industry) and the Agency for Statistics of BiH have been updated. Data on the import of HFC gases were obtained from the competent entity ministries (Ministry of Spatial Planning, Construction and Ecology of the RS and the FBiH Ministry of Environment and Tourism). The data were collected in cooperation with the FBiH and RS Hydrometeorological Institutes. The energy intensity of industrial processes in BiH has been significantly reduced compared to the base year 1990.

Below are the emissions from the CRT 2 Industrial Processes and Product Use sector.



(LEGEND: Proizvodi koji se koriste kao zamjena za supstance koje oštećuju ozonski omotač - Products used as substitutes for substances that deplete the ozone layer*; Ne-energetski proizvodi od goriva i upotreba solvenata - Non-energy fuel products and the use of solvents; Metalna industrija – metal industry; Hemijska industrija – Chemical industry; Minerlna industrija – mineral industry.)*

Chart 34: CO_2 - eq emissions of all categories in the CRT 2 sector Industrial processes and product use in the period 2014 – 2022

From the previous chart it is evident that category 2.C Metal industry occupies the highest share in the total emissions of the CRT 2 Industrial processes and product use sector (83.01% in 2014 and 63.75% in 2022). Throughout the observed period 2014 – 2022, the smallest share in total emissions of category CRT 2 is made up of category 2.D Non-energy fuel products and the use of solvants (0.046% of emissions in 2014 and 0.048% of emissions in 2022), as well as category 2.F Products used as substitutes for substances that deplete the ozone layer, for which data are available from 2019. In 2019, category 2.F. accounted for 5.36% of total CRT 2 emissions, and 9.73% of total CRT 2 emissions in 2022.

4.2 Mineral Industry (CRT 2.A)

Category 2.A Mining industry accounted for 2.28% of total greenhouse gas emissions in 2014, and 3.84% in 2022. This category participates with 15.21% of emissions in 2014 and 24.41% in 2022 in category 2. Within category 2.A, cement production and limestone production were recognized as key categories according to the analysis by level for both observed years (2014 and 2022), while in 2022 their importance was confirmed through trend analysis.

The mineral industry sector in BiH includes processes that result in GHG emissions due to chemical reactions during the production of various mineral products. The most significant sources of emissions within this category are production processes that involve the decomposition of carbonates, which leads to the release of CO_2.

The areas covered by this sector are:

- 2.A.1 – Cement production,
- 2.A.2 – Lime production,

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- 2.A.3 — Manufacture of glass,
- 2.A.4 — Other process uses of carbonates and
- 2.A.5 – Other.

Through the budget of greenhouse gas emissions of BiH for the period 2014 – 2022, the calculation was made for emissions within categories 2.A.1 Cement production and 2.A.2 Production of lime.

These activities have a significant contribution to total emissions in the category of industrial processes and production use of products in BiH, and represent an important focus for monitoring emissions and potential mitigation measures in the future.

GHG emissions from this category remained fairly stable during the period 2014-2021, with a sudden increase in emission values during 2022. Below are the emissions from the Minerals industry (CRT 2.A) sector.

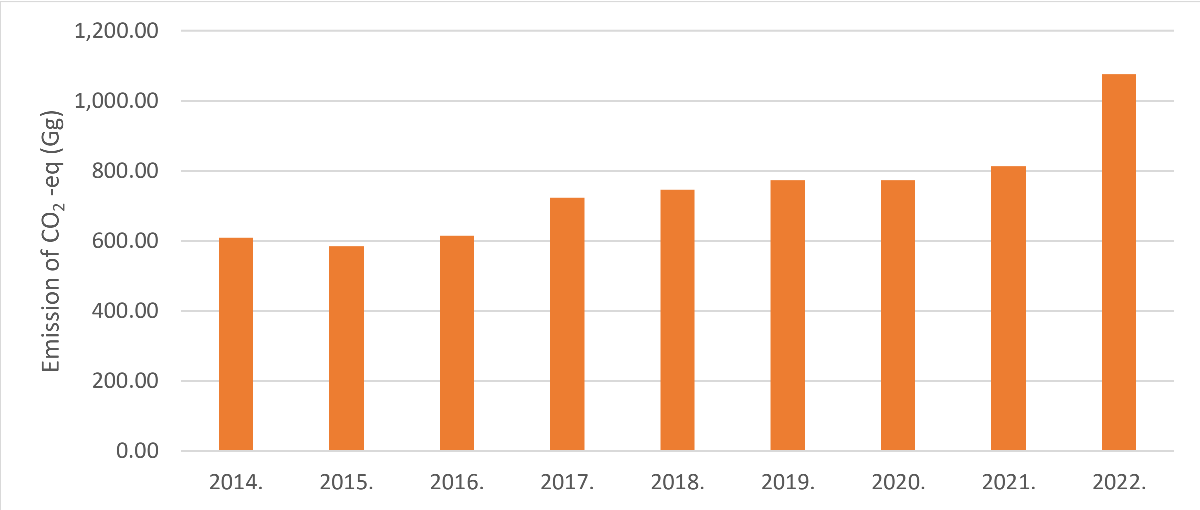
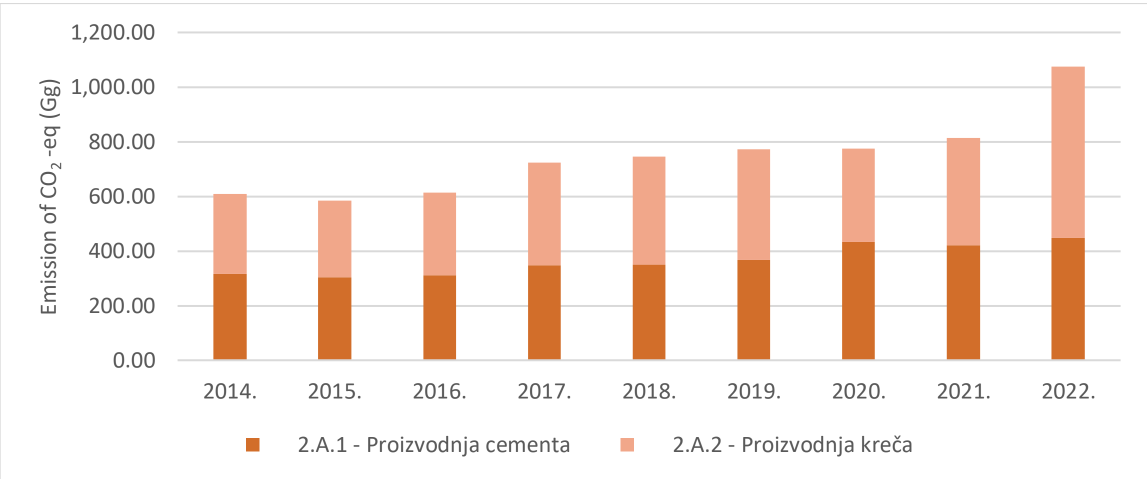


Chart 35: CO_2 - eq emissions in the CRT 2.A sector Minerals industry in the period 2014 – 2022

In the observed period, the highest amount of emissions was recorded in 2022 (1,075.69 Gg CO_2-eq), and the lowest in 2015 (584.92 Gg CO_2-eq).

The following chart shows the share of individual subcategories in total emissions from category 2.A: Minerals industry.



(LEGEND: Proizvodnja cementa – production of cement; Proizvodnja kreča – production of lime.)

Chart 36: CO_2 emissions - eq of all categories in the CRT 2.A sector Minerals industry in the period 2014 – 2022

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The above chart shows that the total CO_2-eq emissions from CRT 2.A consist of emissions from cement production (subcategory 2.A.1) and emissions from lime production (sub-category 2.A.2), with approximately equal shares over the entire observed period. In 2014, cement production accounted for 51.83% and in 2022 for 41.68% of total emissions from the mineral industry. On the other hand, lime production in 2014 accounted for 48.17% of total category 2A emissions, and 58.32% in 2022.

4.2.1 Cement production (CRT 2.A.1)

(a) Basic information about the category

Category 2.A.1 Cement production accounts for 51.83% of emissions in 2014 and 41.68% in 2022 category 2.A. This category participates with 1.18% of emissions in 2014 and 1.60% in 2022 in total emissions of GHG. This category was also key in 2014 and 2022 according to the analysis by level, and in 2022 it was also identified as the key category according to the analysis by trend.

Cement production in BiH is a strategically important industry, given its contribution to domestic construction activity, exports, employment and infrastructural development. At the same time, this activity is one of the largest single sources of greenhouse gas emissions within category 2.A – Mineral industry, primarily due to process emissions that occur during the calcination of carbonate raw materials. Two cement plants are actively operating on the territory of Bosnia and Herzegovina, which form the backbone of domestic cement production.

CO_2 emissions from cement production are the main industrial process source of GHG emissions in the mineral industry. The basic raw material for the production of cement is marl, which is a homogeneous mixture of limestone and clay and which was formed in past geological periods by sedimentation. As there is no longer enough natural marl for mass production, the cement mixture, which must contain 75-78% calcium carbonate ($CaCO_3$), is prepared by mixing components of limestone and clay: from those with 35% CaCO3 to limestone with more than 95% CaCO3. Limestone, which is the source of CaO, usually has an admixture of dolomite, which introduces MgO into the system. Clay components are carriers of SiO2, Al2O3 and Fe2O3. Quartz sand, bauxite and gypsum are added to the homogenized mixture during grinding. CO_2 emissions from cement production are the result of the conversion of CaCO3, the main constituent of limestone, into lime (CaO), while CO_2 is released into the atmosphere as a by-product.

The data on cement production were obtained directly from the two manufacturers, and were verified with statistical data. The calculation uses the Tier 1 method based on data on cement production and import/export of clinker. For the purposes of the calculation, data on the specific shares of clinker in the production of Portland cement were collected. Data on cement production are shown in the following table.

Table 41: Cement production in BiH in the period 2014 – 2022. (t/year)

Cement	2014	2015	2016	2017	2018	2019	2020	2021	2022
CEM I 52,5N / R (Lukavac)	0	0	0	0	0	80,231	90,405	97,325	126,273
CEM I 52,5 N (0,95) (total)	6,462	74,295	92,818	102,110	120,422	0	0	0	0
CEM I 52,5N / R (Kakanj)	0	0	0	0	0	55,011	71,904	92,047	97,047
CEM II B-W 32,5 N(0,6) Lukavac	0	40,228	38,290	42,513	44,462	0	0	0	0
CEM II B-W 42,5 N (0,75) (Lukavac)	294,399	575,709	568,682	651,514	646,621	0	0	0	0
CEM II/A-M (V-L) 42,5 N rinfuza (Lukavac)	0	0	0	0	0	221,422	221,424	224,838	284,682
CEM II/B-W 42,5N (Kakanj)	0	0	0	0	0	336,690	459,597	453,650	452,633
CEM II/B-M (V-L) 32,5 N (Lukavac)	0	0	0	0	0	49,206	58,925	52,796	48,535
CEM II/B-M (V-L) 42,5 N (Lukavac)	0	0	0	0	0	116,665	125,848	101,738	94,403
CEM III B-W 32,5 N (0,34)	0	0	388	1,134	991	0	0	0	0
CEM III/A 42,5N (Kakanj)	0	0	0	0	0	0	4,329	17,409	23,136
CEM III/B 32,5 N SR-LH (Lukavac)	0	0	0	0	0	890	56	83	0
CEM III/B 32,5N SR-LH	0	0	0	0	0	0	0	0	0
CEM III/B 32,5N SR-LH (Kakanj)	0	0	0	0	0	0	0	3,182	2,764
CEM IV B-W 32,5 N (0,50)	115,223	111,003	114,584	106,966	92,086	0	0	0	0
CEM IV/B-W 32,5N (Kakanj)	0	0	0	0	0	92,086	80,905	70,197	53,976
Lukavac	436,177	0	0	0	0	0	0	0	0
Lumal (Lukavac)	0	4,007	3,289	3,070	3,333	4,148	4,989	4,206	3,337
Total	**852,261**	**805,242**	**818,051**	**907,307**	**907,915**	**956,349**	**1,118,382**	**1,117,472**	**1,186,786**

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The previous table shows that the highest values of cement production were recorded in 2020 and 2021, when they amounted to 1,027,978 t/year, and 1,117,473 t/year, respectively. Compared to 2021, there was a visible decrease in cement production in 2022, in the amount of 34.30%.

Based on calculations using IPCC Inventory Software and recommended emission factors (EF=0.51), the following table shows emissions from cement production.

Table 42: Emission trends from cement production

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2 emissions – eq (Gg)	315.93	303.59	310.25	346.58	350.49	367.81	432.91	421.69	448.32

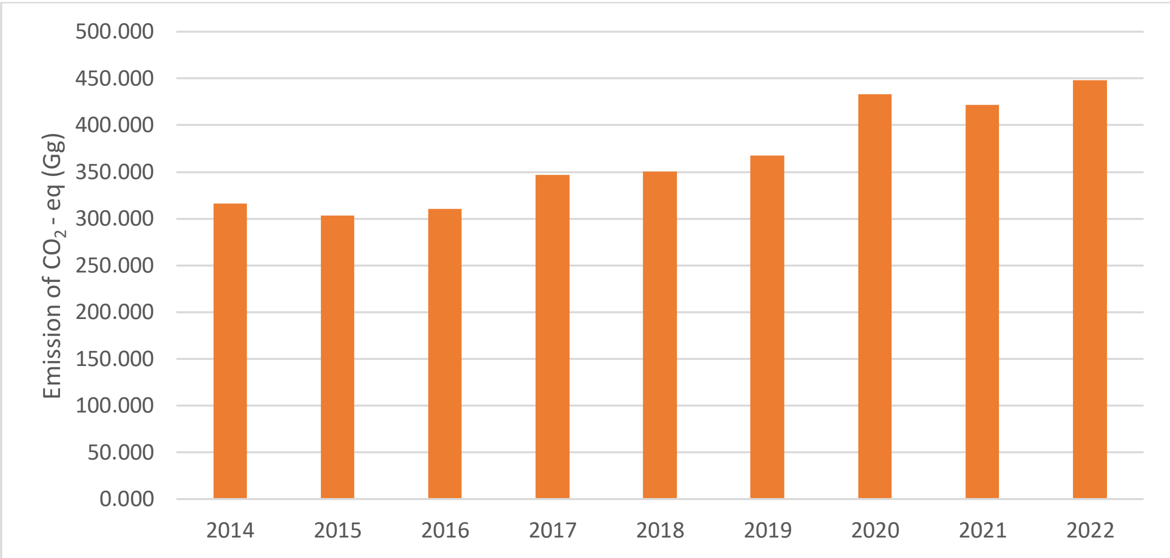

Chart 37: CO_2 - eq emissions in the CTR sector 2.A.1 Cement production in the period 2014 – 2022

The trend of CO_2-eq emissions from the cement production process for the period 2014-2022 is mostly characterized by an upward trend. The lowest value of emissions was recorded in 2015, when it amounted to 303.59 Gg CO_2-eq, while the highest value of emissions was recorded in 2022, when it amounted to 448.32 Gg CO_2-eq,

(b) Methodological approach

For the calculation of emissions, a Tier 1 approach was used, obtained and used data from emission sources with certain percentages of clinker in cement. The data was also verified with data from the BiH Agency for Statistics. The calculation used the default emission factors for clinker (0.51 tCO_2/t clinker), in accordance with the IPCC 2006 methodology (Volume 3, Chapter 2).

(c) Data Uncertainty and Consistency Analysis

For Tier 1, the main component of the uncertainty is the clinker fraction of the cement produced. If clinker is reliable and import and export data are available, then the uncertainty of the production estimate of clinker production will be slightly less. For the analysis of the uncertainty of the calculation of emissions resulting from cement production, the recommended uncertainty factors from the 2006 IPCC methodology (Volume 3, Chapter 2, Table 2.3) were used. According to the above recommendations, uncertainties were adopted: for the chemical composition (clinker content) 7%, for the data of production activities (1-2%), 2% was adopted for the data obtained from cement producers, and for CKD correction 30% was adopted. The emissions are shown for the period 2014 – 2022.

4.2.2 Lime production (CRT 2.A.2)

(a) Basic information about the category

Category 2.A.2 Lime production accounts for 48.16% of emissions in 2014 and 58.32% in 2022 category 2.A. This category participates with 1.10% of emissions in 2014 and 2.23% in 2022 in total GHG emissions. This category is the key category in 2014 and 2022 according to the analysis by level, and in 2022 it was also identified as the key category according to the analysis by trend.

Lime is formed by heating the input raw material (limestone and dolomite) to a high temperature (900°C-1200°C). During this process, the limestone is converted to CaO and emits CO_2.

CO_2 emissions from lime production are considered under the Production of lime (CRT 2.A.2). Data on the volume of mercury lime production, necessary for the calculation of emissions, are taken from the thematic bulletins for industrial production (PRODCOM results) from the Agency for Statistics of BiH. Below is the chart of lime production in the period 2014 – 2022.

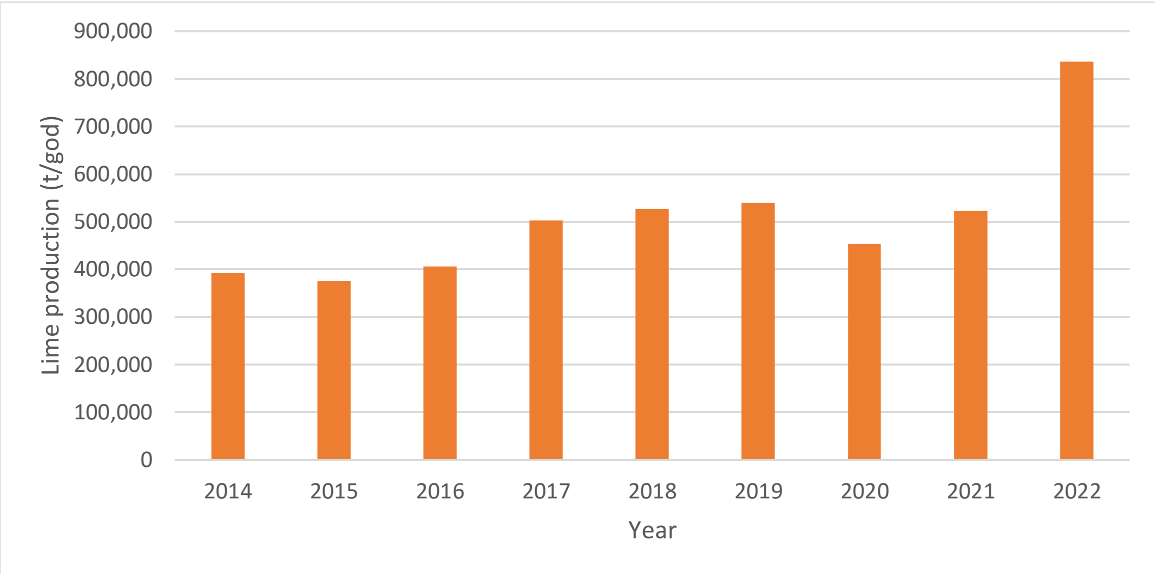

Chart 38: Production in sector CTR 2.A.2 Lime production in the period 2014 – 2022

From the previous chart, it is evident that lime production in BiH in the first three years of the observed period shows minor fluctuations, after which there is an increase in the period 2017 – 2019, and a decline in 2020. The highest lime production was recorded in 2022 when it amounted to 836,486 t, while the lowest value was recorded in 2015 when it amounted to almost 375,105 t.

Below are the CO_2-eq emissions generated from lime production in the period 2014 – 2022.

Table 43 - CO_2-eq emissions from lime production

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2 emissions – eq (Gg)	293.60	281.33	304.59	377.10	395.10	404.69	340.62	391.33	627.36

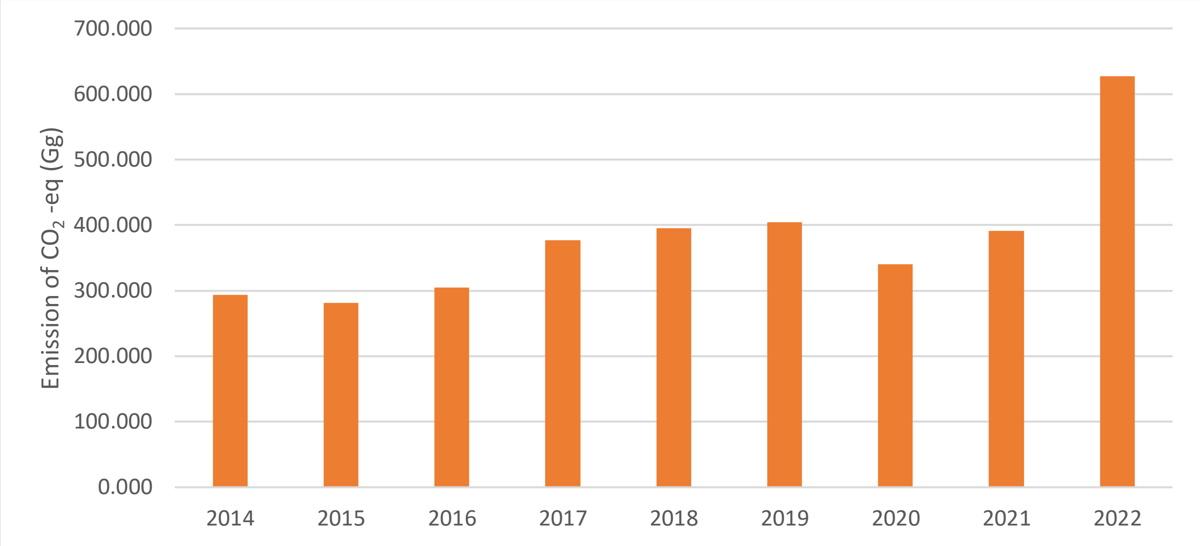

Chart 39: CO_2 - eq emissions in the CRT sector 2.A.2 Lime production in the period 2014 – 2022

From the previous chart, a variable trend in emissions from CRT category 2.A.2 Lime production is noticeable. The emission trend follows the trend of lime production. The highest amount of emissions was recorded in 2022, when it amounted to 627.36 Gg CO_2-eq, while the lowest amount of emissions was recorded during 2015, when it amounted to 281.33 Gg CO_2-eq.

(b) Methodological approach

For the calculation of CO_2-eq emissions, the Tier 1 method was used, and the emission factor (EF=0.75 CO_2 /t lime) in accordance with the IPCC 2006 methodology (Volume 3, Table 2.4). The quantities of produced quicklime are taken from the annual reports on industrial production (PRODCOM results) of the Agency for Statistics of BiH. Data on the content of CaO and MgO in lime were obtained from lime producers in BiH and amount to 89 ± 2% (CaO share) and <2% (MgO share).

(c) Data Uncertainty and Consistency Analysis

Uncertainty estimates for lime production are mainly the result of uncertainty related to activity data, and to a lesser extent from uncertainty related to the emission factor. For the analysis of the uncertainty associated with emissions from limestone production, the recommended values from the IPPC 2006 methodology (Volume 3, Chapter 2, Table 2.5) were used, and 7% was adopted for the uncertainty due to the average CaO content of lime and 25% for the emission factor for high calcium content. The emisisons are shown for the period 2014 – 2022.

4.3 Chemical Industry (CRT 2B)

Category 2.B Chemical industry accounted for 0.22% of total greenhouse gas emissions in 2014 and 0.28% in 2022. In total emissions of GHG, this category participates with 1.46% in 2014, and with

1.79% in 2022. This category was not among the key categories according to the analysis by level in 2014 or 2022, as well as according to the analysis by trend.

CRT category 2.B – Chemical industry includes greenhouse gas emissions that occur during various chemical production processes, where gases are released as a by-product of chemical reactions, not fuel combustion.

In accordance with the IPCC 2006 guidelines, this category includes:

- 2.B.1 — Production of ammonia,
- 2.B.2 – Production of nitric acid,
- 2.B.3 – Production of adipic acid,
- 2.B.4 – Production of caprolactam, glycoxalic and glycoxylic acids,
- 2.B.5 — Production of carbide,
- 2.B.6 — Production of titanium dioxide,
- 2.B.7 – Soda ash production and
- 2.B.8 – Production of petrochemicals and black carbon.

In the context of BiH, emissions from the chemical industry sector were estimated only for subcategory 2.B.7 – Soda ash production, given that the other listed chemical production processes are not present or active in the country during the observed period, and are presented below.

For the Chemical category, GHG emissions remained relatively stable between 2014 and 2022, with soda production as the main source of emissions. The contribution of this category to emissions is 0.24%.

4.3.1 Production of soda (CRT 2.B.7)

(a) Basic information about the category

Category 2.B.7 Production of soda ash accounts for 100.00% of total category 2B emissions in 2014 and 2022, and 0.22% of total GHG emissions in 2014 and 0.28% in 2022. This category was not among the key categories according to the analysis by level in 2014 or 2022, as well as according to the analysis by trend.

Soda ash (sodium carbonate, Na2CO3) is a white crystalline substance used as a raw material in a number of industries including glass, soap and detergent production, pulp and paper production, and water treatment. CO_2 is emitted from the use of soda ash and these emissions are counted as a source within the relevant industrial use. CO_2 is also emitted during production, and the amount emitted depends on the industrial process used for production.

In BiH, the production of soda takes place within an industrial plant and is the only active chemical production that generates process emissions of GHG gases within this category. The data on the production of soda were obtained from the main emission source and are shown in the following chart.

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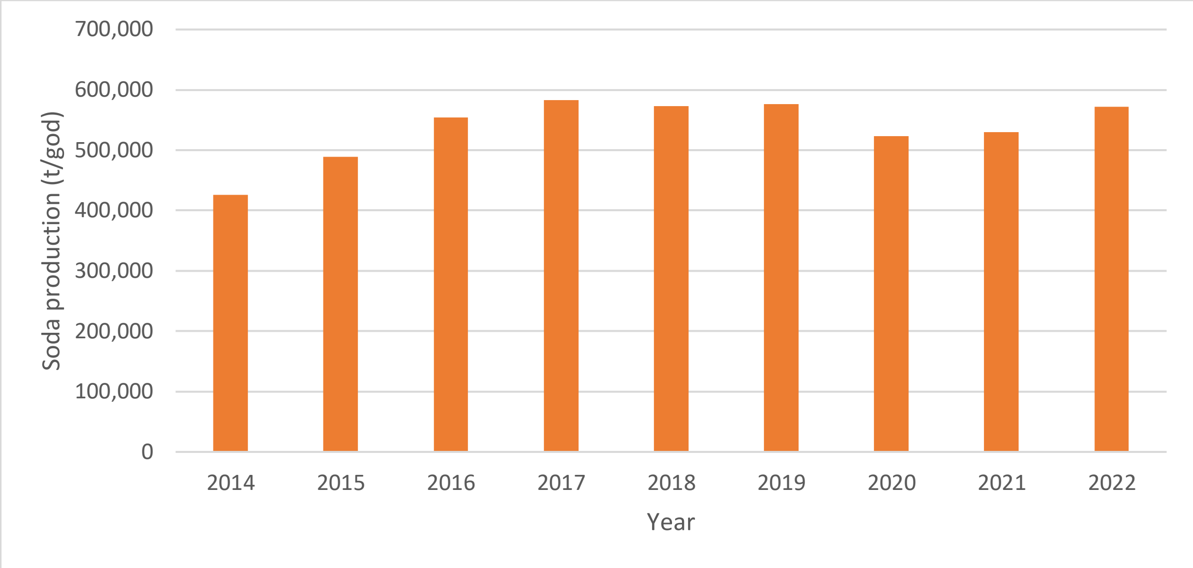

Chart 40: Production in sector 2.B.7 Soda production in the period 2014 - 2022

The previous chart shows that the production of soda was the highest in 2017, when it amounted to 582,710 t/year, while the lowest value was recorded in 2014, when it amounted to 425,867 t/year.

CO_2-eq emissions from soda production follow the trend of soda production, and are shown below.

Table 44 - CO_2-eq emissions from soda production

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2 emissions – eq (Gg)	58.77	67.51	76.42	80.41	79.09	79.53	72.24	73.16	78.96

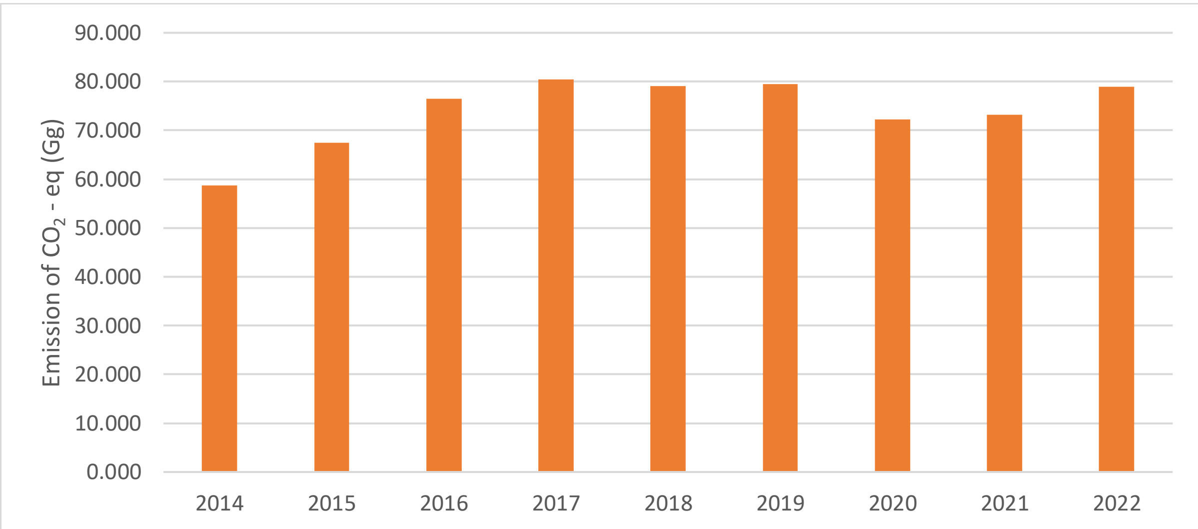

Chart 41: CO_2 - eq emissions in the CRT sector 2.B.7 Soda production in the period 2014 – 2022

From the previous chart, a variable trend in emissions from CRT category 2.B.7 Soda production is visible. The highest amount of emissions was recorded in 2017, when it amounted to 80.41 Gg CO_2-eq, while the lowest amount of emissions was recorded during 2014, when it amounted to 58.77 Gg CO_2-eq.

(b) Methodological approach

The Tier 1 method and recommended values of the emission factor (EFsoda = 0.138 tCO_2/ton of natural soda produced) were used for the calculation of emissions, in accordance with the IPCC 2006 methodology (Volume 3, Chapter 3, Equation 3.14). The quantities of soda produced are taken from the annual reports on industrial production (PRODCOM results) of the Agency for Statistics of BiH.

(c) Uncertainty Analysis

In accordance with the IPCC methodology, Volume 3, Chapter 3, the recommended uncertainty for the emission factor used to calculate emissions from soda production is negligible, and ±5% is adopted for the use of activity data.

4.4 Metal Industry (CRT 2C)

Category CRT 2.C – Metal industry includes GHG emissions that occur during the production and processing of metals, primarily as a result of chemical reactions that take place during the reduction of metals from ore, smelting, refining or processing.

Category 2.C Metal industry accounted for 12.46% of total GHG emissions in 2014 and 10.02% in 2022. In category 2 emissions, this category participates with 83.01% in 2014 and 63.75% in 2022. Within this category, iron and steel production (2.C.1) was a key category in both 2014 and 2022 according to the analysis by level, and in 2022 it was additionally recognized as a key category according to the analysis by trend. Aluminum production (2.C.3) was the key category in both years according to the level analysis, while it was not identified as key according to the trend analysis.

In accordance with the IPCC 2006 guidelines, this category includes:

- 2.C.1 – Production of iron and steel,
- 2.C.2 — Production of ferroalloys,
- 2.C.3 — Aluminium production,
- 2.C.4 — Production of magnesium,
- 2.C.5 – Production of lead,
- 2.C.6 – Production of zinc,
- 2.C.7 Rear Earths Production and
- 2.C.8 Other.

In the context of BiH, for the purpose of creating the GHG inventory, the emission assessment was performed for the following three subcategories:

- 2.C.1 – Production of iron and steel,
- 2.C.2 — Production of ferroalloys and
- 2.C.3 — Aluminium production.

These industrial activities are present on the territory of BiH through the operation of specialized plants and contribute significantly to total industrial emissions.

GHG emissions from the metal industry fluctuated slightly during the reporting period, mainly as a result of changes in iron, steel and aluminum production. In particular, the cessation of crude aluminium production in 2020 and the related emissions were identified.
Below are the emissions from the category Metal industry (CRT 2.C).

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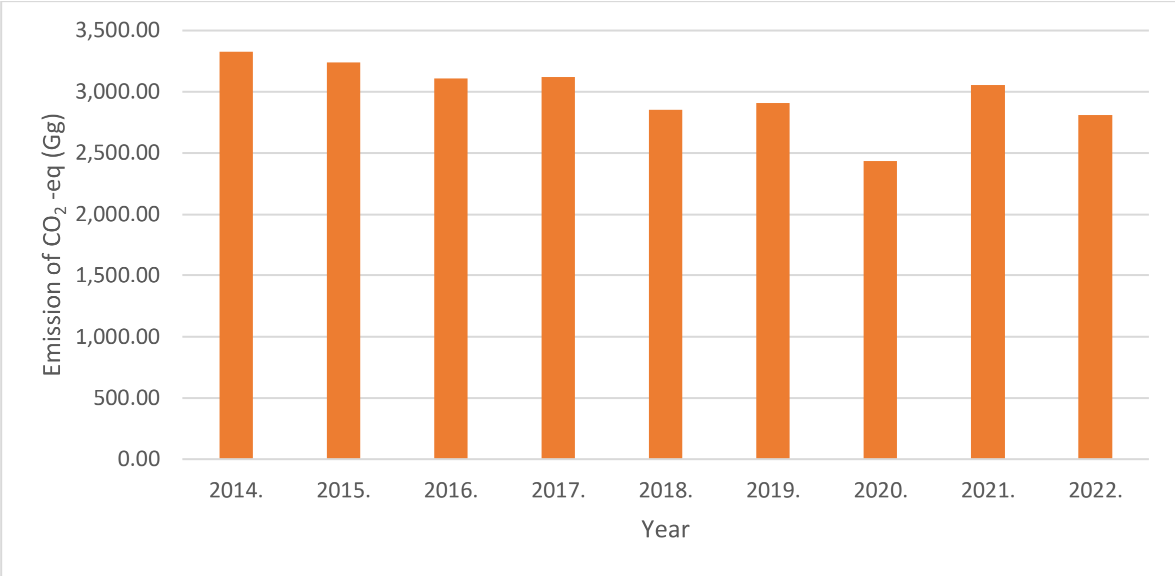
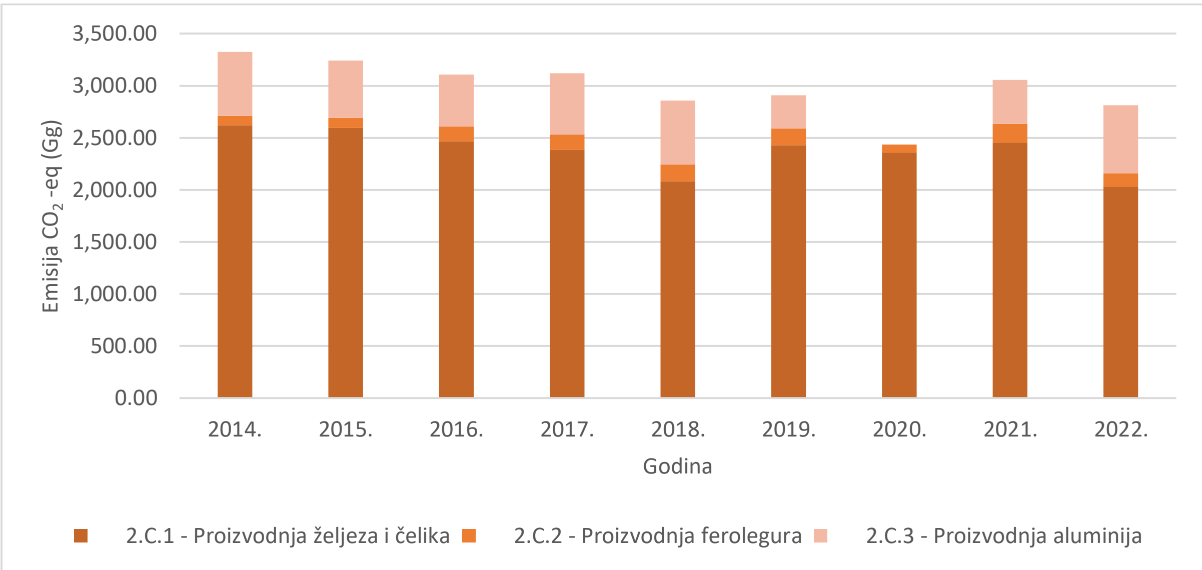


Chart 42: CO_2 - eq emissions in the CRT sector 2.C Metal industry in the period 2014 – 2022

In the observed period, the highest amount of emissions was recorded in 2014 (3,326.10 Gg CO_2-eq), and the lowest in 2020 (2,430.88 Gg CO_2-eq).

The following chart shows the share of individual subcategories in the total emissions from category 2.C Metal industry.



(LEGEND: Proizvodnja željeza i čelika – production of iron and steel; Proizvodnja ferolegura – production of ferroalloys; Proizvodnja aluminija – Aluminium production.)

Chart 43: CO_2 - eq emissions of all categories in the CRT 2.C Metal industry sector in the period 2014 – 2022

It is evident from the previous chart, and it was noted earlier, that the total CO_2-eq emissions from CRT 2.C consist of emissions from iron and steel production (subcategory 2.C.1), emissions from ferroalloy production (2.C.2) and emissions from aluminium production (subcategory 2.C.3). The largest share in total emissions of category 2.C is occupied by subcategory 2.C.1 Production of iron and steel, with a share of 78.75% in 2014 and 72.40% in 2022. The smallest share in total emissions of category 2.C is occupied by subcategory 2.C.2 Production of ferroalloys, with a share of 2.76% in 2014 and 4.42% in 2022. Subcategory 2.C.3 Aluminum production accounts for 18.49% of CRT 2.C emissions in 2014 and 23.18% of CRT 2C emissions in 2022.

4.4.1 Production of iron and steel (CRT 2.C.1)

(a) Basic information about the category

Category 2.C.1 Iron and steel production accounts for 78.75% of emissions in 2014 and 72.40% in 2022 in category 2.C. This category accounts for 9.81% of total GHG emissions in 2014 and 7.25% in 2022. This category is the key category in both 2014 and 2022 according to the analysis by level, and in 2022 it was also identified as the key category according to the analysis by trend.

The estimation of emissions from the Iron and Steel Industry mainly consists of primary plants that produce both iron and steel; secondary steelmaking plants; iron and coke production plants. Data on the production of coke, pig iron, sinter and steel were obtained from the main emission source and from the annual industry reports of the Agency for Statistics (PRODCOM results). Coke production data are related to coke from the coke oven obtained by carbonization of coking coal at high temperatures.

Below are the data on the production of pig iron, sinter and steel in the period 2014 – 2022.

Table 45: Iron and steel production in BiH in the period 2014 – 2022 (t/year)

Product	2014	2015	2016	2017	2018	2019	2020	2021	2022
Crude iron	860,429	845,462	778,123	738,476	664,291	744,778	739,058	795,396	641,417
Sinter	1,336,739	1,286,496	1,201,288	1,398,800	1,083,122	1,258,204	1,244,788	1,364,314	1,146,129
Steel	815,355	819,043	805,397	756,012	663,293	800,641	759,278	756,736	641,417

From the previous table it is evident that the highest production of sinter was recorded in 2017, when it amounted to 1,398,800 t, while the lowest value was recorded in 2018, when it amounted to 1,083,122 t. The highest value of steel production was recorded in 2015, when it amounted to 819,043 t, and the lowest in 2022, when it amounted to 641,417 t. The highest production of pig iron was recorded in 2014, when it amounted to 860,429 t, and the lowest in 2022, when it amounted to 641,417 t.

Iron and steel production in BiH leads to CO_2 and CH_4 emissions, and CO_2-eq emissions from CRT 2.C.1 Iron and steel production are presented below.

Table 46: CO_2-eq emissions from iron and steel production (including coke)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2 emissions – eq (Gg)	2,619.35	2,594.48	2,466.60	2,380.48	2,081.83	2,428.49	2,357.67	2,454.16	2,033.85

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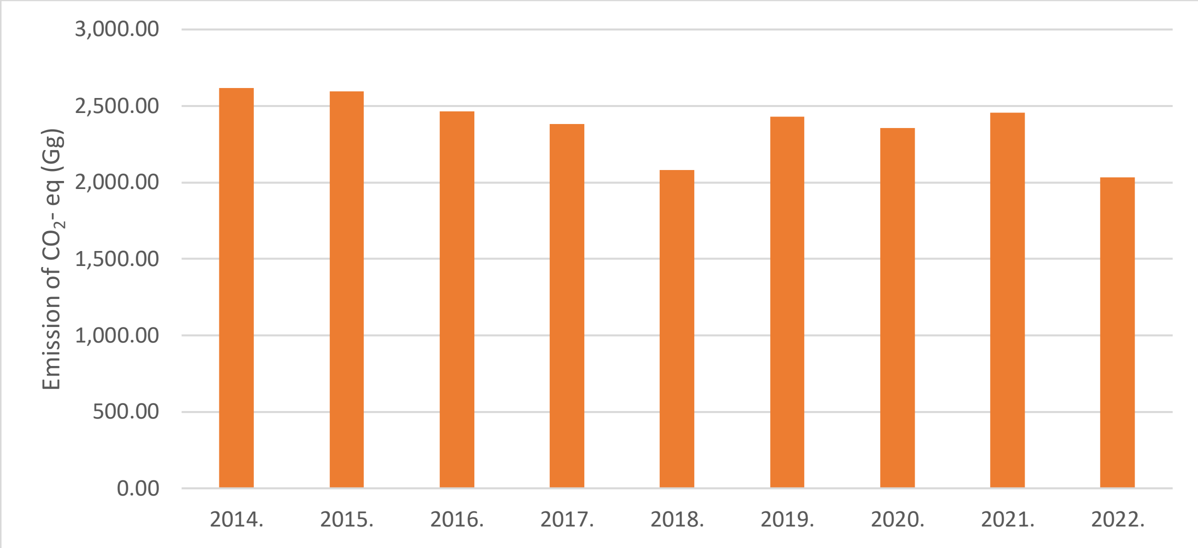

Chart 44: CO_2 - eq emissions in the CRT sector 2.C.1 Iron and steel production in the period 2014 – 2022

From the previous chart, a variable trend in emissions from CRT category 2.C.1 Iron and steel production is noticeable. The highest amount of emissions was recorded in 2014, when it amounted to 2,619.35 Gg CO_2-eq, while the lowest amount of emissions was recorded during 2022, when it amounted to 2,033.85 Gg CO_2-eq.

Only CH4 emissions from iron and steel production are singled out and shown below, noting that they are already included in the CO2-eq emissions shown above.

Table 47: CH4 emissions from iron and steel production (including coke)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Emission CH4 (Gg)	0.184	0.181	0.170	0.183	0.170	0.179	0.166	0.191	0.162

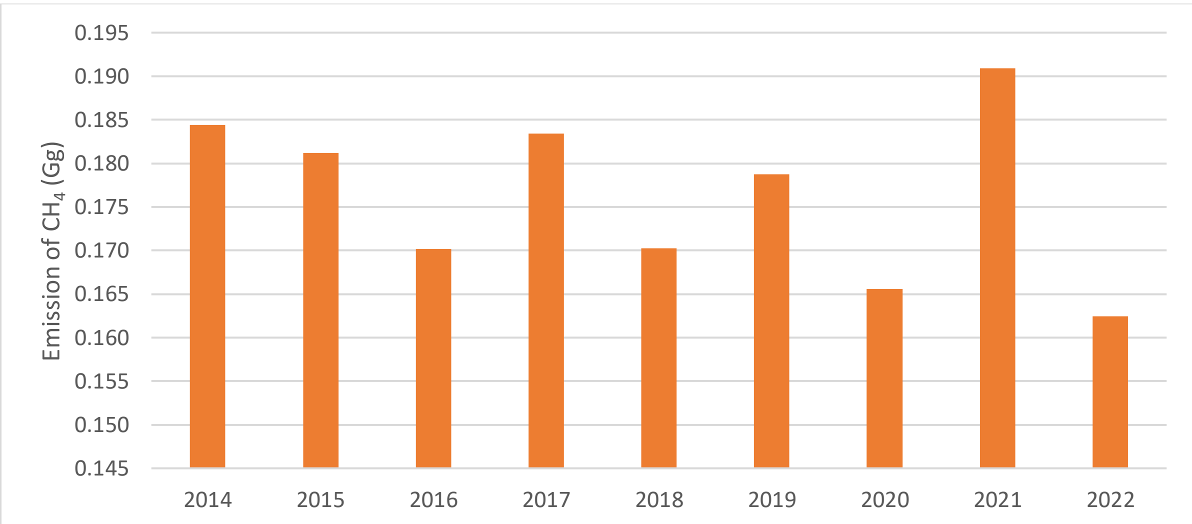

Chart 45: CH4 emissions in CRT sector 2.C.1 Iron and steel production in the period 2014 – 2022

CH_4 emissions from iron and steel production in the period 2014–2022 show an oscillating trend. The highest emissions were recorded in 2021 (0.191 Gg), while the lowest were in 2022 (0.162 Gg).

(b) Methodological approach

The Tier 1 method and the recommended values of emission factors for each production process (sinter, steel and iron production) from the IPCC 2006 methodology (Volume 3, Chapter 4, Table 4.1) were used for the calculation of emissions. An assessment of CO_2 and CH_4 emissions for the production of coke, pig iron, sinter and steel was carried out. Since emissions per unit of steel production vary greatly and depend on the method of steel production, the production of steel from Basic Oxygen Furnaces (BOF) and the recommended emission factor for it (EF_{CO_2}=1.46 tCO_2/t of steel produced) were identified. In accordance with this approach, the emission factor was used for the production of pig iron ($EFCO_2$=0.2 tCO_2/ t), sinter ($EFCO_2$= 1.35 tCO_2/t), and coke ($EFCO_2$=0.56 tCO_2/t).

(c) Data Uncertainty and Consistency Analysis

According to the recommendations of the 2006 IPCC methodology (Volume 3, Chapter 4, Table 4.4), the uncertainty ranges for iron and steel production were adopted ±25% for the recommended emission factors and ±10% for the downloaded production data. The emissions are shown for the period 2014 – 2022.

4.4.2 Production of ferroalloys (CRT 2.C.2)

(a) Basic information about the category

Category 2.C.2 Production of ferroalloys accounts for 2.76% of emissions in 2014 and 4.42% in 2022 in category 2.C. This category participates with 0.34% in total GHG emissions in 2014 and 0.44% in 2022. This category was not among the key categories either according to the analysis by level in 2014 and 2022, nor according to the analysis by trend.

Ferroalloy is a term used to describe concentrated alloys of iron and one or more metals such as silicon, manganese, chromium, molybdenum, vanadium, and tungsten. The production of metal silicon is usually included in the group of ferroalloys because the production process of silicon metal is quite similar to that of ferrosilicon. These alloys are used to deoxidize and change the material properties of steel. The production of ferroalloys in BiH is included through the selection of silicon metal production, and the data were collected from the annual reports on industrial production of the Agency for Statistics (PRODCOM results). Ferroalloy production involves a metallurgical reduction process that results in significant CO_2 emissions, which are shown below.

Table 48: CO_2-eq emissions from ferroalloy production

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2 emissions – eq (Gg)	91.91	93.58	140.69	152.36	157.30	159.56	73.20	179.60	124.29

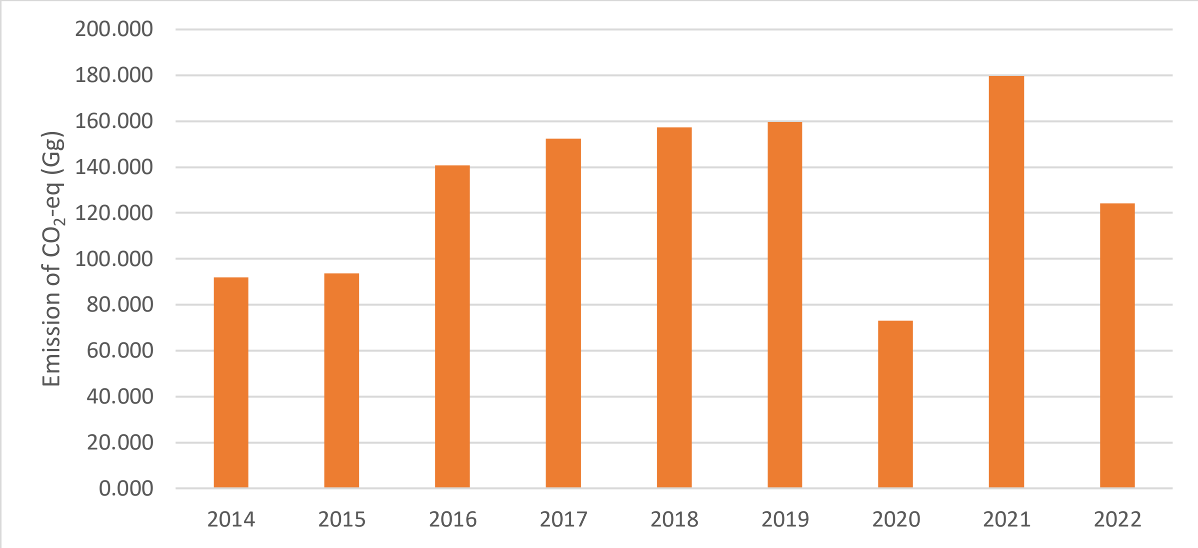

Chart 46: CO_2 - eq emissions in the CRT sector 2.C.2 Production of ferroalloys in the period 2014 – 2022

From the previous chart and table, a variable trend in emissions from CRT category 2.C.2 Ferroalloy production is noticeable. The highest value of emissions was recorded in 2021, when it amounted to 179.60 Gg CO_2-eq, while the lowest value of emissions was recorded during 2020, when it amounted to 73.20 Gg CO_2-eq.

(b) Methodological approach

An assessment of CO_2 and CH_4 emissions for the production of silicon metal was carried out. The Tier 1 method and recommended values of emission factors according to the IPCC 2006 Methodology (Volume 3, Chapter 4, Table 4.5 for the CO_2 emission factor (EF_{CO_2}= 5 tCO_2/t) and Table 4.7 for the emission factor for CH_4 ($EFCH_4$=1.2 tCO_2/ t of silicon metal produced) were used.

(c) Data Uncertainty and Consistency Analysis

The uncertainty factor of the statistical data used for the calculation of emissions from ferroalloy production was determined using the recommended values from the IPCC 2006 methodology (Volume 3, Chapter 4, Table 4.9).

The uncertainty factor of emissions from the production of ferroalloys is related to the production statistics and they are adopted 2% (recommended <5%) for the input statistical data used and 20% (recommended <25%) for the emission factors. The emissions are shown for the period 2014 – 2022.

4.4.3 Aluminium production (CRT 2.C.3)

(a) Basic information about the category

Category 2.C.3 Aluminum production accounts for 18.48% of emissions in 2014 and 23.18% in 2022 in category 2. This category accounts for 2.30% of total GHG emissions in 2014 and 2.32% in 2022. This category was among the key categories by level in 2014 and 2022 (by CO2 emissions and PFCs), but was not recognized as a key category by trend analysis.

Emissions from CRT 2.C.3 Aluminium production imply process emissions from the primary production of crude aluminium. In this production, Sodeberg technology of raw aluminum is used, whereby two main emissions from the production process are selected:

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- CO_2 emissions from the consumption of carbon anodes in the reaction to convert aluminium oxide to aluminium metal and
- Emissions of perfluorocarbons CF4 and C2F6 during anode effects.

The values of annual aluminum production are taken from the data on annual industrial production of the Agency for Statistics (PRODCOM results) and shown in the following chart.

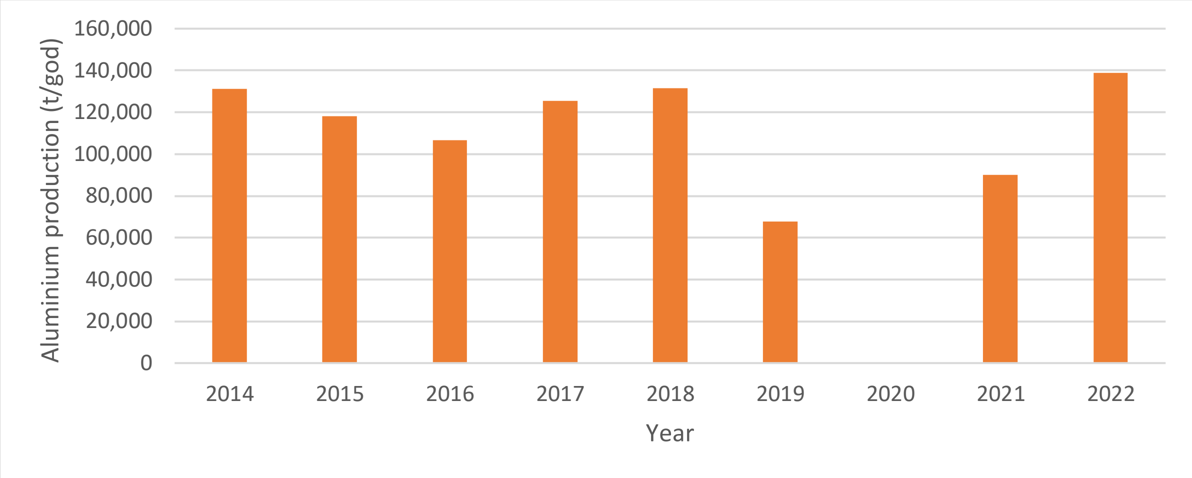

Chart 47: Aluminium production in BiH (t/yr) in the period 2014 - 2022

From the previous chart, it is evident that aluminum production in BiH (t/year) shows certain oscillations in the period 2014 – 2022, when the lowest value was recorded in 2019 (67,690 t), and the highest in 2022 (138,969 t). In 2020, there was no aluminum production in BiH.
The CO_2-eq emissions from CRT 2.C.3 Aluminium production are shown below.

Table 49- CO_2 emissions from aluminium production

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2 emissions – eq (Gg)	614.85	554.02	499.65	588.14	616.11	317.13	0.00	421.83	651.07

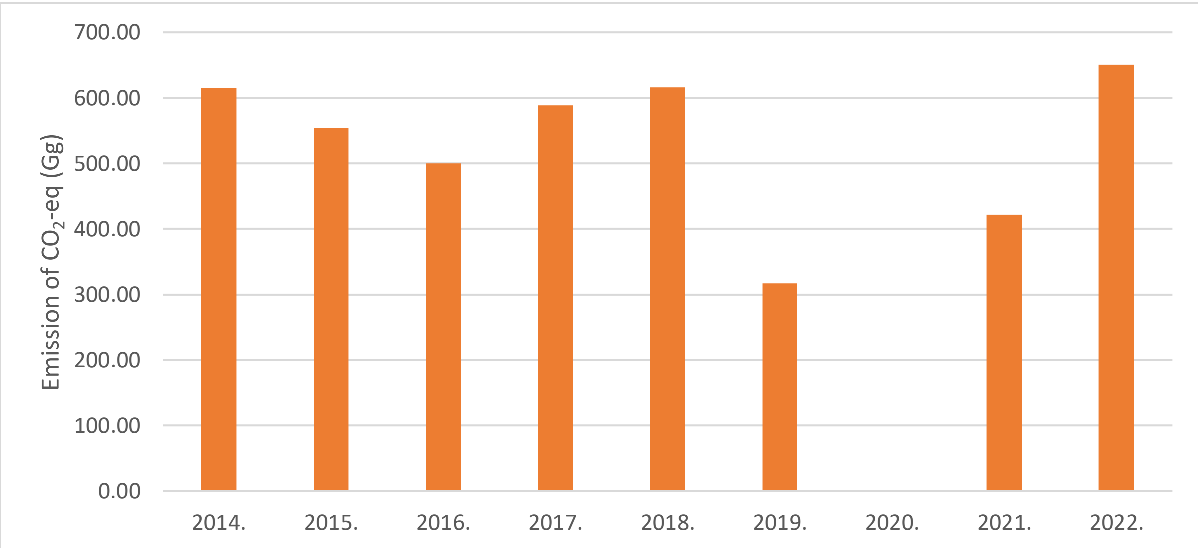

Chart 48: CO_2 - eq emissions in the CRT sector 2.C.3 Aluminium production in the period 2014 – 2022

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From the previous graph, a variable trend in emissions from CRT category 2.C.3 Aluminium production is noticeable. The highest value of emissions was recorded in 2022, when it amounted to 651.07 Gg CO_2-eq, while the lowest value of emissions was recorded during 2019, when it amounted to 317.13 Gg CO_2-eq. Emissions from CRT 2.C.3 in 2020 were not recorded due to the cessation of crude aluminium production in that year. Category 2.C.3 accounts for 2.02% of total CO_2-eq (excluding sinks) emissions in 2022.

(b) Methodological challenges

An assessment of CO_2 and PFC emissions for HSS technology has been performed. The Tier 1 method and recommended values of emission factors in the production of aluminium using the Sodeberg process according to the IPCC 2006 Methodology (Volume 3, Chapter 4, Table 4.10 for the CO_2 emission factor (EF_{CO_2} = 1.7 tCO_2/tproduced aluminium) and Table 4.15 for the emission factor for CF4 (EFCF4= 0.4 kg CF4/tproduced aluminium)) were used. Data on aluminum production are taken from the PRODCOM report of the Agency for Statistics of BiH.

(c) Data Uncertainty and Consistency Analysis

For the calculation of emissions from aluminium production, the recommended uncertainty associated with the CO_2 emission factor is ±10%, while the uncertainty associated with the emission factor for CF4 is higher at ±100% (IPCC 2006, Volume 3, Chapter 4, Table 4.15). The uncertainty of the activity data is low and ±0.5% has been adopted, according to the recommendations of the IC IPCC guidelines (Volume 3, Chapter 4, 4.4.3.2). The emissions are shown for the period 2014 – 2022.

4.5 Non-energy products from fuels and the use of solvents (CRT 2.D)

Category 2.D – Non-energy products from fuels and solvent use includes GHG gas emissions resulting from the use of fuels and chemical substances for non-energy purposes, i.e. when they are used not for combustion, but for industrial or other technical purposes. According to the IPCC classification, this category includes the following subcategories:

- 2.D.1 – Use of lubricants (e.g. engine oils and other technical lubricants),
- 2.D.2 – Use of paraffin wax (e.g. in the manufacture of candles, packaging, etc.),
- 2.D.3 – Use of solvents (e.g. in the paints, varnishes and cleaning products industry) and
- 2.D.4 – Other.

In the GHG inventory of BiH for the period 2014 – 2022, the calculation of emissions from the use of lubricants (CRT 2.D.1) and the use of paraffin (CRT 2.D.2) was made. Due to the impossibility of separating the data on the consumption of lubricants and paraffins, the two categories are calculated in the inventory through CRT 2.D.1, where the input data used implies the total amount of lubricants and paraffins used. The quantities of consumption of lubricants and paraffins are taken from the annual statistical reports: Statistics of Energy, Oil, Oil derivatives, and are presented below.

Table 50: Data on the consumption of lubricants and paraffins in BiH in the period 2014 - 2022 (t)

Year	Consumption of lubricants and paraffins (t)	Standard net calorific values (TJ/t)	Consumption of lubricants and paraffins for total quantities (TJ)
2014	20,716	40.20	832.78
2015	23,322	40.20	937.54
2016	18,234	40.20	733.01
2017	14,789	40.20	594.52
2018	25,423	40.20	1,022.00
2019	22,786	40.20	916.00
2020	21,637	40.20	869.81
2021	20,441	40.20	821.73
2022	22,730	40.20	913.75

From the previous table, it can be seen that the trend of consumption of lubricants and paraffins in the period from 2014 to 2022 shows certain oscillations, but without a clearly expressed long-term growth or decrease. The highest consumption was recorded in 2018 (25,423 t), while the lowest value was recorded in 2017 (14,789 t). Compared to 2014, when consumption amounted to 20,716 t, the value from 2022 (22,730 t) is higher by about 9.70%.

Table 51: CO_2-eq emissions from CRT 2.D Non-energy products from fuels and solvent use in the period 2014 – 2022

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO_2-eq emissions (Gg)	12.21	13.75	10.75	8.72	14.99	13.44	12.76	12.05	13.40

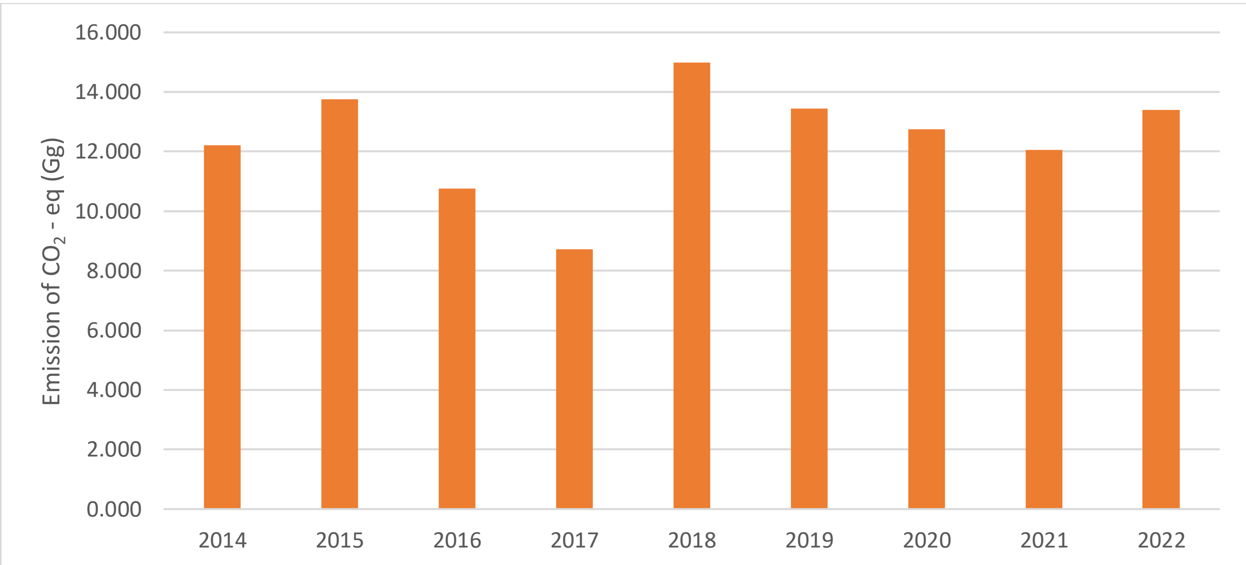

Chart 49: CO_2-eq emissions from CRT 2.D Non-energy products from fuels and solvent use

CO_2 emissions from the use of lubricants and paraffins between 2014 and 2022 show slight annual fluctuations, with no pronounced upward or downward trend. The lowest value of emissions was recorded in 2017 (8,720 Gg), while the highest emission was recorded in 2018 (14,989 Gg).

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Compared to the initial year (2014), when emissions amounted to 12.21 Gg, in 2022 emissions were slightly higher and amounted to 13.40 Gg, which represents an increase of about 9.70%. This dynamic follows the movement of lubricant and paraffin consumption.

4.5.1 Methodological approach

The Tier 1 method was used for the calculation with recommended values of emission factors according to the recommendations of the 2006 IPCC methodology (Volume 2, Chapter 2, Table 2.2). For the type of lubricant, the IPPC recommended value for total lubricants and paraffins has been adopted. Data on the total consumption of lubricants and paraffins (statistical reports) and calculated calorific values of lubricant consumption (TJ) were collected using standard net calorific values of 40.2 TJ/t (source: https://mdgs.un.org/unsd/energy/balance/2013/05.pdf). According to the IPCC Methodology, the recommended value of the oxidation fraction for lubricants and paraffins (ODU) of 0.2 was used (Volume 2, Chapter 2, Table 2.4). The calculation of the lubricants used for two-stroke engines was not specifically carried out due to a lack of data. The quantities of lubricants and paraffins are available in the total value in the statistical reports. Given that the same emission factors and other relevant parameters are used for the calculation of emissions from lubricants and paraffins, a joint calculation was made

4.5.2 Uncertainty Analysis

According to the recommendations of the 2006 IPCC Guidelines, oxidation fraction factors for lubricants and paraffins (ODU) are very unsafe, and according to expert estimates it is 59%. Furthermore, the uncertainty of the activity data is 10-20% based on an expert assessment of the accuracy of energy statistics.

Table 52: Uncertainty analysis for CRT category 1.B.1

Solid fuels	**Uncertainty, %**
	CO_2
Input data	20%
Oxidation fraction factors (ODU)	59%
Combined uncertainty	62%

4.6 Substitutes for ozone-depleting substances (CRT 2F)

4.6.1 Basic information about the category

This chapter includes emissions from stationary and mobile refrigeration/cooling and air-conditioning systems. In BiH, there is no production of HFC gases, and for the first time, imported F-gases are taken into account in the calculation and inventory. Data on the import of HFC gases were obtained from the competent entity ministries (RS Ministry of Spatial Planning, Construction and Ecology and the FBiH Ministry of Environment and Tourism), and are presented below.

Table 53: Import and consumption of F-gases in BiH in the period 2019 - 2022

Gas	**Consumption (kg/year)**			
	2019	**2020**	**2021**	**2022**
HCFC-22	30,872.00	23,228.80	0.00	0.00

Gas	Consumption (kg/year)			
	2019	2020	2021	2022
HFC- 134a	774,831.00	147,817.40	45,152.0	272,147.80
R404A	88,149.70	165,331.20	105,948.00	187,058.00
R406A	0.00	0.00	0.00	0.00
R407C	39,248.00	29,898.00	12,339.60	3,017.10
R410A	66,827.50	55,596.00	23,854.00	24,365.40
R507A	226.00	11.10	0.00	203.40
R32	26,200.00	98,00.00	21,247.00	2,515.00
R600a	193.20	362.56	245.70	0.00
R1234yf	75.00	0.00	100.00	0.00
R 407A	1,130.00	0.00	0.00	0.00
R290	8.88	0.00	9.99	0.00
SF6	0.00	156.00	312.00	312.00
HFC 152A	0.00	0.00	5,361.00	0.00
R125	0.00	0.00	0.00	75.00
R422D	0.00	0.00	0.00	576.30

From the previous table, it is evident that the largest share in the total quantities of import and consumption of F-gases is achieved by HFC-134a, with particularly high values in 2019 and 2022. The consumption of some gases, such as R404A and R600a, also records high values. Certain gases (e.g. R407A, R125) are not recorded in all years, indicating occasional use. A decline in 2021 is visible for most gases, with a partial recovery in 2022.

Within this category, HFC and SF6 emissions are calculated. Total CO_2-eq emissions as well as CO_2-eq emissions per individual gas are shown below. Category 2.F.1 Refrigeration/Cooling and Air Conditioning was the key category in 2022 according to the analysis by level and was also recognized as the key category according to the analysis by trend.

Table 54CO_2-eq emissions from the use of F-gases (CRT 2F)

CO2 emissions – eq (Gg)	2019	2020	2021	2022
HFC (CO_2-eq)	213,954	299,310	335,611	427,921
SF6 (CO_2-eq)	0,021	0,385	1,080	1,339
Total HFC & SF6 (CO_2-eq)	213,98	299,70	336,69	429,26

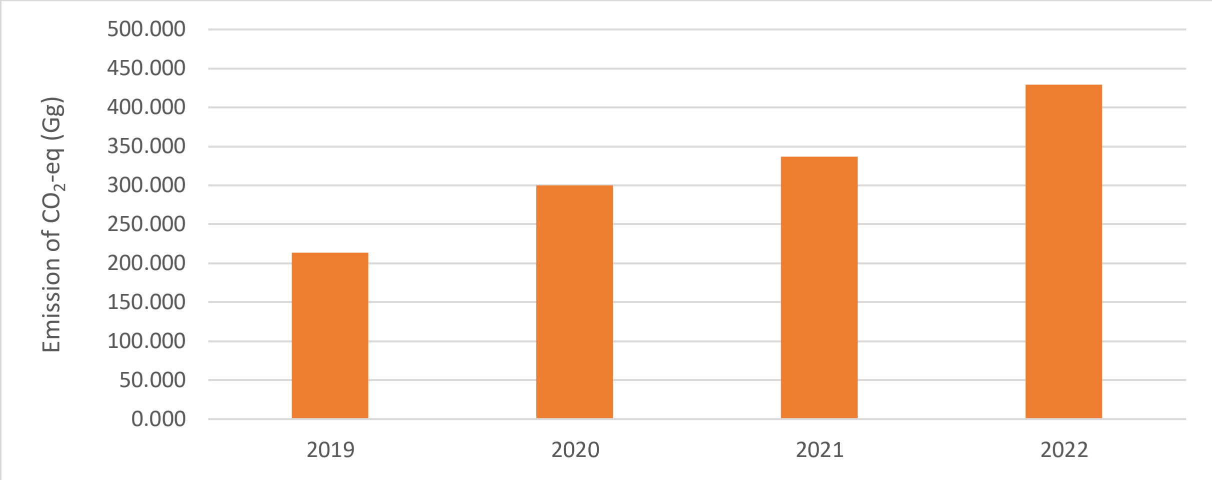

Chart 50CO_2-eq emissions from the use of F-gases (CRT 2F)

Emissions have increased from 213.98 Gg CO_2-eq in 2019 to 426.26 Gg CO_2-eq in 2022, indicating increased consumption of F-gases and their increasing contribution to total GHG emissions.

4.6.2 Methodological approach

According to the IPCC 2006 guidelines, and in accordance with national circumstances, the Tier 1 method and recommended values of emission factors were used.

In BiH, statistical data are not provided separately for the subcategories given under 2.F. Data on the total quantity of imported products available at the national level are available. Data on the import of HFC gases were obtained from the competent entity ministries (RS Ministry of Spatial Planning, Construction and Ecology and the FBiH Ministry of Environment and Tourism). For purpose of calculating emissions, F-gases are categorized into stationary and mobile systems, according to their dominant use. HFC-134a, which is primarily used in mobile air conditioning systems (e.g., air conditioning in passenger vehicles), is classified as a mobile emission source. All other recorded F-gases, including mixtures such as R404A, R410A, R407C and others, are predominantly used in stationary refrigeration and air-conditioning systems (e.g. commercial refrigeration, industrial plants), and as such are included in the calculation of emissions from stationary sources.

These gases were taken into the calculation without detailed data and information related to the required chemical data, data on the growth rate in sales of new equipment, the assumed lifetime of the equipment and the emission factor for the installed base and the percentage of gas destroyed at the end of the life of the equipment. In this case, an assessment of these parameters was made based on experience from other countries and experiences on the use of relevant equipment and management of used devices and equipment (Emissions and Reduction Potentials of Hydrofluorocarbons, Perfluorocarbons and Sulphur Hexafluoride in Germany, LEISEWITZ & SCHWARZ, 2010). In this regard, the following parameters have been adopted:

- Growth rate in sale of new equipment: 0.7% for HFC gases and 0.05% for SF6,
- Estimated service life of the equipment: 12 years,
- Emission factor for the installed base: 10% and
- Percentage of gas destroyed at the end of the life of the equipment: 30%.

4.6.3 Data Uncertainty and Consistency Analysis

The activity data available for this sector is a reliable source for imported and used F-gases. However, there is a lot of uncertainty related to the way it is used, and ±30% uncertainty is adopted. This is caused in part by commercial confidentiality issues within the dataset and the unreliable estimation required. Uncertainty for use and service life are adopted at the level of 40% due to experiential evaluation. It is of great importance that uncertainty in data on activities and use is reduced in order to allow for future emission calculation.

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5 Agriculture, forestry and other land use (CRT 3)

5.1 Sector overview

Sector CRT 3 Agriculture, forestry and other land use predominantly removes GHG emissions, while a certain part is emitted back into the atmosphere, due to agricultural activities of tillage, crop protection, harvesting, heating or cooling of buildings/greenhouses. From the part of livestock production, part of the removed gases is also returned to the soil through manure, converted into organic products (meat, milk, wool, leather), and a smaller part is returned to the atmosphere. GHG emissions from this sector included in CRT category 1.A.4.c. In addition, part of the CO_2 emissions resulting from the breakdown of organic matter from soil and biomass remaining on land after harvest are included in sector (CRT 4) 'Land use land cover' (LULUCF).

Within this category, enteric fermentation (3.A.1) direct N_2O emissions from soil (3.C.4) were the key category in 2014 and 2022 according to the level analysis, and in 2022 they were confirmed through the trend analysis. In addition, fertilizer management (3.A.2), fires (3.C.1), indirect N_2O emissions from soil (3.C.5) are recognized as key according to trend analysis.

Sector **CRT 3 – Agriculture, forestry and other land use (AFOLU)** consists of the following main categories and subcategories:

- **3.A – Livestock farming**
  - 3.A.1 — Enteric fermentation
  - 3.A.2 – Manure management
- **3B – Land**
  - 3.B.1 – Forest land
  - 3.B.2 – Cultivated land
  - 3.B.3 — Grasslands
  - 3.B.4 – Wetlands
  - 3.B.5 – Settlements
  - 3.B.6 – Other land
- **3C – Aggregate sources and non-CO_2 emissions from land**
  - 3.C.1 — Combustion
  - 3.C.2 – Calcification of land
  - 3.C.3 – Use of urea
  - 3.C.4 – Direct N_2O emissions from cultivated land
  - 3.C.5 – Indirect N_2O emissions from cultivated land
  - 3.C.6 – Indirect N_2O emissions from manure management
  - 3.C.7 – Rice cultivation
  - 3.C.8 — CH_4 from drained organic soils
  - 3.C.9 — CH_4 from drainage channels
  - 3.C.10 — CH_4 from re-soaked organic soils
  - 3.C.11 – CH_4 from rewatering mangroves, etc.
  - 3.C.12 — N_2O from aquaculture

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    - 3.C.13 — CH_4 from irrigated and created wetlands
    - 3.C.14 — Other
- **3D – Other**
    - 3.D.1 — Products of felled wood
    - 3.D.2 – Other

Within this sector, six areas/categories have been analyzed in the GHG inventory of BiH:
- 3.A.1 — Enteric fermentation,
- 3.A.2 — Manure management,
- 3.B.1 – Forest land,
- 3.C.1 — Fires,
- 3.C.3 – Application of urea,
- 3.C.4 – Direct N_2O emissions from cultivated land,
- 3.C.5 — Indirect N2O emissions from soil;
- 3.c.6 - Indirect N2O emissions from fertilisers and
- 3.D.1 — Products made of felled wood.

Gas emissions that may result from the calcification of acidic soils (3.C.2) are not recorded either in statistical publications or in strategic documents related to agricultural development, so they have not been estimated. Rice production is not represented in BiH. BiH belongs to the belt of Mediterranean, temperate-continental and mountainous climate, there is no savanna burning.
The trend of emissions from the CRT 3 Agriculture, forestry and other land use sector (excluding sinks) for the period 2014 – 2022 is presented below.

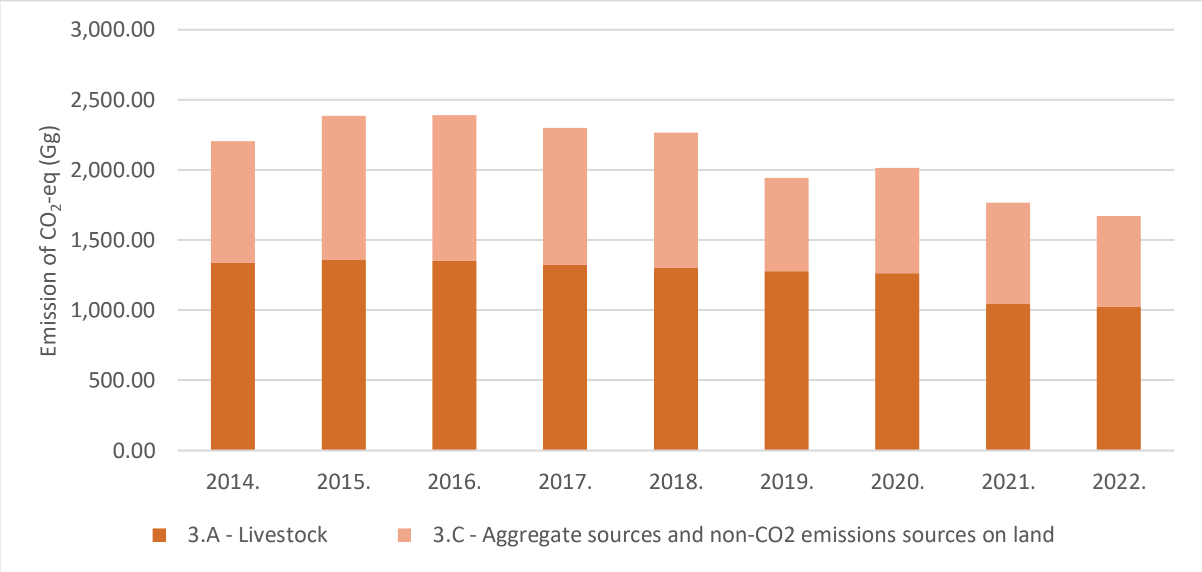

Chart 51: CO_2 emissions - eq of all categories in sector 3 Agriculture, forestry and other land use in the period 2014 – 2022

The previous chart shows that category 3.A Livestock farming accounts for the majority share of CO_2-eq emissions from the agricultural sector, with a share of 60.63% in 2014 and 61.29% in 2022. Total CO_2-eq emissions from the agricultural sector show a downward trend in the observed period, from

2,205.47 CO_2-eq in 2014 to 1,673.97 CO_2-eq in 2022, which is mainly caused by the decline in the number of livestock.

5.2 Livestock farming (CRT 3A)

Category 3.A Livestock farming accounts for 5.01% of total GHG emissions in 2014 and 3.66% in 2022. Within this category, subcategory 3.A.1 Enteric fermentation was recognized as key in both 2014 and 2022 according to the analysis by level, while in 2022 it was also identified as the key category according to the analysis by trend. Also, category 3.A.2. Fertilizer management is recognized as a key category according to the analysis by trend.

Category 3.A includes GHG emissions from livestock production, which occur due to the biological processes of digestion in ruminants, as well as during the management of manure. In BiH, livestock production has a long tradition and is significantly represented in rural areas, dominated by cattle, sheep, pigs, goats, horses and poultry. Data on the number of livestock are available through statistical sources on an annual basis and have been used to estimate emissions from relevant subcategories.

The CRT 3A Livestock category includes GHG emissions from the following two subcategories:

- 3.A.1 — Enteric fermentation, and
- 3.A.2 – Manure management

Both subcategories are included in the GHG inventory in BiH in accordance with the IPCC 2006 guidelines, using the Tier 1 methodology and available data on livestock from the Agency for Statistics of BiH. Emissions from this category contribute to the formation of CH_4 and N20, and are shown in the following table.

Table 55: Emissions of CH_4 and N_2O from category 3A Livestock farming

Year	CO_2-eq	CH_4	N_2O
3A	**Gg**	**Gg**	**Gg**
2014	1,337.23	44.66	0.33
2015	1,358.16	45.37	0.33
2016	1,353.91	45.26	0.33
2017	1,325.11	44.28	0.32
2018	1,301.35	43.51	0.31
2019	1,279.20	42.63	0.32
2020	1,265.45	42.35	0.30
2021	1,044.91	35.05	0.24
2022	1,025.98	34.47	0.23

Below are the CO_2 - eq emissions from the CRT 3A category in the period 2014 – 2022.

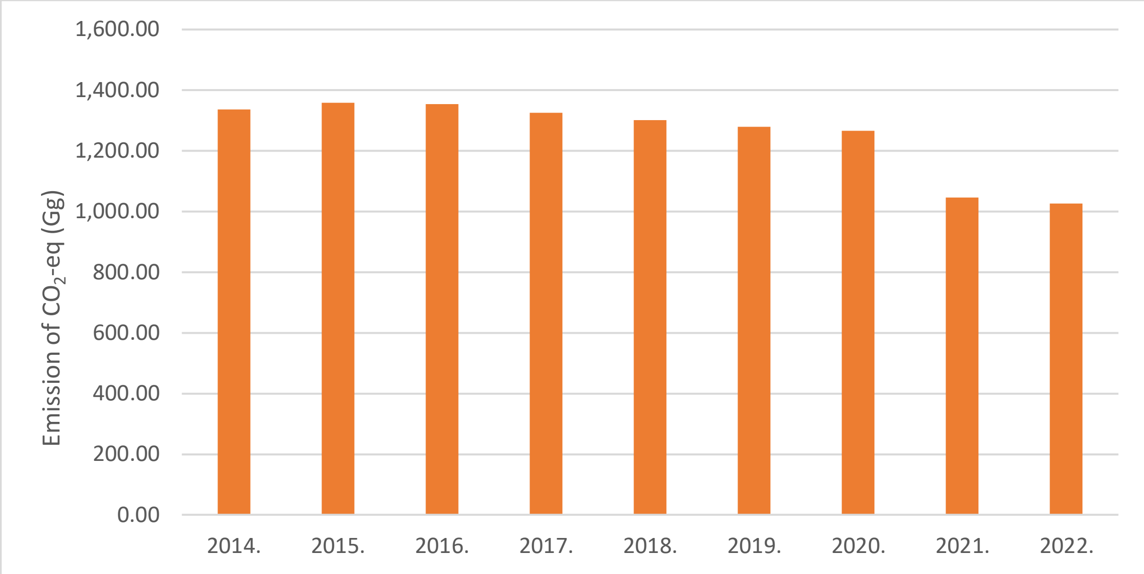

Chart 52: CO_2 - eq emissions in sector 3A Livestock farming in the period 2014 – 2022

The previous chart shows that emissions from sector 3A – Livestock farming show a decreasing trend in the period from 2014 to 2022. After the highest recorded value in 2015 (1,358.16 Gg CO_2-eq), emissions are gradually decreasing, and in 2022 they amount to 1,025.98 Gg CO_2-eq. The total decrease in this period is approximately 24.50%, which can be related to the decline in the number of livestock, especially ruminants, which are the main source of CH_4 through enteric fermentation.
The share of individual categories in the total CO_2-eq emissions from CRT 3A Livestock in the period 2014 – 2022 is presented below.

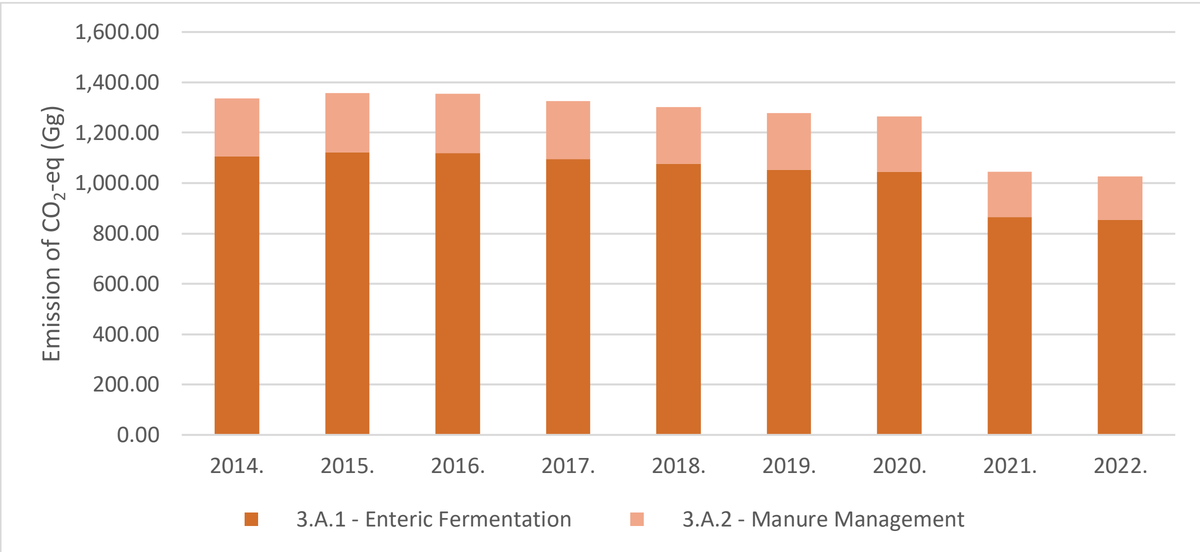

Chart 53: CO_2 emissions - eq of all categories in sector 3.A Livestock farming in the period 2014 – 2022

The previous chart shows that within sector 3A – Livestock farming, emissions from subcategory 3.A.1 – Enteric fermentation during the entire period 2014-2022 are dominant compared to 3.A.2 – Fertilizer management. The share of enteric fermentation in total Sector 3A emissions is approximately 83-86% per year, while emissions from manure management account for the remaining 14-17%.

Both subcategories recorded a gradual decrease in emissions over the observed period. Enteric fermentation fell from 1,105.05 Gg CO_2-eq in 2014 to 853.94 Gg CO_2-eq in 2022, while emissions from manure management decreased from 232.18 Gg CO_2-eq to 172.03 Gg CO_2-eq in the same period. These trends indicate a general decline in livestock, especially ruminants, but also possible changes in manure management practices.

5.2.1 Enteric fermentation (CRT 3.A.1)

(a) Basic information about the category

Category 3.A.1 Enteric fermentation accounts for 82.63% of emissions in 2014 and 83.23% in 2022 in category 3.A, and 4.14% of total GHG emissions in 2014 and 3.04% in 2022. This category was among the key categories according to the analysis by level in 2014 and 2022, as well as by the analysis by trend.

CH_4 emission arises from the digestive tract due to enteric fermentation of various animal species such as cattle (CRT 3.A.1), sheep (CRT 3.A.2), pigs (CRT 3.A.3), horses, goats and other animals (CRT 3.A.4). Below are the emissions and CO_2-eq generated by enteric fermentation for the period 1990 – 2022.

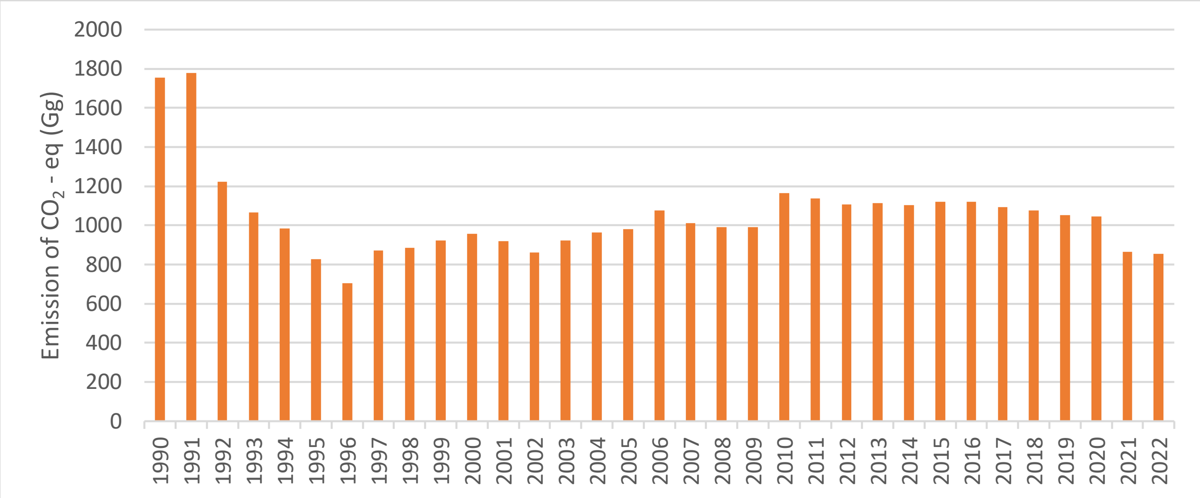

Chart 54: CO_2 - eq emissions in sector 3.A.1 Enteric fermentation in the period 1990 – 2022

The previous chart shows that emissions from enteric fermentation (CRT 3.A.1) in BiH in the period 1990–2022 show a marked decline, then stabilization and a slight decreasing trend in later years.

The highest emissions were recorded in 1990 and 1991, after which there was a sharp decrease due to the war and the reduction of livestock. From the late 1990s until 2022, emissions range between 1,000 and 1,300 Gg CO_2-eq, with a slight decline in the last years of the observed period. This trend directly reflects changes in the number and structure of livestock, especially ruminants, which are the main source of CH4 through the process of enteric fermentation. In 2014, emissions from enteric fermentation amounted to 1,105.05 Gg, while in 2022 they amounted to 853.94 Gg, which represents a decrease of 251.11 Gg, or approximately 22.70% compared to 2014.

Below is an overview of the share of individual categories in total CRT 3.A.1 emissions. Enteric fermentation.

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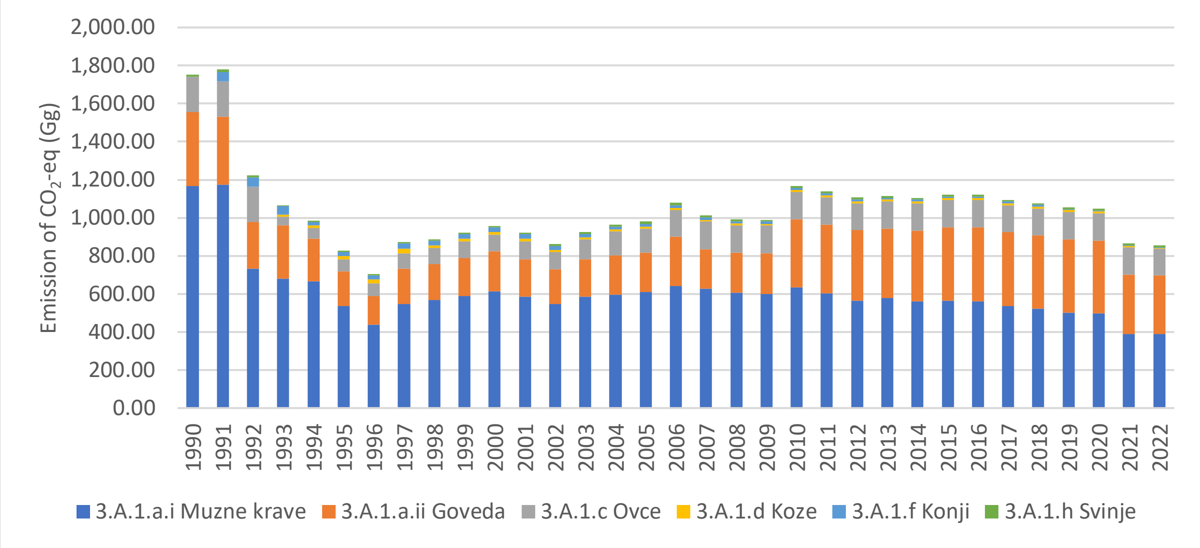


(LEGEND: Muzne krave - *Dairy cows; Goveda - cattle; Sovce - heep; Koze - Goats; Konji - Horses; Svinje - Pigs.*)

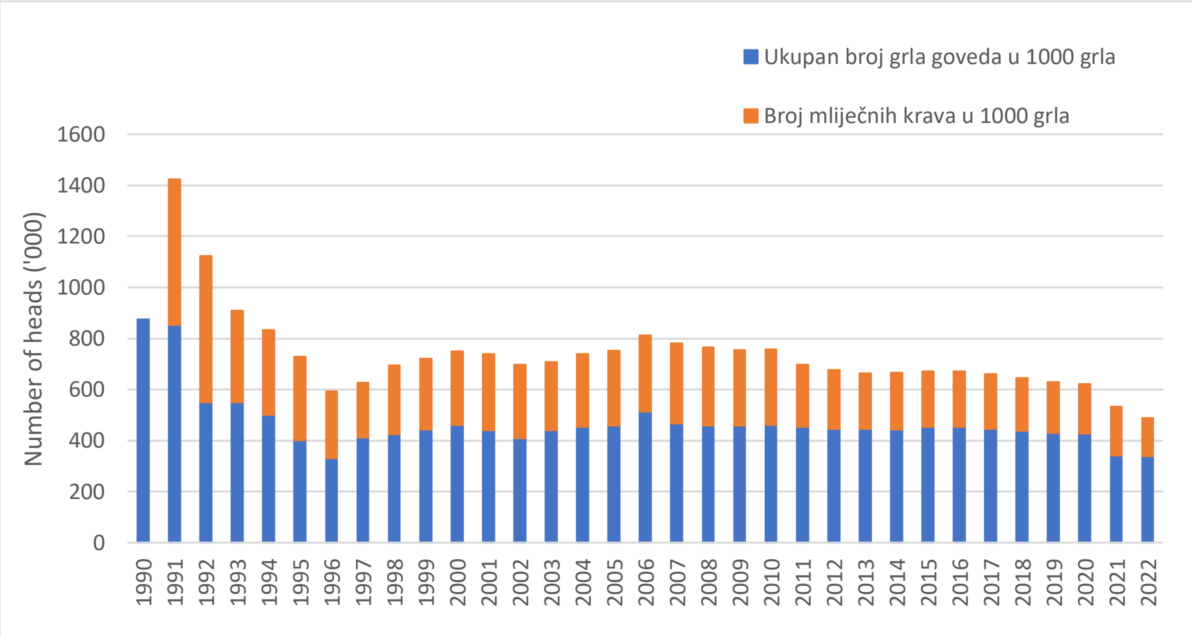
Chart 55: CO_2 - eq emissions of all categories in sector 3.A.1 Enteric fermentation in the period 1990 – 2022

The previous chart shows that the main source of CH_4 emissions is generated by energy fermentation from the category of dairy cows (CRT 3.A.1.a.i), followed by cattle (CRT 3A.1.ii), which together accounts for almost 82% of emissions of category 3.A.1. The share of emissions from sheep (CRT 3.A.1.c) is 16% in 2022 and 13% in 2014. The lowest share of greenhouse gas emissions is from the breeding of horses, goats and pigs.

(b) Cattle (CRT 3.A.1.a)

Basic information about the category

For purposes of the calculation, the classification of cattle into the appropriate IPCC categories was performed: dairy cows (CRT 3.A.1.a.i Dairy cattle) and other cattle (CRT.3.A.1.a.ii other cattle). Below is a chart showing the trend in the number of cattle from 1990 to 2022.

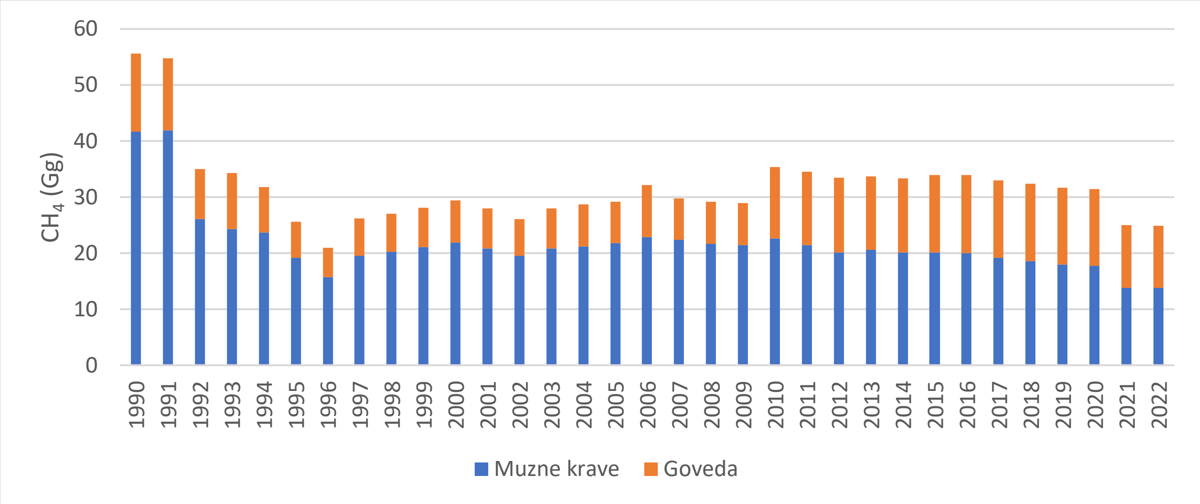


(LEGEND: Ukupan broj grla goverda u 1000 grla- *Total number of cattle in 1000 heads; Broj mliječnih krava u 1000 grla - Number of dairy cows in 1000 heads.*)

Chart 56: Breeding trend in sector 3.A.1.a Cattle in the period 1990 – 2022

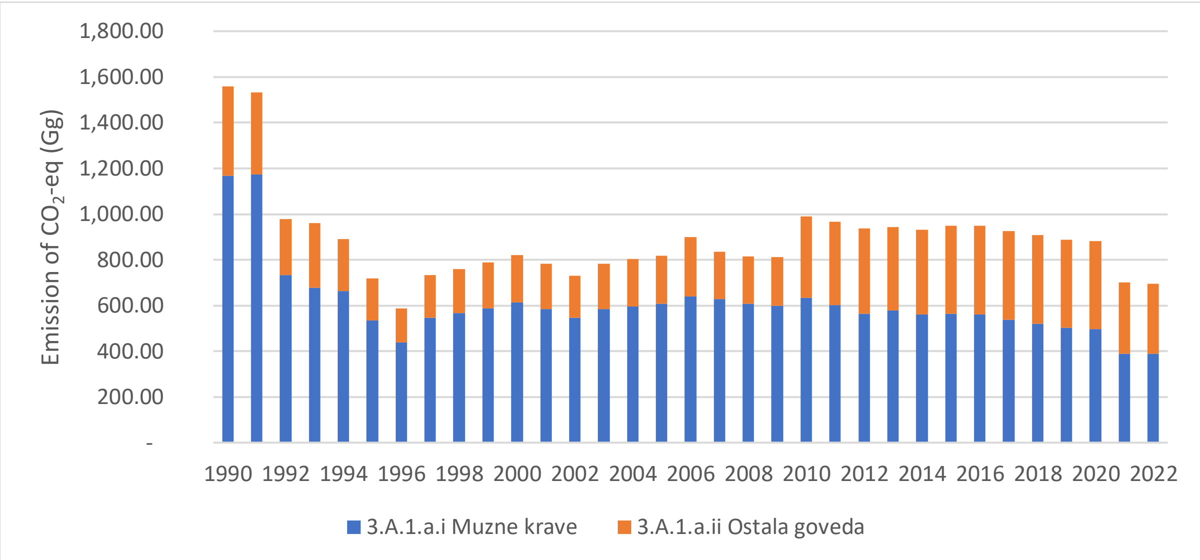
There was a drastic decline in the number of cattle from 874,000 to only 330,000 between 1990 and 1996, a decrease of 62%. This was followed by a slight increase and a stable number of heads

averaging around 452,000 in the period from 1997 to 2020. After that, there is again a sharp decline in the number of cattle by 21% in 2022. Overall, from 1990 to 2022, the number of dairy cows was more than tripled.
Below are the CH_4 and CO_2-eq emissions from enteric fermentation of dairy cows and other cattle.



(LEGEND: Muzne krave – Dairy cows; Goverda – other cattle.)

Chart 57: CH_4 emissions in sector 3.A.1.a of Cattle in the period 1990 – 2022



(LEGEND: Muzne krave – Dairy cows; Goverda – other cattle.)

Chart 58: CO_2 - eq emissions in sector 3.A.1.a Cattle in the period 1990 – 2022

The previous chart shows that CO_2-eq emissions from CRT 3.A.1.a – Cattle decreased significantly in 2022 compared to 1990, and in the period between 1990 and 2022 show a variable trend. The highest emissions were recorded at the beginning of the observed period, when total emissions exceeded 1,500 Gg CO_2-eq, followed by a sharp decline in the 1990s, due to a decrease in livestock, especially dairy cows.
In the emission structure, dairy cows (3.A.1.a.i) have a higher share than other bovine animals (3.A.1.a.ii) over the entire period, confirming their dominant contribution to CH4 emissions from enteric fermentation. In 2022, the share of dairy cow emissions in total emissions of category 3.A.1.a was 56%, while the share of other cattle was 44%. In 2014, the share of dairy cow emissions in total emissions of category 3.A.1.a was 60%, while the share of emissions of other cattle was lower and amounted to 40%.

Methodological approach

CH_4 emissions from enteric fermentation are calculated according to the Tier 1 approach, which is in line with the 2006 IPCC guidelines. The activity data used are the average annual population in livestock, for each subcategory. These data on activities for the entire time series were taken from the Agency for Statistics of BiH. Emission factors are taken from the 2006 IPCC Guidelines (Volume 4, Chapter 10, Table 10.11). The emission factors used are 93 kg CH_4/head/year for dairy cows and 58 kg CH_4/head/year for other cattle.

(c) Sheep (CRT 3.A.1.b)

Basic information about the category

The chart below shows the total number of sheep since 1990, which has decreased by 75% due to the war, and from 1995 until 2006 it gradually increased and remained stable, and in 2022 it is about one million heads.

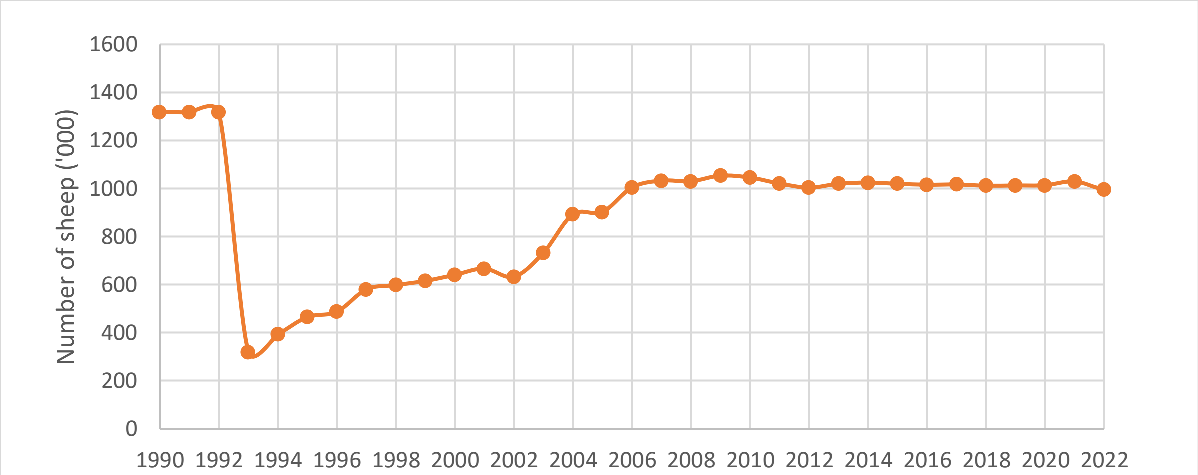


Chart 59: Breeding trend in sector 3.A.1.b Sheep in the period 1990 – 2022

The trend of CH_4 emissions from the CRT subcategory 3.A.1.b, shown in the following chart, is directly proportional to the number of sheep. Given that the number of sheep has been relatively stable for the last fifteen years, emissions amount to about 5.1 Gg CH_4.

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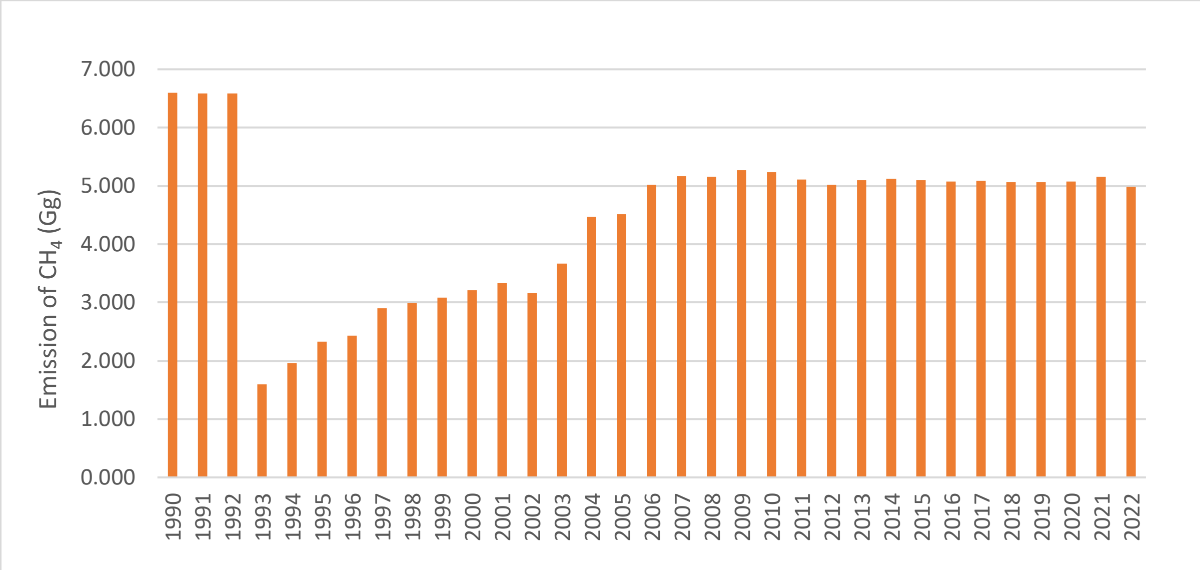


Chart 60: CH_4 emissions in sector 3.A.1.b Sheep in the period 1990 – 2022

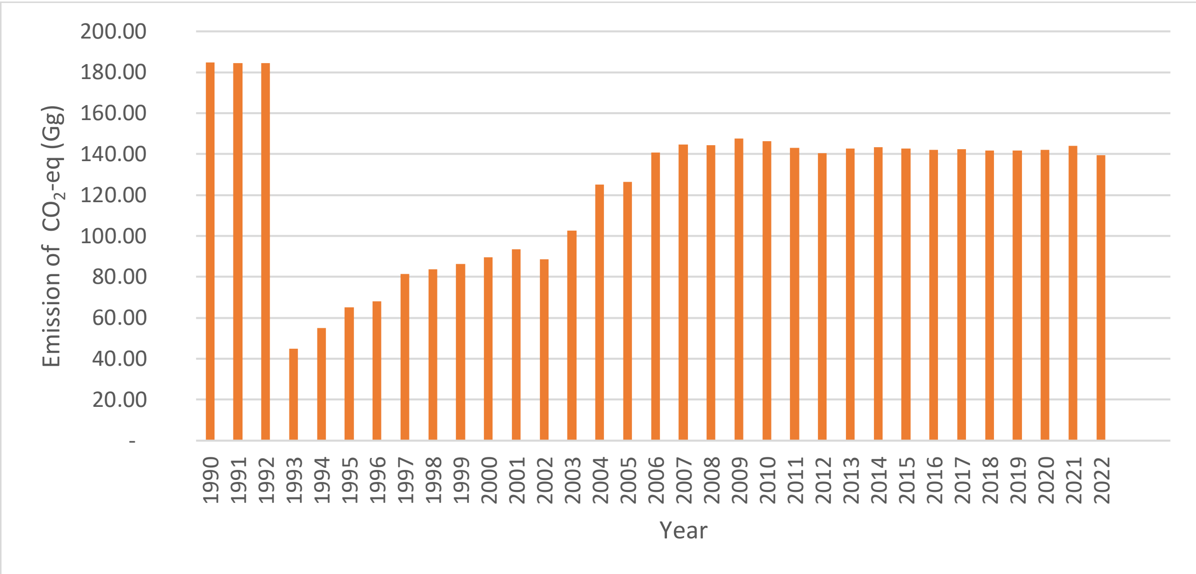


Chart 61: CO_2-eq emissions in sector 3.A.1.b Sheep in the period 1990-2022

The highest value of CO_2-eq emissions was recorded in 1990, when it amounted to 184.66 Gg CO_2-eq, while the lowest value was recorded in 1993, when it amounted to 44.82 Gg CO_2-eq. CO_2-eq emissions in 2022 were 2.73% lower than in 2014.

Methodological approach

CH_4 emissions from enteric fermentation are calculated according to the Tier 1 approach, which is in line with the 2006 IPCC guidelines. The activity data used are the average annual population in livestock. These data on activities for the entire time series were taken from the Agency for Statistics of BiH. The default value of the emission factor from the IPCC 2006 methodology, which is 5 kg CH_4/head per year (Volume 4, Chapter 10, Table 10.10), was used.

(d) Goats (CRT 3.A.1.d)

Basic information about the category

An increase in the number of goats was observed from 1993 to 1997, reaching a number of 170.00 heads. Between 1998 and 2010, there was a continuous decline of 62%. In the period 2010-2020, a relatively stable number of goats between 65 and 75 thousand heads was observed, and in 2021 and 2022 there was a sharp decline of approximately 32%. The chart below shows that there are currently three times fewer goats compared to 1997, when the highest value of 170,000 heads was recorded.

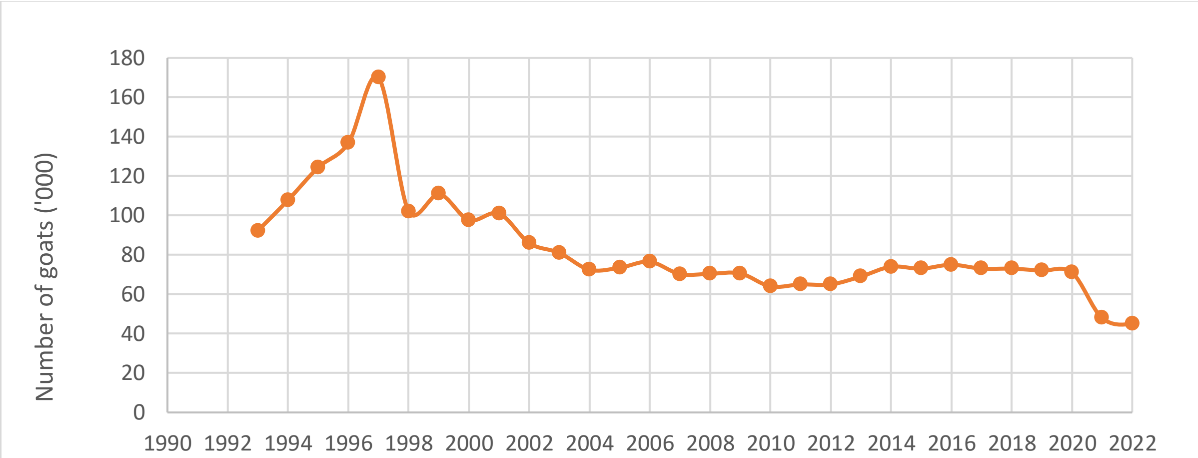
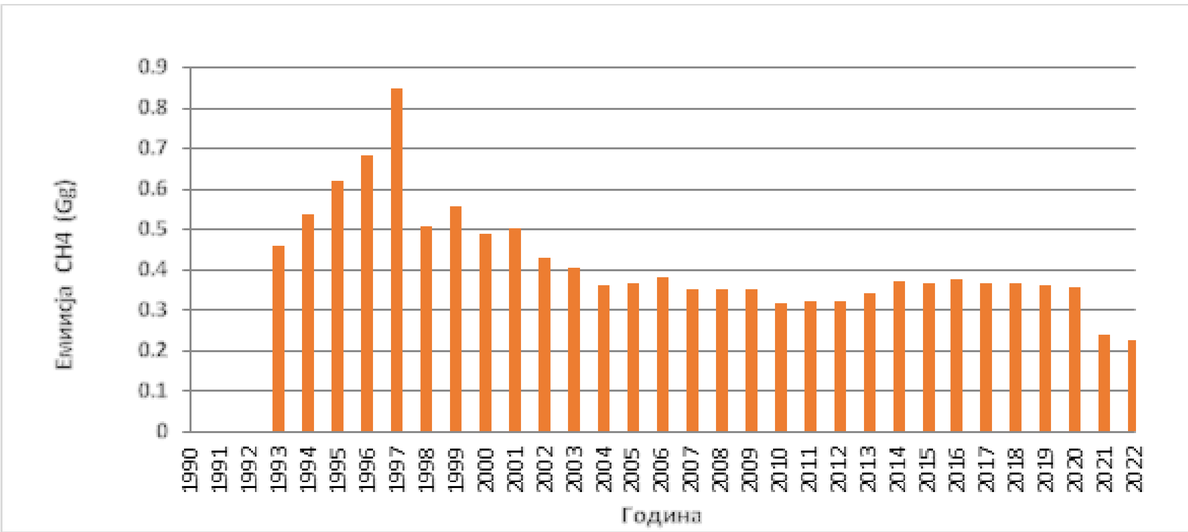


Chart 62: Breeding trend in sector 3.A.1.d Goats in the period 1990-2022

Below are charts of CH_4 and CO_2-eq emissions from CRT 3.A.1, which show that CH_4 emissions produced by goats have decreased significantly compared to 1997 when three times more goats were bred than in 2022. In the absence of data from 1990, it can be concluded that CH_4 emissions decreased by 73% compared to the year with the highest number of goats on record, or by 38% compared to 2018. year.



(LEGEND: Emisija – emission; Godina – Year.)

Chart 63: CH_4 emissions in sector 3.A.1.d Goats in the period 1990 – 2022

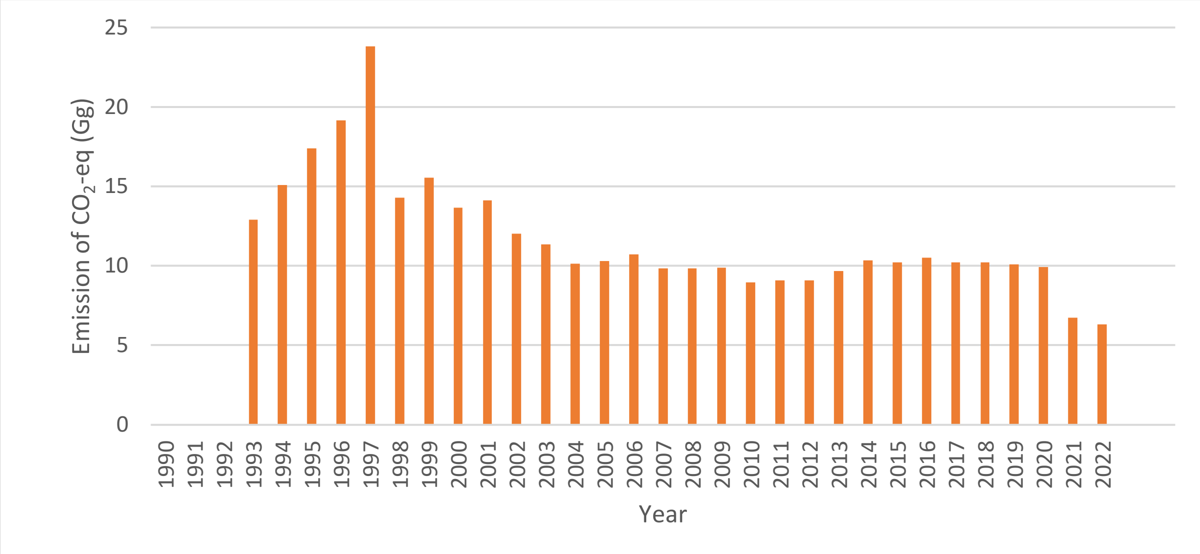


Chart 64: CO_2 - eq emissions in sector 3.A.1.d Goats in the period 1990 – 2022

The previous chart shows that the CO_2-eq emissions from CRT 3.A.1.d show a variable trend in the period 1993-2022. The lowest value of emissions was recorded in 2022 when it amounted to 6.30 Gg CO_2-eq, which is almost 40% less than the emissions in 2014.

Methodological approach

CH_4 emissions from enteric fermentation are calculated according to the Tier 1 approach, which is in line with the 2006 IPCC guidelines. The activity data used are the average annual population in livestock. These data on activities for the entire time series are taken from the report of the Agency for Statistics of BiH. It should be noted that no data on the number of heads in the period 1990-1992 were recorded. The emission factor used to calculate CH_4 for the entire time series is taken from the 2006 IPCC guidelines (Volume 4, Chapter 10, Table 10.11), and is 5 kg CH_4/head of head per year.

(e) Horses (CRT 3.A.1.f)

Basic information about the category

The chart below shows the trend in the number of horses in BiH in the period 1990 – 2022. During 1991, the number of horses was 99,800 and it has been continuously decreasing, and in 2022 it has reached a value of only 6,732 heads, which is a decrease of 93% or almost 15 times.

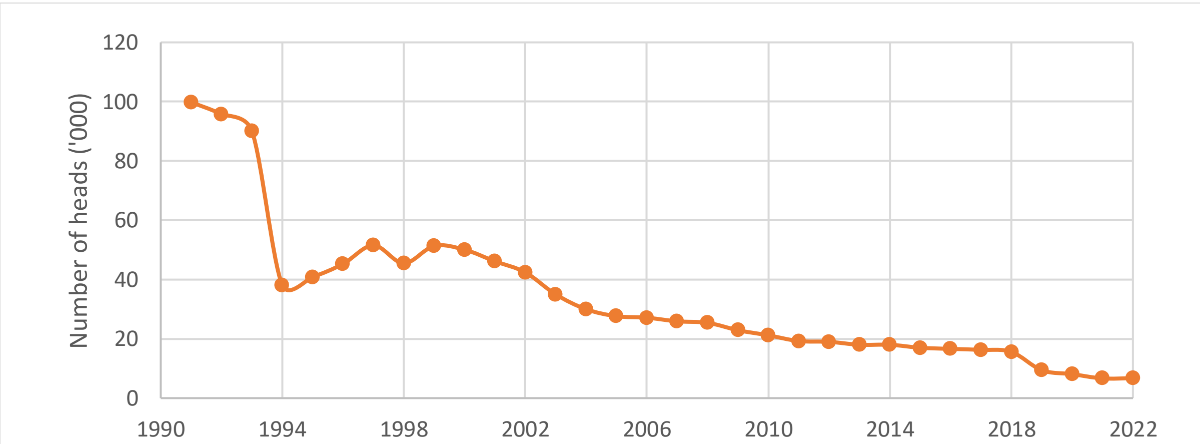


Chart 65: Breeding trend in sector 3.A.1.f Horses in the period 1990 – 2022

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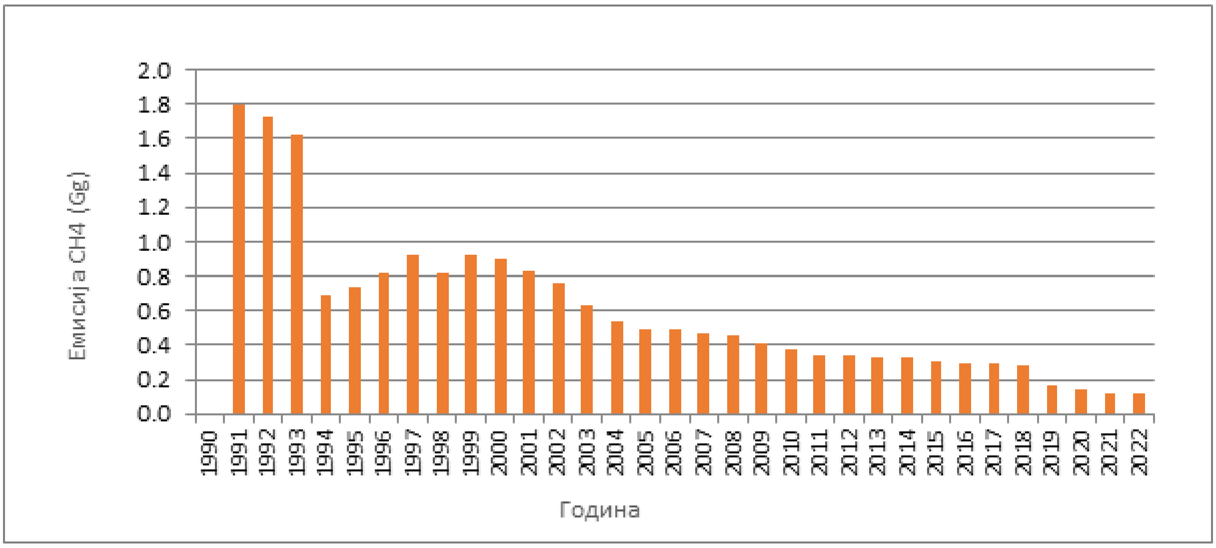
The chart below shows the CH_4 and CO_2-eq emissions produced by horses. As expected, the drop in emissions is directly proportional to the decline in the number of horses, so emissions are negligible today. The share of total emissions from greenhouse gases is less than 1%.



(LEGEND: Emisija – emission; Godina – Year.)

Chart 66: CH_4 emissions in sector 3.A.1.f Horses in the period 1990 – 2022

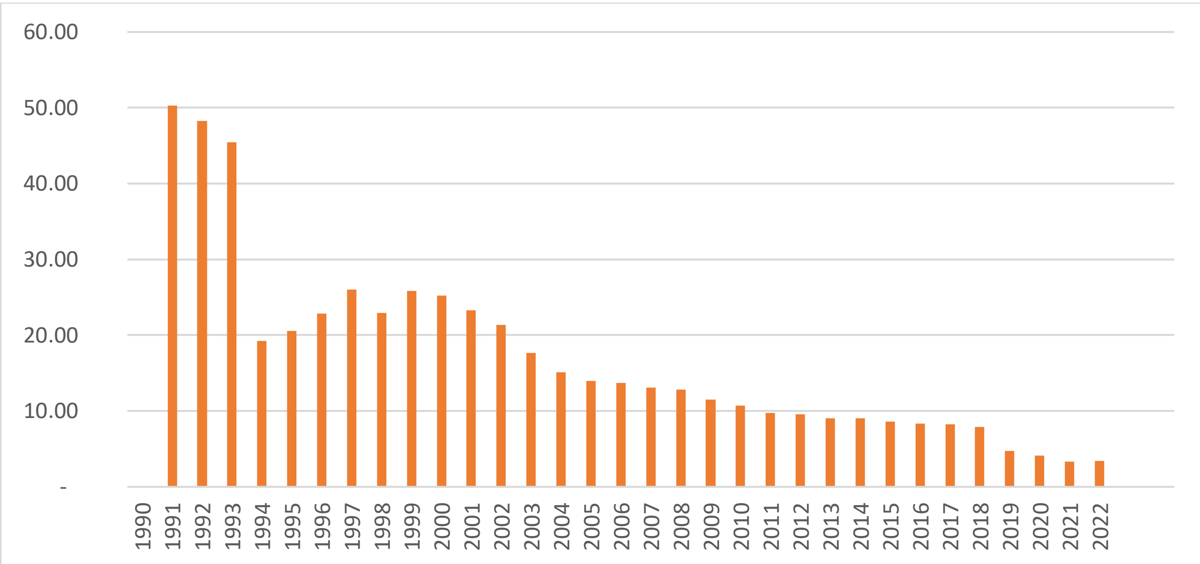


Chart 67: CO_2 - eq emissions in sector 3.A.1.f Horses in the period 1990 – 2022

Due to the reduced number of horses in 2022, the lowest CO_2-eq emissions were recorded (3.39 Gg CO_2-eq), which is almost 63% less than in 2014.

Methodological approach

CH_4 emissions from enteric fermentation are calculated according to the Tier 1 approach, which is in line with the 2006 IPCC guidelines. The activity data used are the average annual population in livestock. These data on activities for the entire time series were taken from the Agency for Statistics of BiH. The emission factor used to calculate the CH_4 for the entire time series is taken from the 2006

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IPCC guidelines (Volume 4, Chapter 10, Table 10A-3) and is 18 kg CH_4/head per year. It is important to note that there is no data on the number of horses for 1990.

(f) Pigs (CRT 3.A.1.h)

Basic information about the category

For the calculation of emissions in accordance with the IPCC 2006 categorization, (Table 10.1 (UPDATED) Representative livestock categories 1,2) - pigs are divided into two categories: breeding pigs and pigs for fattening.

The chart below shows the trend of the total number of pigs. It can be stated that from 1994 to 2006 there was an increase in the number of pigs, then there was a decrease in the number by 30%. Since 2010, the number of pigs has been relatively stable and varies between 470,000 and 570,000 heads.

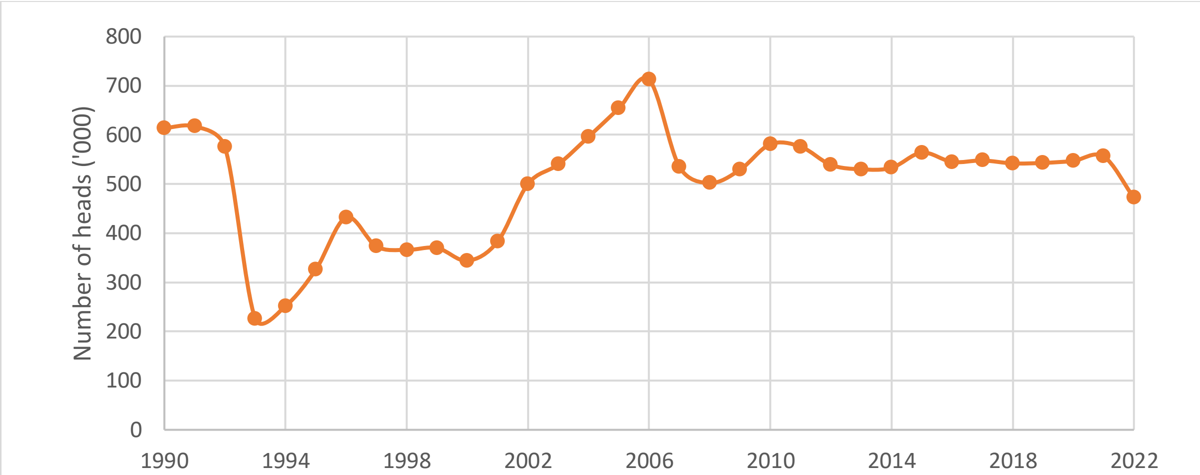

Chart 68: Pig breeding trend in the period 1990 – 2022.

The chart below shows the trend of CH_4 emissions from porcine enteric fermentation. Pig farming contributes only 1% of CH_4 emissions.
Below are charts of CH_4 and CO_2-eq emissions from pig production in the period 1990 – 2022.

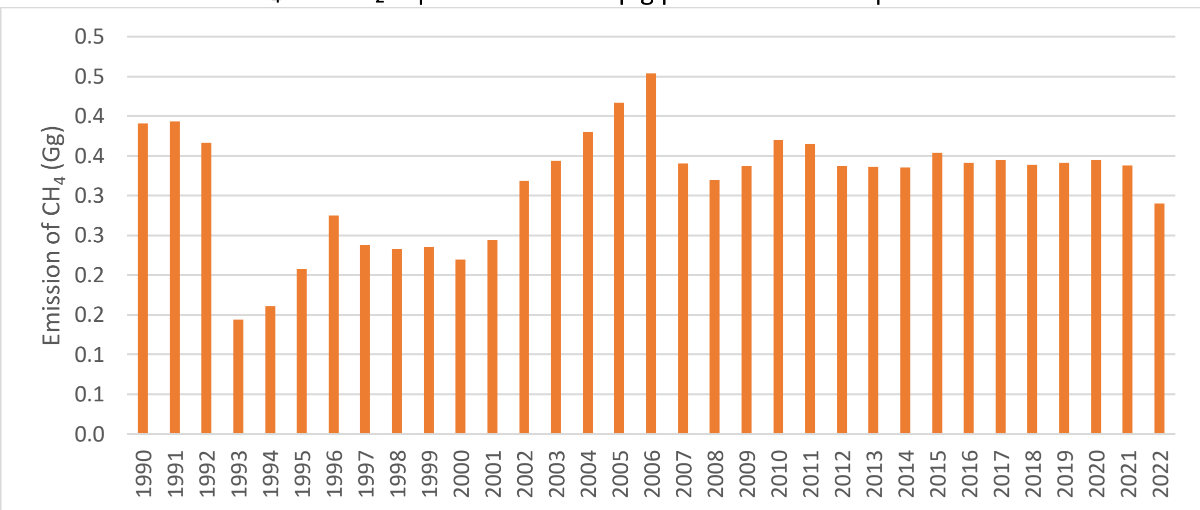

Chart 69: CH_4 emissions in sector 3.A.1.h Pigs in the period 1990 – 2022

Methodological approach

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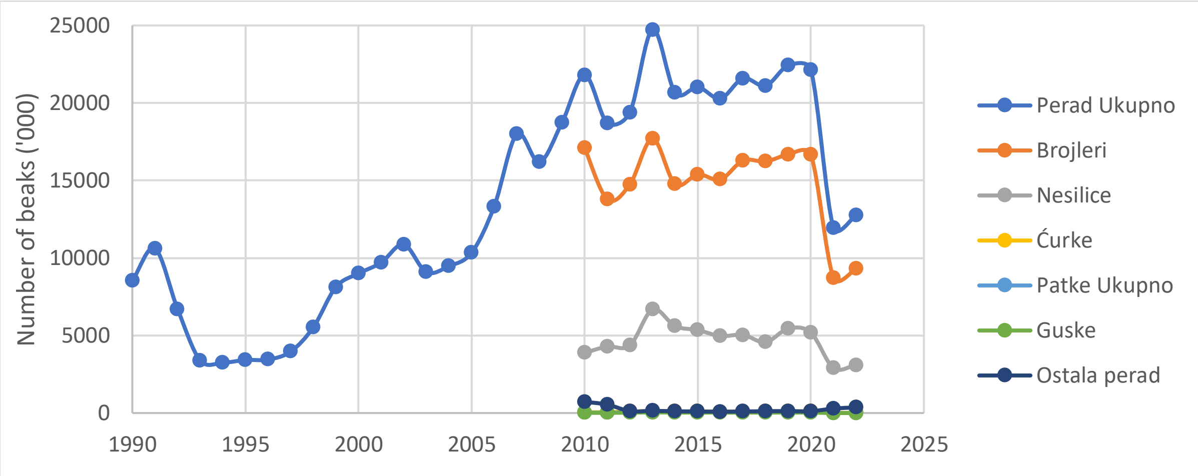
CH_4 emissions from enteric fermentation are calculated according to the Tier 1 approach, which is in line with the 2006 IPCC guidelines. The activity data used are the average annual population in heads, for each subcategory (sows, boars, piglets, etc.). These data on activities for the entire time series were taken from the Agency for Statistics of BiH. The emission factor used to calculate CH_4 for the entire time series is taken from the 2006 publication of the IPCC methodology (Volume 4, Chapter 10, Table 10A-3). For the period 1990-2010, an average emission factor of 0.637 CH_4/head per year was used.

(g) Poultry (CRT 3.A.1.i)

Basic information about the category

The chart below shows the trend in the number of beaks by species. The total number of poultry is shown for the entire period, while the number by species is shown only for the period 2010-2022. There has been a continuous increase in the number of beaks from 1993 when it was 3.3 million beaks to 2013 when it was 20.7 million beaks. The stable and high level of poultry remained until 2021, when a decrease of 48% was observed.



(LEGEND: Perad ukupno – poultry, total; Brojleri - *Broilers; Nosilice – Laying hens; Ćurke - Turkeys; Patke ukupno - Ducks in total; Guske - Geese*; Ostala perad – Other poultry.)

Chart 70: Trend of breeding by category in sector 3.A.1.i Poultry in the period 1985 – 2025

Methodological approach

The calculation was made according to the Tier 1 method. In terms of CH_4 emissions, this category was not taken into account, but this data was used to calculate indirect emissions from manure, using the emission factor in accordance with the IPCC 2006 methodology (Volume 4, Chapter 10, Table 10A-9).

Data Uncertainty and Consistency Analysis

The uncertainty factors for the input data and the emission factor for categories 3.A.1 are presented below, using the default uncertainty factors according to the IPCC 2006 methodology (Volume 4, Chapter 10.2.3 for the input data and Chapter 10.4.4 for the emission factor).

Table 56: Uncertainty analysis for CRT category 3.A.1 Enteric fermentation

CRT 3.A.1	**Uncertainty, %**
	CH_4
Input data	20%
Emission factor	30%

Combined uncertainty	36

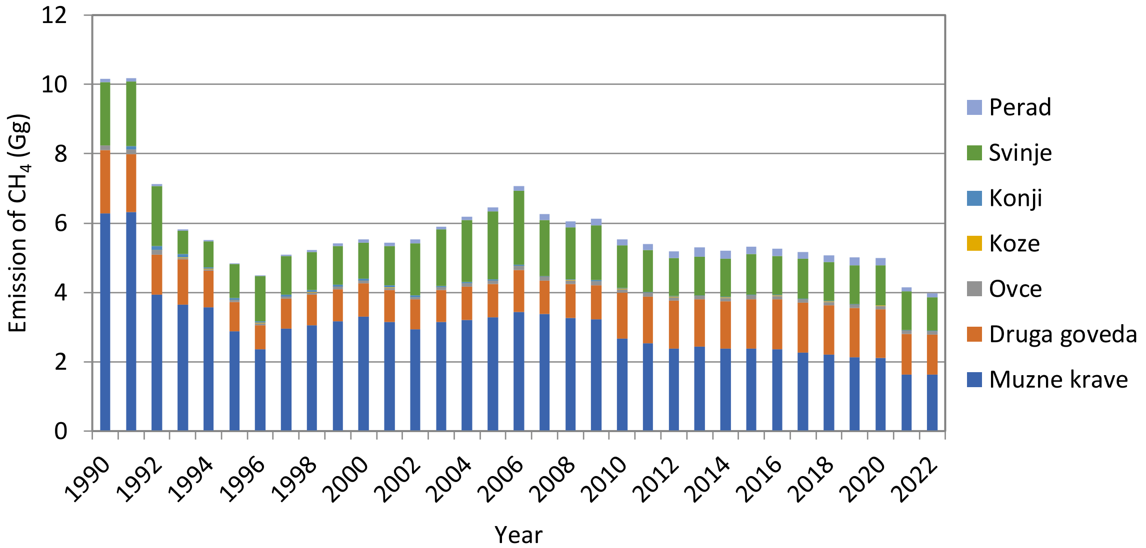
5.2.2 Fertiliser management (CRT 3.A.2)

(a) Basic information about the category

Category 3.A.2 Fertilizer management accounts for 21.01% of emissions in 2014 and 16.77% in 2022 in category 3.A, and 0.87% of total GHG emissions in 2014 and 0.61% in 2022. This category was not key according to the analysis by level in either 2014 or 2022, but it was among the key categories according to the analysis by trend.

All farmed animals produce secretions from which gases such as CH_4 and N_2O are emitted. In BiH, the quantities of manure they excrete were considered: cattle, sheep, pigs, horses, goats and various types of poultry. As described in the 2006 IPCC Guidelines. (Chapter 10.4), CH_4 is produced during manure decomposition under anaerobic conditions, during manure storage and treatment. The contribution of this category to category 3A emissions is 16.77%.

The chart below shows manure gas emissions by subcategory of animals. The total emission from manure management in 2022 is 3.975 Gg, which is 23.48% less than in 2014. From the graphs, there is a noticeable decrease in CH_4 emissions compared to 1990 by as much as 60.87%.



(LEGEND: Perad – poultry; Svinje – pigs; Konji – horses; Koze – goats; Ovce – sheep; Druga goveda – other cattle; Muzne krave – Dairy cows.)

Chart 71: CH_4 emissions in CRT 3.A.2 Fertilizer management 1990-2022

The largest contribution to CH_4 emissions comes from the cattle subcategories (41% dairy cows and 29% other cattle), followed by pigs (24%), poultry (3%), sheep and goats.

The chart below shows N_2O emissions by subcategory. Total emissions in 2022 are 0.229 Gg and are approximately 30% lower than in 2014. The decrease compared to 1990 is 53%.

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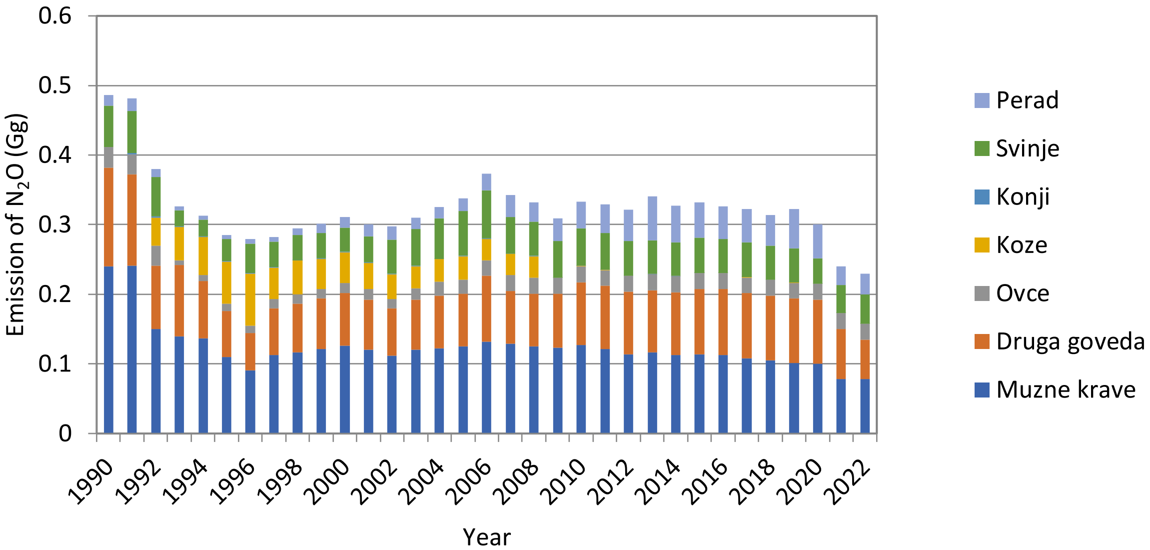

(LEGEND: Perad – poultry; Svinje – pigs; Konji – horses; Koze – goats; Ovce – sheep; Druga goveda – other cattle; Muzne krave – Dairy cows.)

Chart 72: N_2O emissions in sector CRT 3.A.2 Fertilizer management in the period 1990 - 2022

The largest contribution to total N20 emissions from CRT 3.A.2 comes from cattle farming (34% from dairy cows and 25% from other cattle), followed by pigs (18%), poultry (13%) and sheep (10%).

(b) Methodological approach

The 2006 IPCC methodology, the Tier 1 method and Equation 10.25 (Volume 4, Chapter 10) and the same input data on the number of animals as for the calculation of CH_4 emissions from fermentation were used to calculate emissions. The default values of the excretion rate (Nex) for all categories of animals (Volume 4, Chapter 10, Table 10.19 of the 2006 IPCC methodology) and the default values of the typical animal weight (TAM) (Volume 4, Chapter 10, Table 10.21 Updated) were used. enteric nitrogen

The estimates were calculated using the VS and BO setpoints for Eastern Europe from the IPCC 2006 Guide (Table 10A-1 to 10A-9), in combination with the default values on the typical mass of animals (TAM) from the 2006 IPCC Guide and default values for ratios of MMS for all animals. In the cattle categories, a distinction was made between dairy cows and other cattle. In the pig category, the difference between fattening pigs, sows, gilts was taken into account. Finally, the second category for poultry distinguishes different types of animals: laying hens, broilers, turkeys and other poultry

Statistical yearbooks do not keep records of the quantities of collected manure, liquid fertilizer such as succulent, and there are no literary sources on the quantities of them.

(c) Data Uncertainty and Consistency Analysis

The uncertainty factors for the input data and the emission factor for categories 3.A.2 are presented below, using the default uncertainty factors according to the IPCC 2006 methodology (Volume 4, Chapter 10.2.3 for the input data and Chapter 10.4.4 for the emission factor). The emissions are shown for the period 1990 – 2022.

Table 57: Uncertainty analysis for CRT category 3.A.2 Fertilizer management

CRT 3.A.2	Uncertainty, %	
	CH_4	N_2O
Input data	30%	30%
Input: Manure Management System Usage	30%	30%
Emission factor	30%	250% (direct emissions) 50% (indirect emissions)
Combined uncertainty	42	252 (direct emissions) 58% (indirect emissions)

5.3 Land, Land Use Change and Forestry (CRT 3B)

The Land Use, Land Use Change and Forestry (LULUCF) sector in BiH plays a key role in the balance of GHG emissions and removals. The specific organization of forestry and land management, with a pronounced fragmentation of competencies between the entities and BD BiH, significantly affects the collection and processing of data in this sector.

Reporting relies on available data from entity and cantonal institutions, as well as spatial data when available. The methodological framework is based on the IPCC Tier 1 approach, with limited capacity to apply more precise methods (Tier 2 and 3).

Forest land is a major carbon sink, with a positive balance thanks to forests that make up about 50% of BiH's territory. However, the loss of forest areas due to urbanization, conversion to arable land and degradation contributes to emissions. Agricultural land and grassland contribute to emissions mainly through changes in soil organic carbon, while wetlands and other lands are less prevalent.

The challenges and constraints associated with the sector are listed below:

- There is no harmonized way of collecting and processing data in the entities,
- Lack of long-term monitoring (e.g. forest inventory over large areas),
- Limited capacity to apply advanced methodologies (Tier 2 and 3) and
- Lack of precise cartographic data on changes in land cover.

The LULUCF sector remains crucial for BiH's climate policies, with potential for improvement through better data management and the implementation of sustainable land-use practices.

For reporting purposes, in accordance with the 2006 IPCC methodology, land is classified into six main categories according to the IPCC methodology:

- 3.B.1 Forest land,
- 3.B.2 Agricultural land,
- 3.B.3 Grasslands,
- 3.B.4 Wetlands,
- 3.B.5 Settlements and
- 3.B.6 Other land.

For the GHG inventory of BiH, the principle allocation of land to one category was applied, and the calculation of only category 3.B.1 Forest land was made, in order to avoid double recording of areas, due to limited capacities for detailed analysis and calculation of other categories.

The limitations and challenges of the methodological approach to the calculation of sinks in this area are listed below:

- Differences in the methodology of statistical sources and CLC data require additional checks and harmonisation of data,
- Lack of up-to-date field data can affect the accuracy of land change estimates,
- Different availability of data at the entity level makes it difficult to uniquely represent land areas and
- Lack of capacity to calculate land use change matrices.

The combined approach allows for a balance between consistency and spatial accuracy, taking into account the limitations of individual data sources. Further improvement of the methodology is possible through increased integration of satellite images, GIS analysis and field data validation.

The categories in Chapter 3.B.1.b relating to other types of land converted to forest land have not been addressed due to a lack of data and limited capacity for detailed analysis and calculation of individual categories, as already stated. It should be emphasized that according to the recommendations of the 2006 IPPC Guidelines and the GPG for LULUCF of 2003, the recommendation of the use of the "20-year rule" is stated, i.e. that the land must spend 20 years in the same type of use in order to be considered as a specified category of land (for example, land can be considered a forest only 20 years after afforestation) ("Under default assumptions therefore land will be transferred from a conversion category to a remaining category after it has been in a given land use for 20 years"). Here, among other things, abandoned agricultural land that is currently under forest cover can be considered, but due to the lack of official data, this category could not be analyzed within this calculation.

The GHG study, which was prepared as part of the inventory preparation process, recorded changes in individual land categories, as well as carbon sequestration, but did not calculate the amounts of sinks or emissions resulting from these changes.

5.3.1 Forest land (CRT 3.B.1)

(a) Calculation methodology used for CRT category 3.B.1 Forest land

For the calculations of storage and emissions from the forestry sector in BiH, official data of the entity statistical institutes and the Agency for Statistics of BiH were used, as well as data obtained from representatives of the Government of BD BiH. According to official statistical data for 2022, the total area of forests and forest land in public and private ownership, including RS, FBiH and BD, is 2,598,665 ha (about 51% of the total area of BiH), of which 2,048,128 ha or 78.81% are forest-covered areas, while 550,537 ha or 21.19% are forest land, i.e. areas suitable for afforestation, areas unsuitable for afforestation and usurpation.

It is necessary to reiterate the fact, which is also stated in the Fourth National Communication of BiH in accordance with the UNFCCC, that there is no uniform data on the area under forests and forest land in BiH, which leads to the question of the accuracy of estimates related to adaptation and/or mitigation, as well as the development of future strategic goals. Although the results of the Second Forest Inventory in BiH (which covered the period from 2006 to 2009) have not yet been officially published, the data show that the total area of forests and forest land is 3,231,500 ha or 63.08% of the total area of the country, while forests cover 2,904,600 ha, which makes 56.7% of the territory of BiH. Comparing the data of the Second Forest Inventory in BiH with the official statistical data, there is a clear difference in the data that for the area of forests and forest land in BiH is about 615 thousand ha or about 12% of the total area of BiH.

For implementation of the GHG inventory in the forestry sector, which includes forests and forest land, the official IPCC methodology was used, namely:

- Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 4: Agriculture, Forestry and Other Land Use, i 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
    - Chapter 4: Forest land.

In addition to the use of reference scientific literature in the field, the data were collected exclusively using the "desk research" method, i.e. existing data at the national level were used to create the GSB inventory, without additional measurements in the field. According to the available official data, a total of 22 categories of forest land have been defined. Data on forest areas and forest land in BiH are taken from official statistical sources and relevant sectoral publications for the entities and BD BiH. For the territory of the Republika Srpska, data from the statistical bulletins "Forestry" of the RS Statistics Bureau were used, as well as data from the Cadastre of Forests and Forest Land of the Public Enterprises "Forests of the Republika Srpska". For the FBiH, the data of the FBiH Bureau of Statistics from the annual statistical bulletins "Forestry in FBiH" and from the annual reports of the FBiH Ministry of Agriculture, Forestry and Water Management on forest management and management plans were used. For the area of BD BiH, data until 2021 were taken from the forest-economic bases for state and private forests that were valid for the period from 01.01.2007 to 31.12.2016.

Table 58: Forest categories used for inventory calculation

Ord. No.	BD BiH	FBiH	RS
1.	Private deciduous forests of BD BiH	Deciduous forests of FBiH	Degraded state deciduous trees of RS
2.	Outcrop forests of the state deciduous forests of BD BiH	Tall forests of the FBiH	Degraded private deciduous trees RS
3.	Conifer cultures of the state BD BiH	High Forest Conifers FBiH	Outcrop forests private deciduous trees RS
4.	Conifer cultures of private BD BiH		Deciduous forests of the state of RS
5.	High state forests of conifers BD BiH		Conifer cultures of the state RS
6.	High State Deciduous Forests BD BiH		Conifer cultures of private RS
7.	High private deciduous forests BD BiH		Deciduous tree cultures of the state of RS
8.			Cultures of deciduous trees private RS
9.			High state deciduous trees RS
10.			High State Conifers RS

11.			High Private Deciduous Trees RS
12.			High Private Conifers RS

The term "state forests" in the previous table refers to publicly owned forests. By defining these categories, a detailed analysis was made without focusing exclusively on the Tier 1 approach, with an effort to define as much of the available data as possible for the conditions and combination with the Tier 2 approach. This type of calculation contributes to much greater accuracy and obtaining more relevant data.

The input data used for the calculation of the sinks from category 3.B.1.a – Forest Land Remaining Forest Land are described below.

(b) Inputs used for the calculation

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For tall forests – in the data of the RS Statistics Bureau, conifers and deciduous trees are clearly separated, except for the part related to "other". The percentage share of conifers in the total area was determined and this percentage was applied to the category "other", which resulted in an area from the group "other" that is associated with conifers. The rest of the "other" category is associated with the area of deciduous trees. The type and status of the land have been retained and aligned with the inventories made for previous periods. Within the "Land use manager" tab, the data for BCEFi, BCEFs and Litter C stock at maturity have been further adjusted.

For high degraded forests, the data of the RS Statistics Bureau provide data for deciduous forests, while there are no areas related to conifers. Given the above, the entire area refers to high degraded deciduous forests. The type and status of the land have been retained and aligned with the inventories made for previous periods. In the "Land use manager" data for BCEFi, BCEFs and Litter C stock at maturity have been further adjusted. The "Root to Shoot (R/S) ratio" has been reduced from more than 150 t/ha for aboveground biomass to 75-150 t/ha for aboveground biomass.

For forest crops, the data of the RS Statistics Bureau contains data for different conifers, and for deciduous trees for oak and other deciduous trees. By summarizing the data, the total areas for conifers and deciduous trees were obtained. The type and status of the land have been retained and aligned with the inventories made for previous periods. In "Land use manager" the status has been changed from "natural forests" to plantation". The data for BCEFi, BCEFs and Litter C stock at maturity have been further adjusted.

For coppice forests, the data of the RS Statistics Bureau provide data for deciduous forests, while there are no areas related to conifers. In view of the above, the entire area refers to deciduous shoot forests. The type and status of the land have been retained and aligned with the inventories made for previous periods. In the "Land use manager" data for BCEFi, BCEFs and Litter C stock at maturity have been further adjusted.

For all of the above cases, a value for the "ratio of belowground biomass" has been assigned because CO_2 is stored in the underground and aboveground parts.

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As already stated, the data of the FbiH statistics Bureau from the annual statistical bulletins "Forestry in FBiH" and from the annual reports of the FBiH Ministry of Agriculture, Forestry and Water

Management on forest management and management plans were used. Data for forest crops are included in the data for high forests. For all cases, in the "Land use manager" there are additional data for BCEFi, BCEFs and Litter C stock at maturity. For all cases, a value for the "ratio of belowground biomass" has been assigned because CO_2 is stored in the underground and aboveground parts.

Brčko District of BiH

Available input data were submitted by representatives of the Government of BD BiH, by structure as input data for RS.

For all three regions (RS, FBIH, BD BiH) categories have been formed and areas suitable for afforestation, areas unsuitable for afforestation and usurpation (only for state forests) have been entered, the total amounts of areas have been taken from the official data of statistical institutes in order to record these data, but according to the IPCC 2006 guidelines it is stated that areas that are not managed (unmanaged) are not included in the calculation.

Table 59: Forest areas in BiH

Type of land	RS	FBiH	BD BiH	Total
Forests (ha)	1,059,108	978,624	10,396	2,048,128
Forest land (areas suitable for afforestation, areas unsuitable for afforestation, usurpations) (ha)	284,310	265,070	1,157	550,537
Total (ha)	1,343,418	1,243,694	11,553	**2,598,665**

The largest share in total forests has the RS with 1,343,418 ha (52%), followed by the FBiH with 1,243,694 ha (48%), while BD BiH participates with only 11,553 ha (0.4%) in the total area of 2,598,665 ha. Below are the areas of individual categories of forests in RS, FBiH and BD BiH.

Table 60: Areas of forests (ha) that are regularly managed, that are not managed (unmanaged) and total in the period 2014 - 2022.

Year	Type	BD BiH (ha)	FBiH (ha)	RS (ha)	BiH (ha)
2014	Managed	9,974	962,842	1,038,302	2,011,118
	Unmanaged	2,143	298,076	255,584	555,803
	Total	**12,117**	**1,260,918**	**1,293,886**	**2,566,921**
2015	Managed	9,974	979,533	1,041,706	2,031,213
	Unmanaged	2,143	279,491	257,541	557,760
	Total	**12,117**	**1,259,024**	**1,299,247**	**2,588,973**
2016	Managed	9,974	979,840	1,054,457	2,044,271
	Unmanaged	2,143	281,360	257,887	541,390
	Total	**12,117**	**1,261,200**	**1,312,344**	**2,585,661**
2017	Managed	9,974	981,268	1,054,870	2,046,112
	Unmanaged	2,143	270,878	257,868	530,889
	Total	**12,117**	**1,252,146**	**1,312,738**	**2,577,001**
2018	Managed	9,974	980,135	1,059,889	2,051,114
	Unmanaged	2,143	267,486	256,455	526,084
	Total	**12,117**	**1,247,631**	**1,316,344**	**2,577,198**
2019	Managed	9,974	976,042	1,063,257	2,049,273
	Unmanaged	2,143	264,547	254,322	521,012
	Total	**12.117**	**1.240.589**	**1.317.579**	**2.570.285**

Year	Type	BD BiH (ha)	FBiH (ha)	RS (ha)	BiH (ha)
2020	Managed	9,974	975,472	1,062,647	2,048,093
	Unmanaged	2,143	264,100	254,887	521,130
	Total	**12,117**	**1,239,572**	**1,317,534**	**2,569,223**
2021	Managed	10,396	977,666	1,059,085	2,047,147
	Unmanaged	1,157	265,070	250,700	516,927
	Total	**11,533**	**1,242,736**	**1,309,785**	**2,564,054**
2022	Managed	10,396	978,624	1,059,108	2,048,128
	Unmanaged	1,157	260,791	248,310	514,537
	Total	**11,533**	**1,239,415**	**1,307,418**	**2,562,645**

The total area varies between 2.5 and 2.6 million ha. Most of the land is forests that are regularly managed, while areas that are not regularly managed (areas suitable and unsuitable for afforestation, as well as usurpations) account for approximately 20% of the total area. In 2022, the largest forest areas are recorded in RS (approximately 51%), followed by FBiH (approximately 48%), while BD BiH participates with less than 0.5%.

(c) Input data used for biomass losses (G&L 2/4)

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From the Statistical Bulletin Forestry 2023, the data from Tables 3.3 and 3.4 were taken over. Data for tall long-age forests were included in the category of High State Deciduous or Coniferous Forests of the RS, Data for Tall Single-Age Forests were placed in the category of Conifer or Deciduous Tree Cultures of the State forest of the RS, Data for Shoot Forests of the RS were placed in the category of Deciduous Shoot Forests of the RS, and data for other forests were placed in the category of Degraded State Forests of the RS. The data from the Statistical Bulletin relating to the category "deciduous trees-conifers" are divided in a ratio of 50:50% into deciduous and conifers. The same method was used for private forests. The term "state forests" refers to publicly owned forests.

Federation of BiH

The input data is divided into categories: tall coniferous, tall deciduous and shoot forests. The category "Other" is associated with coppice forests. All data can be found in the Statistical Yearbook in Table 4.2. The data from the Statistical Bulletin relating to the category "deciduous trees-conifers" are divided in a ratio of 50:50% into deciduous and conifers. From the table, the data for tall multi-age forests are included in the category of high coniferous or tall deciduous forests, while the data for tall single-age forests are placed in the category of deciduous or coniferous culture.

BD BiH

The necessary data were submitted according to a structure similar to those for the RS, except for the data for 2019 for forests owned by the District, for which the average of firewood harvested for the period 2018-2022 was taken.

The "ratio of belowground biomass" is not specified for any area (RS, FBIH, BD) because the stump and root are not removed by felling, which still remains a CO_2 store.

(d) Input data used for biomass losses (G&L 3/4)

Republika Srpska

Given that the data are provided solely for public and private deciduous and coniferous species, the expert assessment determined that 80% of firewood is from high and 20% from low forests. This average was used for both public and private forests. Given that the assortment method is applied, all quantities of firewood are listed as "removal of whole trees". All outcrop forests are listed as deciduous.

FBiH

Given that the data are provided solely for state and private deciduous and coniferous species, the expert assessment determined that 80% of firewood is from high and 20% from low forests. This average was used for both state and private forests. Data for state and private forests were collected and data were obtained for three categories – tall coniferous, tall deciduous and shoot forests. Data for firewood from crops is not available, so the values are 0, but firewood is certainly included in one of the three categories mentioned above. Given that the assortment method is applied, all quantities of firewood are listed as "removal of whole trees".

BD BiH

The necessary data were submitted according to a structure similar to those for the RS, except for the data for 2019 for forests owned by the District, for which the average of firewood harvested for the period 2018-2022 was taken. Given that data were available only for state and private deciduous and coniferous forests, a 50:50% division was made by coppice and tall forests. Data for firewood from crops are not available, so the values are 0, but firewood is certainly included in one of the three categories mentioned above.

Using the input data and the methodology described, the following chart shows the total sinks from category 3.B.1 Forest land for the period 2014–2022.

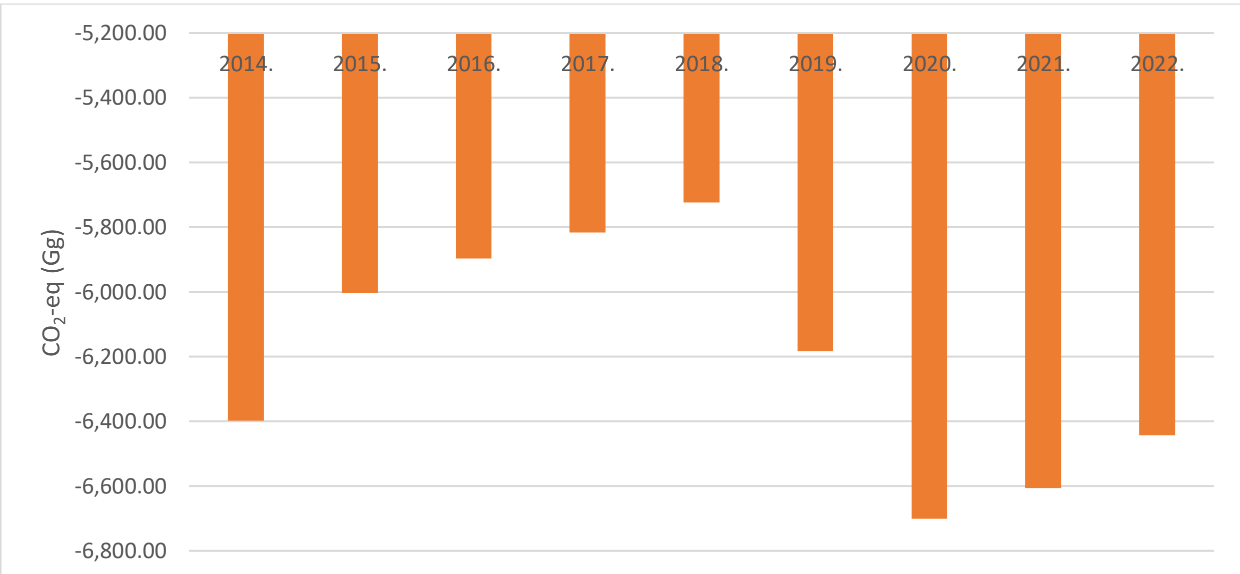

Chart 73: Forest land emissions sink trends 3.B.1.1 for the period 2014-2022.

It is evident that forests acted as a net sink in all years, with the highest absorptions in 2020 (−6,700.38 Gg CO_2-eq) and 2021 (-6,605.96 Gg CO_2-eq). Values vary, but the sink remains stable and significant throughout the observed period. The value of sinks from forest land that does not change category

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in 2022 is approximately the same as in 2014, with a slight increase of less than 1%.

(e) Data Uncertainty and Consistency Analysis

The following table shows the uncertainty factors for the input data used and the emission factors used in the calculation of the sinks of CRT category 3.B.1.1. Forest land that does not change the category. The factors were selected in accordance with the recommendations of the IPCC 2006 Guidelines.

Table 61: Uncertainty analysis for CRT category 3.B.1.1 Forest land not changing the category

CRT 3.B.1.1.	Uncertainty, %
	CO_2
Input data	10%
Emission factor	20%
Combined uncertainty	22%

5.4 Aggregate sources and sources of other (non-CO_2) emissions on land (CRT 3C)

5.4.1 Sector overview

Category 3.C Aggregate sources and sources of non-CO_2 emissions on land accounted for 3.25% of total GHG emissions in 2014 and 2.31% in 2022. Within this category, direct N_2O emissions from soil (3.C.4) were the key category in both 2014 and 2022 according to the analysis by level, and in 2022 they were confirmed as the key category according to the analysis by trend. Emissions from fires (3.C.1) were not key according to the analysis by level, but in 2022 they were recognized as key categories according to the analysis by trend. Indirect N2O emissions from soil were the key category according to the analysis by level in 2014, and the key category according to the trend.

This category covers key sources of CH4 and nitrogen oxide emissions associated with agriculture and land use, and provides guidance for accurate measurement and reporting of these emissions.

The main sources of CH4 emissions are related to gas production in the digestive system of animals (enteric emissions), as well as manure management. On the other hand, nitrogen oxide emissions arise from the application of fertilizers to agricultural land, including synthetic fertilizers and manure.

To accurately estimate emissions in this sector, it is important to take into account the specific characteristics of different agroecosystems, such as pastures, crops and forest areas. The methodologies for calculating these emissions have been developed to allow for a detailed separation of emission sources, thereby increasing the accuracy of estimates. The section also deals with the identification of direct and indirect sources of emissions, including those resulting from changes in soil.

Sector Aggregate sources and sources of other (non-CO_2) emissions on land (CRT 3C)

- 3.C.1 — Fires,
- 3.C.2 – Calcification (application of lime to acidic soils),
- 3.C.3 – Use of urea,
- 3.C.4 — Direct N_2O emissions from soil,
- 3.C.5 - Indirect N_2O emissions from soil,

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- 3.C.6 - Indirect N_2O emissions from fertilisers,
- 3.C.7 - Rice cultivation,
- 3.C.8 – CH_4 from drained organic soils,
- 3.C.9 — CH_4 from drainage channels on organic soils,
- 3.C.10 — CH_4 from resoaking of organic soils;
- 3.C.11 — CH_4 from resoaking of mangroves and intertidal zones,
- 3.C.12 — Nitrogen oxide (N_2O) emissions from aquaculture;
- 3.C.13 — CH_4 from re-soaked and created wetlands,
- 3.C.14 — Other and
- 3.D – Products made of felled wood.

Through the GHG inventory of BiH, the calculation of emissions from the following subcategories was made:

- 3.C.1 Fires (only sub-category 3.C.1 fires on forest land is included in the calculation),
- 3.C.3 Use of urea,
- 3.C.4 Direct N_2O emissions from soil,
- 3.C.5 Indirect N_2O emissions from soil,
- 3.C.6 Indirect N_2O emissions from fertilisers and
- 3.D Felled wood products.

5.4.2 Fires (CRT 3.C.1)

(a) Fires on forest land (CRT 3.C.1.a)

Basic information about the category

Category 3.C.1 Fires accounted for 0.30% of total emissions in 2014 and 9.46% in 2022 in category 3C, and 0.01% of total greenhouse gas emissions in 2014 and 0.21% in 2022. This category was not key according to the analysis by level in either 2014 or 2022, but it was among the key categories according to the analysis by trend.

CRT category 3.C.1.a – Fires on forest land includes GHG emissions resulting from forest fires. The calculation of this category according to the IPCC 2006 methodology requires the entry of data on the type of fire (high or ground), forest type (deciduous or conifers), ownership (state or private), and available biomass per category.

Given the specific administrative structure of BiH, data on burned forest areas were collected and processed separately for each entity - RS, FBiH, and BD BiH. The method of collection and format of the available data vary between entities, as described below. Data on fires were collected from the entity bureaus of statistics and the Department of Agriculture, Forestry and Water Management of BD BiH.

For the RS, the data of the RS Statistics Bureau for State-Owned Forests provides data on burned areas, by classification into:

- Ground and high fires and
- Fires in pure deciduous, pure coniferous and mixed forests (divided into deciduous and conifers).

For privately owned forests, data are given only by classification into ground and high fires. Given the available data, it was possible to define a detailed breakdown by type of fire, type of ownership and type of forest. Given that six categories for public forests and six categories for private forests in the Republika Srpska have been defined for the calculation in IPCC Software, of which in both public and private forests two categories for conifers and four categories for deciduous trees, the size of burned areas in individual defined categories has been estimated. All fires are said to be uncontrollable, i.e. not the result of controlled wildfire.

For public forests, in order to obtain the most accurate data on the percentage of burned areas in the defined categories, the average of the areas of different forest categories for the analyzed period was primarily calculated. After that, the areas related to deciduous trees and conifers were separated, after which the percentage share of individual categories was calculated. The calculated percentage ratio was used in the distribution of burned areas by individual categories. The results of this analysis are shown in the table below.

Table 62: Data on burned areas in forests in the RS for the period 2014 - 2022

State forests (ha)				
Year	**High**		**Low**	
	Conifers	**Deciduous trees**	**Conifers**	**Deciduous trees**
2014	2.00	0.00	33.00	170.00
2015	4.50	13.50	396.00	4,330.00
2016	0.00	71.00	266.00	2,858.00
2017	21.50	14.50	2,199.50	15,715.50
2018	2,008.50	1,082.50	33.50	53.50
2019	44.00	25.00	52.50	749.50
2020	169.50	12.50	392.00	4,397.00
2021	37.50	25.50	338.50	6,199.50
2022	3.50	198.50	265.00	6,276.00
Private forests (ha)				
Year	**High**		**Low**	
	Conifers	**Deciduous trees**	**Conifers**	**Deciduous trees**
2014	0.00	0.00	7.24	77.76
2015	0.00	0.00	90.31	969.58
2016	0.00	0.00	56.66	608.34
2017	0.00	0.00	428.22	4,597.78
2018	0.26	2.74	3.75	40.25
2019	0.00	0.00	92.70	995.30
2020	0.00	0.00	157.88	1,695.12
2021	0.00	0.00	22.32	239.68
2022	0.00	0.00	329.38	3,536.62

The term "state forests" in the previous table refers to publicly owned forests. From the previous table, it is evident that the largest fires in state forests were recorded during 2017, due to the large area of burned deciduous forests (15,715.50 ha). During 2017, the highest values of burned areas in private forests were recorded (4,597.78 ha).

When it comes to fires in the FBiH, they are divided into ground and high fires. Given that only 3 categories of forests have been defined for the FBiH (tall conifers, tall deciduous trees, shoots), the entire burned area is divided into 3 equal parts and listed equally for the three mentioned categories.

Data on fires in the FBiH were collected from the report of the FBiH Bureau of Statistics and are presented below.

Table 63: Data on the burned area in the FBiH for the period 2014 - 2022.

Year	Low (ha)	High (ha)
2014	740.00	7.00
2015	7,672.00	141.00
2016	6,175.00	298.00
2017	24,034.00	3,941.00
2018	1,215.00	19.00
2019	3,574.00	62.00
2020	12,490.00	5,697.00
2021	18,226.00	206.00
2022	12,344.00	722.00

From the said table, it is evident that the largest burned areas in the FBiH were recorded during 2017, with over 24,000 ha of low fires and almost 4,000 ha of high fires. High values of burned areas were also recorded in 2021 and 2022, when low fires affected over 18,000 ha and 12,000 ha of area, while high fires in 2020 reached as much as 5,697 ha. These data indicate a marked trend of increasing burned areas in the last years of the observed period.

In the BD BiH, most forests are deciduous, so the division was made solely into tall and shoot forests in state and private ownership. For all analyzed years (2014-2022), the average ratio for state forests is 56% of tall and 44% of coppice forests, and for private forests this ratio is 27% of tall and 73% of coppice forests. Given that for the mentioned period (2014-2022) the total burned area was 58.5 ha, a more detailed division into categories was not made, but the data for all burned areas, based on the defined percentage share of tall and shoot forests, were divided into high fires in high state forests deciduous trees, low fires in high state forests deciduous trees, high fires in high state forests deciduous trees, low fires in highland state forests of deciduous trees, high fires in high private deciduous forests, low fires in high private forests of deciduous trees, high fires in high-growth private forests of deciduous trees and low fires in high-growth private forests of deciduous trees.

Input data on fires in BD BiH were obtained from the Government of BD BiH and shown in the table below.

Table 64: Data on the burned area in BD BiH for the period 2014 - 2022

Year	Low (ha)	High (ha)
2014	1.00	0.00
2015	20.00	25.00
2016	0.00	0.00
2017	0.00	1.00
2018	0.00	0.00
2019	0.00	0.00
2020	7.50	4.00
2021	0.00	0.00
2022	0.00	0.00

The largest fires in BD BiH were recorded in 2015, when the burned area amounted to 45 ha.

Using the described input data on the burned area, and the methodological approach described below, CH_4 and CO_2-eq emissions resulting from fires on forest land were calculated.

Table 65: CH_4 and CO_2-eq emissions from CRT 3.C.1.a Forest fires

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
CH_4	0.10	1.17	0.90	4.25	0.41	0.52	2.31	2.33	2.19
CO2 emissions – eq (Gg)	2.8	32.76	25.2	119	11.48	14.56	64.73	65.43	61.34

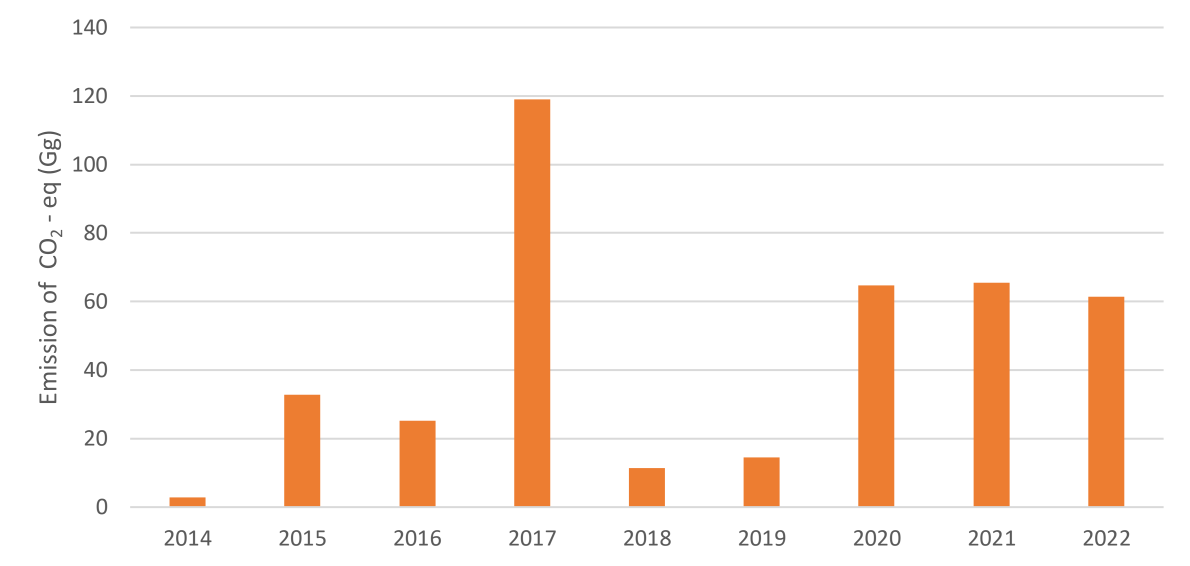

Chart 74: CO_2 - eq emissions in CRT sector 3.C.1.A Forest fires in the period 2014 – 2022

The highest emissions were recorded in 2017, when the burned areas were the highest, with total emissions amounting to 119.00 Gg CO_2-eq. High emissions were also recorded in the period 2020-2022, which is in line with the increase in areas affected by fires in those years. In 2014, the lowest emissions caused by fires were recorded.

Methodological approach

For the calculation of emissions from CRT 3.A.1. Tier 1 approach was used in accordance with the 2006 IPCC methodology. For all analyzed categories, within the "Fire types and area burnt" tab, the data for the burned area for high crown fires and low fires (surface fire) was entered. In the "Availible C pools" section, the "Biomass perennial" option was selected for high fires, and the "Biomass annual" option was selected for low fires. Note that by selecting the "Biomass perennial" option, it automatically enters the "CO_2 emission report" field, while the "Biomass annual" does not enter this category. After that, in the ''Emissions from burning'' tab (1 of 2), the gas option is selected: Carbon dioxide and Methane (CH_4). The default value of fuel consumption per hectare, which is 19.8 t/ha (Volume 4, Worksheet Table 2.6), was used, after which the data for CO_2 or CH_4 Emission factor for "Extra tropical forest" was entered from the drop-down menu, which is 1,569 for CO_2 and 4.7 for CH_4. (Volume 4, Chapter 2, Table 2.5).

(b) Fires on other surfaces (CRT 3.C.1.d)

No fires were observed in overmoist and other agricultural areas.

5.4.3 Calcification (CRT 3.C.2)

Due to the unavailability of data for the calculation of the CRT 3.C.2 Calcification category, it has not been implemented, but it will be included in the inventory improvement plan as necessary.

5.4.4 Use of urea (CRT 3.C.3)

(a) Basic information about the category

Category 3.C.3 Urea use accounts for 0.043% of total GHG emissions in 2014 and 0.046% in 2022, as well as 1.34% of category 3C emissions in 2014 and 2.03% in 2022. This category was not among the key categories either by level analysis or by trend analysis.

The amount of urea was calculated on the basis of production in BiH, then import and export, according to the FAOSTAT database. The amount of urea applied is shown in the chart below.

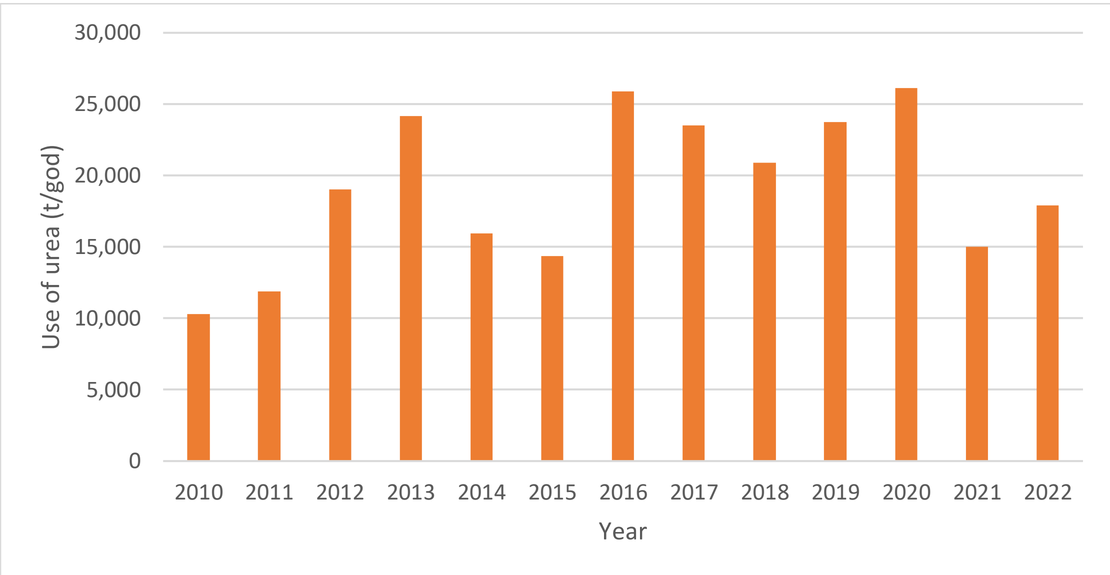

Chart 75: Amount of urea applied in BiH in the period 2014 - 2022

In the period 1990-2010, there was no data available for urea, so the calculations were made only for the period 2010-2022. The presented data indicate a large fluctuation in the amount of urea applied in the observed period. These fluctuations may arise due to uncertainty about the accuracy of the input data, because mineral fertilizers can be introduced and produced without being applied that year but in the next few years. Based on the available data, a variable trend in the use of urea can be observed, with the lowest value recorded during 2010, when it amounted to 10,277 t/year, while the highest value was recorded in 2020, when it amounted to 26,141 t/year.

It should be noted that agronomists did not recommend the application of UREA for most cultivated crops, but only for potatoes and leafy vegetable crops, but the application of NPK and KAN. Also, it should be noted that the imported amount of mineral fertilizers was not always applied in the same year, but that there were stocks, lack of import of certain mineral fertilizers, so one gets the impression that they were not applied, which is certainly not the case.

The following chart shows emissions from CRT category 3.C.3 Urea use in the period 2010 - 2022.

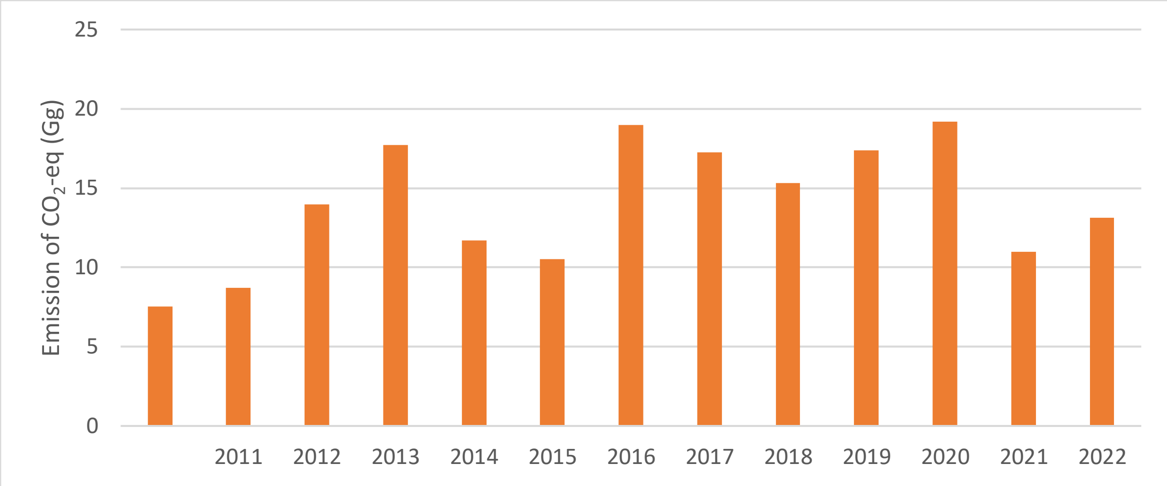

Chart 76: CO_2 - eq emissions in sector 3.C.3 Urea use in the period 2010 – 2022

CO_2-eq emissions from urea application follow trends in urea consumption in the observed period. The highest emission was recorded in 2020 and amounted to 19.17 Gg CO_2-eq, while the lowest emission was recorded in 2010, when it amounted to 7.54 Gg CO_2-eq.

(b) Data Uncertainty and Consistency Analysis

The following table shows the uncertainty factors for the input data used and emission factors in the calculation of emissions from CRT category 3.C.3 Urea application. Uncertainty factors for input data and emission factors have been adopted in accordance with the recommendations of the IPCC 2006 methodology (Volume 4, Chapter 11, Chapter 11.4.4). The emissions are shown for the period 2010 – 2022.

Table 66: Uncertainty Analysis for CRT Category 3.C.3 Urea Application

CRT 3.B.1.1.	**Uncertainty, %**
	CO_2
Input data	10%
Emission factor	50%
Combined uncertainty	51%

5.4.5 Direct N_2O emissions from soil (CRT 3.C.4)

(a) Basic information about the category

Category 3.C.4 Direct N_2O emissions from managed lands accounted for 2.23% of total GHG emissions in 2014 and 1.42% in 2022, as well as 68.69% of Category 3C emissions in 2014 and 61.69% in 2022. This category was among the key categories according to the analysis by level in 2014 and in 2022, and was also identified as a key category according to the analysis by trend.

The activity data considered for direct N_2O emissions from agricultural land depend on the amount of mineral and organic fertilisers introduced. It is believed that mineral fertilizers are applied only on used agricultural land (crop land), while grassy areas are fertilized with manure. Given that the quantities of applied mineral fertilizers are not recorded in the Agency for Statistics of BiH, estimates of applied quantities of fertilizers have been made in two ways. On the basis of literature sources

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(LUT1), the required quantities of mineral fertilizers for the realization of real yields per hectare in the RS and the FBiH for the period 2019-2022 have been determined, as shown in the following table.

Table 67: Estimation of the required quantities of manure (t/ha) and mineral fertilizers (kg/ha) to obtain average yields (t/ha)

Culture	Manure (t/ha)	Basic fertilization NPK	Basic fertilization KAN	Plant food KAN	Qty UREA	Average yields RS	Average yields FBIH	Average yield (2019-2022)	Average yield (2000-2009)
Winter cereals/Wheat		200-300		200-350		5.12	4.25	6	2.2-3.8
Jare žitarice	20-35		200	200					
CornCorn	20-35			200		62	5,075	4	2.3-5.4
Corn	35	200			150-200	6.2		8	
Barley		200-300		200-300		4,525	3,325	3.5	2-3.8
Rye		200-300		150-200		3.35	3,575	3	1.7-2.9
Triticale		200-300		150-200		4.1		4	
Oats		200-300		200		3.65	3,075	3	1.7-2.8
Soybeans		600		100-150		2.45	2	2.5	0.9-2.5
Rapeseed		500-600		150		2.48		2.5	
Potato	40	400			200-300	15.5	9.35	40	6.4-12.3
Lucerne	30-40	400-500		150-200			3.8	20	
Grass-clover mixture		400-500		150		3.4	3.45	8 to 10	
Beans		200	150			3.95		3.95	0.6-2.5
Hay-meadow						3.15		3.15	
Orchards	30	600	450						
Cabbage	40	200				5.12	4.25		

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Based on the data on total yields by crops taken from the Agency for Statistics of BiH, the total applied quantities of mineral fertilizers NPK, KAN, UREA and manure were calculated, shown in the following table. It should be noted that agronomists did not recommend the application of UREA for most cultivated crops, but only for potatoes and leafy vegetable crops (a total of about 4,000 t), but the application of NPK and KAN, which is confirmed by the quantities shown in the following table.

Table 68: Estimation of the total amount of fertilizer applied based on the yield achieved

Year	NPK (t)				KAN (t)			
Culture	2019	2020	2021	2022	2019	2020	2021	2022
Corn	19,176	19,176	21,397	21,177	19,055	21,397	21,177	19,055
Winter cereals /Wheat	8,903	8.903	9,477	8,500	8,885	9,477	8,500	8,885
Barley	2,945	2,945	3,082	2,843	2,855	3,082	2,843	2,855
Rapeseed	861	0	0	0	0	736	575	738
Rye	505	505	477	460	516	477	460	516
Oats	1,600	1,066	1,282	1,155	1,252	1,923	1,732	1,878
Triticale	549	366	282	279	297	423	419	445
Soybean	3,572	1,339	1,401	1,749	1,889	3,735	4,665	5,036
Beans	660	440	485	486	493	728	729	739
Potatoes	5,192	2,596	2,801	2,542	2,677	5,602	5,084	5,354
Licerne	1,634	0	0	0	0	1,630	1,597	1,582
Clover	1,043	1,043	1,055	1,037	1,014	1,055	1,037	1,014
Grass-clover mixture	12,221	0	0	0	0	9,322	9,434	10,249
Orchards /int	11,228	0	0	0	0	11,119	10,752	9,305
Orchards /trad	14,974	39,931	41,939	40,081	38,059	15,727	15,030	14,272
Cabbage	580	0	0	0	0	615	532	568
Total	85,644	78,313	83,679	80,310	76,992	87,049	84,567	82,492

In the next step, data on imports, exports and production of mineral fertilizers by type for the period 2019-2022 were taken from the FAO database for BiH (www.faostat.org) and a calculated balance, on the basis of which an estimate of the total amount of fertilizer applied was made, shown in the following table.

Table 69: Estimate of total fertilizer applied (t/year)

Min fertilizer (t)	2019	2020	2021	2022
Ammonia, anhydrous	7,497.20	12,257.90	8,955.0	2,052.90
Ammonium nitrate (AN)	8,078.80	9,221.80	6,385.0	6,919.50
Ammonium sulfate	-6,868.40	-6,696.60	-6,683.2	-4,752.90
Calcium ammonium nitrate (KAN) and other mixtures with calcium carbonate	78,544.90	144,493.20	8,278.7	41,607.10

Double ammonium phosphate (DAP)	1.90	1.30	0.90	1.30
Other mineral fertilizers (n.e.s.	147.00	97.90	305.60	196.10
Monoammonium phosphate (MAP)	1,782.10	2,213.20	1,224.30	708.90
NPK fertilizers	55,754.40	6,0684.4	37,949.90	30,649.80
Other nitrogen fertilizers	1,271.00	2,027.30	1,949.00	1,525.20
Other NP compounds	132.80	255.90	203.20	275.00
Other phosphate fertilisers (n.e.s. classified)	3.30	0.80	4.90	6.60
Phosphate rock	0.10	0.10	0.00	3.00
PK Joints	182.60	225.30	6.50	0.10
Potassium chloride (potash muriate)	2,765.90	3,810.00	4,519.80	10.40
Potassium nitrate	63.90	148.00	99.20	3,612.00
Potassium sulphate (potassium sulphate)	24.20	50.30	73.20	73.10
Sodium nitrate	0.0	0.70	0.10	10.80
Other superphosphates		205.90	2.90	0.50
Urea	23,728.10	26,140.80	121.00	2.40
Urea and ammonium nitrate solutions			15,002.10	17,925.0

It is important to point out that the imported amount of mineral fertilizers was not always applied in the same year, but that there were stocks, lack of import of certain mineral fertilizers, so one gets the impression that they were not even applied, which is certainly not the case. Also, it should be noted that a large amount of ammonia (Ammonia, anhydrous) was imported, which was not applied in this form as a mineral fertilizer. Certain quantities were used in industry for other purposes. Some of these raw materials are used in the energy sector. It is also observed by the imported quantities that ammonium sulfate is produced from imported ammonia.

If we compare the estimated values of mineral fertilizers obtained in two ways (according to the data of the FAO balance (import-export + production) and according to the estimate according to the required quantities), it is clearly seen that the required quantities of mineral fertilizers are higher by about 15,000 t than actually applied, as shown in the following table.

Table 70: Comparison of the total amount of fertilizer calculated by different methods

Total amount of min. fertilizers/year (t/year)	**2019**	**2020**	**2021**	**2022**	**Average**
Estimated according to FAO data balance (imports-exports + production) (t/year)	179,699	255,180	78,091	100,612	153,396
Estimated by required quantities (t/year)	167,850	174,930	168,690	163,500	168,743
Difference (t/year)	11,849	80,250	-90,598	-62,888	-15,347

An increase in the application of mineral fertilizers of 330 kg/ha was observed in 2010 and grew each year to over 530 kg/ha in 2015 and 2016, leading to increased gas emissions. The change in the prices of mineral fertilizers on the market and the purchasing capacity of farmers affects the decrease in the applied quantities (KAN, NPK and Urea), constantly since 2016, especially since 2019 and 2020, when the average was applied only 90 kg/ha and 133 kg/ha, respectively. The following chart shows the applied amount of KAN, NPK and UREA according to FAOSTAT data.

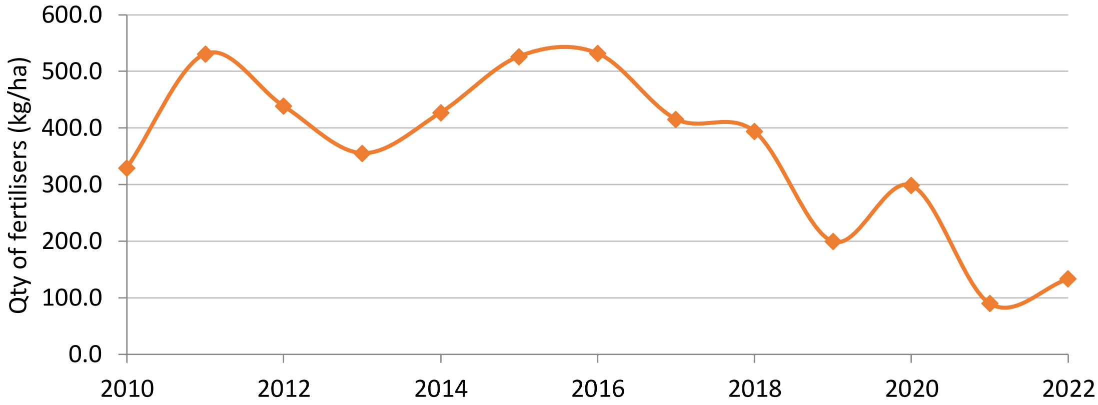

Chart 77: Applied amount of KAN, NPK and UREA according to FAOSTAT data

There has been a noticeable trend of decreasing the use of mineral fertilizers (KAN, NPK and Urea), constantly since 2016, especially since 2020.

Direct NO2 emissions from soil are shown in the following chart. There is a lot of variation over the course of the observed period. The values range from 399.77 Gg CO_2-eq in 2022 to 417.41 Gg CO_2-eq in 2019. However, there is a clear decrease in N_2O emissions of 18.33% compared to 2010.

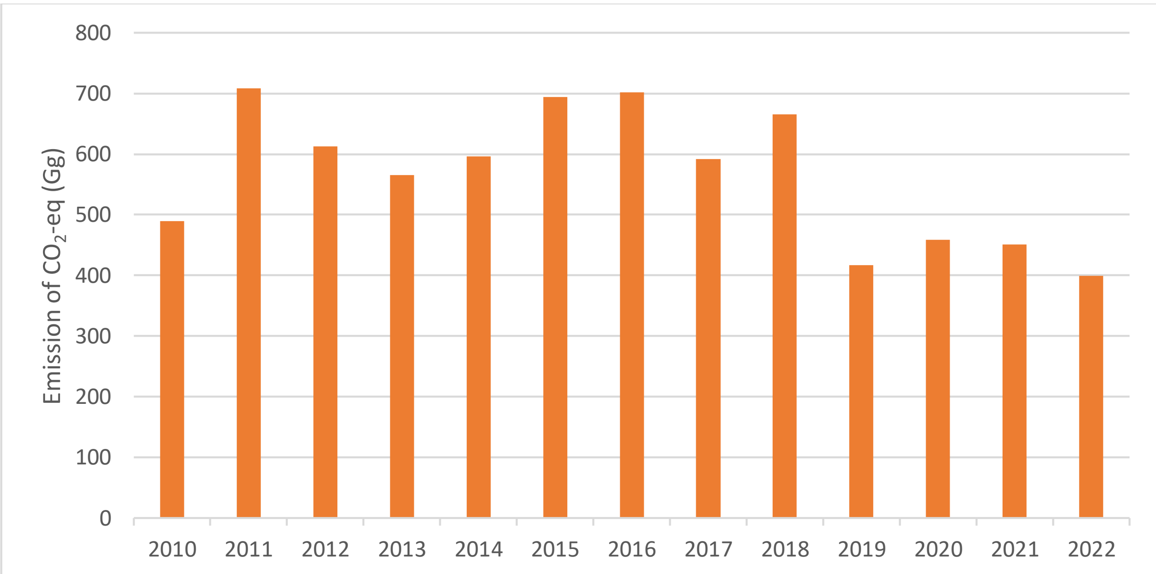

Chart 78: CO_2 - eq emissions in sector CRT 3.C.4 direct N_2O emissions from soil in the period 2010 – 2022

In the period 2019-2022, a significant decrease in these emissions was observed compared to previous years, and approaching the level of 2010.

(b) Data Uncertainty and Consistency Analysis

The uncertainty factors used for the input data and the emission factor for category 3.C.4 are presented below, in accordance with the recommendations of the IPCC 2006 methodology (Volume 4, Chapter 11, Chapter 11.4.4). The emissions are shown for the period 2010 – 2022.

Table 71: Uncertainty Analysis for CRT Category 3.C.4 Direct N_2O Emissions from Soil

CRT 3.C.4	Uncertainty, %
	N_2O
Input data	5%
Emission factor	30%
Combined uncertainty	**30%**

5.4.6 Indirect N_2O emissions from soil (CRT 3.C.5)

5.4.6.1 Basic information about the category

Category 3.C.5 Indirect N_2O emissions from soil accounted for 0.74% of total GHG emissions in 2014 and 0.46% in 2022, as well as 20.02% of category 3C emissions in 2014 and 20.01% in 2022. Category 3.C.5 Indirect N_2O emissions from soil was the key category in 2014 according to the analysis by level, while in 2022 it was not key according to the analysis by level, but in 2022 it was recognized as the key category according to the analysis by trend.

Indirect N_2O emissions from the soil are shown in the following figure. There is a strong similarity in the trend with direct emissions in the analyzed period 2010-2022. The values range from 129.65 Gg CO_2-eq in 2022 to 233.73 Gg CO_2-eq in 2011. However, in 2022, a decrease in indirect $NO_{2\ \text{emissions}}$ by 21.97% can be observed compared to 2010.

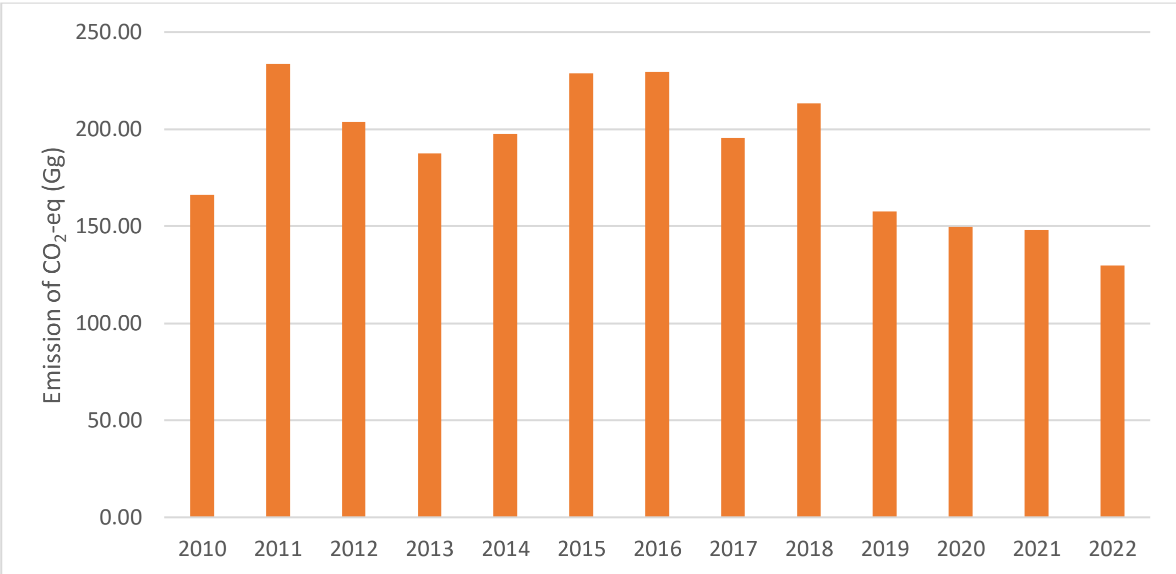

Chart 79: CO_2 - eq emissions in sector CTR 3.C.5 Indirect N_2O emissions from soil in the period 2010 – 2022

Indirect N_2O emissions from CRT 3.C.5 account for 20.01% of total CO_2-eq emissions from CRT 3.C in 2022. A significant drop in emissions was observed compared to previous years, and the level of emissions in 2022 fell below the level of emissions in 2010.

5.4.6.2 Data Uncertainty and Consistency Analysis

The uncertainty factors used for the input data and the emission factor for category 3.C.5 are presented below, in accordance with the recommendations of the IPCC 2006 methodology (Volume 4, Chapter 11, Chapter 11.4.4). The emissions are shown for the period 2010 – 2022.

Table 72: Uncertainty Analysis for CRT 3.C.5 Indirect N_2O Emissions from Soil

CRT 3.C.5	**Uncertainty, %**
	N_2O
Input data	5%
Emission factor	101%
Combined uncertainty	**101%**

5.4.7 Indirect N_2O emissions from fertilisers (CRT 3.C.6)

Category 3.C.6 Indirect N_2O emissions from fertilizers accounted for 0.22% of total GHG emissions in 2014 and 0.15% in 2022, as well as 6.89% of Category 3C emissions in 2014 and 6.80% in 2022. This category was not among the key categories according to the analysis by level in 2014 and 2022, as well as according to the analysis by trend.

Indirect N_2O emissions from managed lands are based on the 2006 IPCC Guideline 1 emission estimation methodology. The same input data as in the previous chapter were used, the amounts of N applied to the soil were recalculated to obtain the amounts of N evaporated and added/mineralized in the soils through leaching and runoff.

Indirect N_2O emissions from storage and delayed decomposition are shown in the chart below. In the presented period, it can be concluded that the emission of N_2O gases in the period 2010-2020 is relatively stable, but a slight decrease is observed. A slightly larger decrease of 50% occurred during the last two years of the analyzed period compared to 2010.

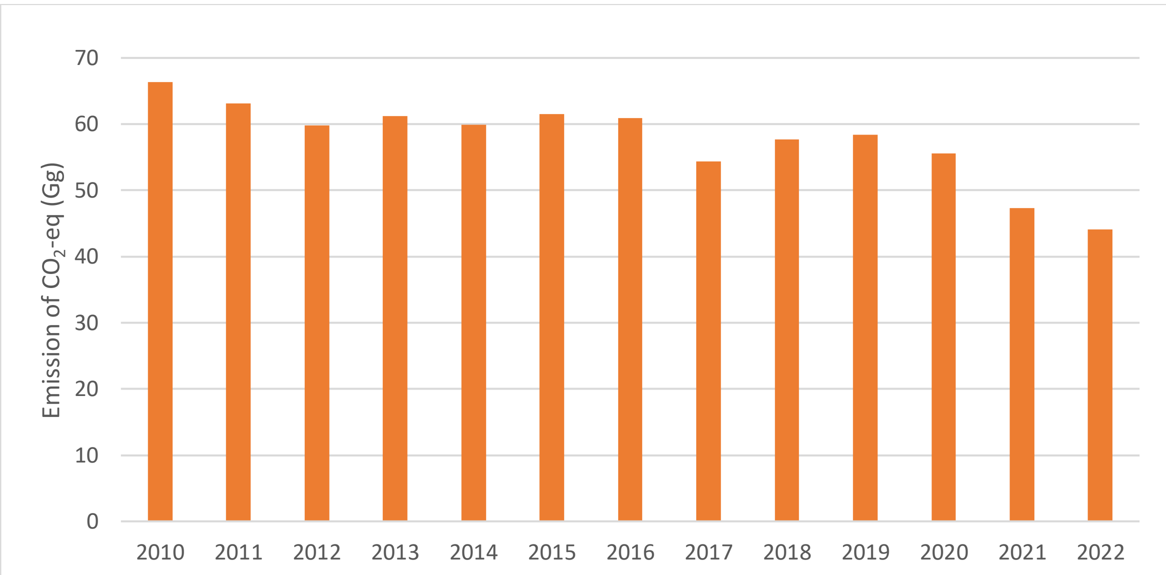

Chart 80: CO_2 - eq emissions in the CRT sector 3.C.6 Indirect N_2O emissions from fertilizers in the period 2010 – 2022

In the observed period, the highest value of emissions from category 3.C.6 Indirect N_2O emissions from fertilizers was recorded in 2010, when it amounted to 66.32 Gg CO_2-eq, while the lowest value of emissions was recorded in 2022, when it amounted to 44.08 Gg CO_2-eq.

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5.4.8 Rice cultivation (CRT 3.C.7)

Rice is not grown in BiH and it has not been taken into consideration.

5.5 Miscellaneous (CRT 3D)

5.5.1 Products of felled wood (CRT 3.D.1)

Category 3.D.1 Felling products accounted for 100.00% of emissions in 2014 and 100.00% in 2022 in category 3.D. This category accounted for -0.59% in 2014 and -1.71% in 2022 in total GHG emissions.

(a) Methodological approach

For the calculation, we needed data on:

- Firewood (Fuelwood),
- Industrial roundwood/logs (Industrial roundwood),
- Sawn wood,
- Wood panels,
- Paper and paperboard,
- Wood pulp + rec. paper,
- Chips and particles,
- Wood charcoal, and
- Wood residues.

Data on felled trees in BiH are taken from the official FAO statistics from the website: http://www.fao.org/faostat/en/#data/FO, http://www.fao.org/faostat/en/#data/FT

No data is available for charcoal and wood residues. The data used for the calculation are presented in the following tables.

Table 73: Data on production, import and export of firewood and industrial round logs in the period 2014 – 2022

Year	Firewood (Fuelwood)			Industrial roundwood		
	Production (m3)	Imports (m3)	Exports (m3)	Production (m3)	Imports (m3)	Exports (m3)
2014	1,347,900	628	694,000	2,804,300	22,000	1,200,000
2015	1,462,270	326	670,660	2,959,440	44,070	684,200
2016	1,501,090	620	798,280	3,072,010	42,440	99,870
2017	1,491,300	1,020	877,620	2,884,000	35,060	95,430
2018	1,555,000	3,450	839,720	3,250,849	81,000	54,670
2019	1,549,000	2,060	670,430	3,077,000	157,430	37,980
2020	1,484,000	1,450	559,150	2,993,000	162,140	50,350
2021	1,488,000	1,540	699,090	2,887,000	144,540	72,620
2022	1,318,608	1,912	465,713	2,710,139	256,179	45,609

The production of firewood in the period 2014 – 2022 had the highest value in 2018 when it amounted to 1,555,000 m3, while in 2022 it had the lowest value and amounted to 1,318,608 m3. Imports of firewood were the highest in 2022 and amounted to 1,912 m3, while in 2014 they were the lowest and amounted to 326 m3. Exports of firewood were the highest in 2017 when they amounted to 877,620 m3, while the lowest was in 2022 when they amounted to 465,713 m3. The production of industrial wood cladding in the period 2014 – 2022 had the highest value in 2018 when it amounted to 3,250,849 m3, while in 2022 it had the lowest value and amounted to 2,710,139 m3. Imports of industrial wood cladding were the highest in 2022 and amounted to 256,179 m3, while in 2014 they were the lowest and amounted to 22,000 m3. Exports of industrial wood cladding were the highest in 2014 when they amounted to 1,200,000 m3, while the lowest was in 2019 when they amounted to 37,980 m3.

Table 74: Data on production, import and export of sawn timber and wood panels in the period 2014 – 2022

Year	Sawn wood			Wood panels (Wood panels)		
	Production (m3)	Imports (m3)	Exports (m3)	Production (m3)	Imports (m3)	Exports (m3)
2014	969,390	109,000	899,000	35,100	217,000	19,670
2015	1,060,000	110,810	936,090	40,890	220,980	19,710
2016	1,109,610	139,550	951,530	36,930	250,010	22,230
2017	1,902,480	131,720	983,120	41,840	272,600	22,810
2018	1,749,790	164,870	942,570	33,880	285,850	18,870
2019	1,625,970	157,960	845,120	30,460	284,510	17,790
2020	1,477,000	136,020	846,170	41,000	284,450	18,300
2021	1,650,000	161,200	987,540	48,000	334,380	22,930
2022	1,075,157	113,635	600,703	46,897	308,864	23,164

Production of sawn timber in the period 2014 – 2022 had the highest value in 2017 when it amounted to 1,902,480 m3, while in 2014 it had the lowest value and amounted to 969,390 m3. Imports of sawn timber were the highest in 2018 and amounted to 164,870 m3, while in 2014 they were the lowest and amounted to 109,000^{m3}. Exports of sawn timber were the highest in 2021 when they amounted to 987,540 m3, while the lowest was in 2022 when they amounted to 600,703 m3. The production of wooden panels in the period 2014 – 2022 had the highest value in 2021 when it amounted to 48,000 m3, while in 2018 it had the lowest value and amounted to 33,880 m3. Imports of wooden panels were the highest in 2021 and amounted to 334,380 m3, while in 2014 they were the lowest and amounted to 217,000 m3. Exports of wooden panels were the highest in 2022 when they amounted to 23,164 m3, while the lowest was in 2020 when they amounted to 18,300 m3.

Table 75: Data on production, import and export of paper and cardboard and pulp and recycled paper in the period 2014-2022

Year	Paper and paperboard			Wood pulp and recycled paper		
	Production (m3)	Imports (m3)	Exports (m3)	Production (m3)	Imports (m3)	Exports (m3)
2014	106,000	93,000	91,640	80,000	38,031	110
2015	146,020	86,290	105,520	86,240	37,833	0
2016	97,133	97,410	78,930	46,000	41,903	10
2017	135,450	97,990	105,130	67,880	41,584	0
2018	142,840	105,,940	112,850	80,700	39,596	24
2019	99,600	104,880	82,100	65,500	39,980	20
2020	122,000	99,190	112,690	77,000	41,320	0

2021	136,000	114,440	134,220	80,000	38,520	0
2022.	113,981	108,495	110,898	84,000	42,723	8

Paper and cardboard production in the period 2014 – 2022 had the highest value in 2015 when it amounted to 146,020 m3, while in 2016 it had the lowest value and amounted to 97,133 m3. Imports of paper and cardboard were the highest in 2021 and amounted to 114,440 m3, while in 2015 they were the lowest and amounted to 86,290^{m3}. Exports of paper and cardboard were the highest in 2021 when they amounted to 134,220 m3, while the lowest was in 2016 when they amounted to 78,930 m3. The production of pulp and recycled paper in the period 2014 – 2022 had the highest value in 2015 when it amounted to 86,240 m3, while in 2016 it had the lowest value and amounted to 46,000 m3. Imports of pulp and recycled paper were the highest in 2016 and amounted to 41,903 m3, while in 2014 they were the lowest and amounted to 38,031 m3. Exports of pulp and recycled paper were the highest in 2014 when they amounted to 110 m3, while the lowest were in 2015, 2017, 2020 and 2021 when they amounted to 0 m3.

Table 76: Data on production, import and export of other industrial roundwood and wood chips in the period 2018 – 2022

Year	Other industrial rounds			Wood chips		
	Production (m3)	Imports (m3)	Exports (m3)	Production (m3)	Imports (m3)	Exports (m3)
2014	162,000	Inaccessible data	Inaccessible data	105,000	7,270	47,000
2015	162,660			200,000	5,770	39,510
2016	176,340			275,000	2,060	17,080
2017	159,000			330,000	6,690	20,680
2018	192,443			300,000	18,920	22,190
2019	168,000			300,000	11,750	24,170
2020	174,000			267,000	8,530	30,310
2021	150,000			250,000	23,060	33,270
2022	143,526			96,459	20,176	12,522

The production of other industrial roundwood in the period 2014 – 2022 had the highest value in 2018 when it amounted to 192,443 m^3, and the lowest value was in 2022 when it amounted to 143,526m^3. Data on imports and exports of other industrial roundwood in the period 2014-2022 are not available. Wood chip production in the period 2014 – 2022 had the highest value in 2017 when it amounted to 330,000 m^3, while in 2022 it had the lowest value and amounted to 96,459 $^{m3.}$ Imports of wood chips were the highest in 2021 and amounted to 23,060 m3, while in 2016 they were the lowest and amounted to 2,060 m^3. Wood chip exports were the highest in 2021 when they amounted to 33,270 m^3, while the lowest was in 2022 when they amounted to 12,522m^3.

Below is the trend of sinks from category 3.D.1 Products of felled wood for the period 2014-2022.

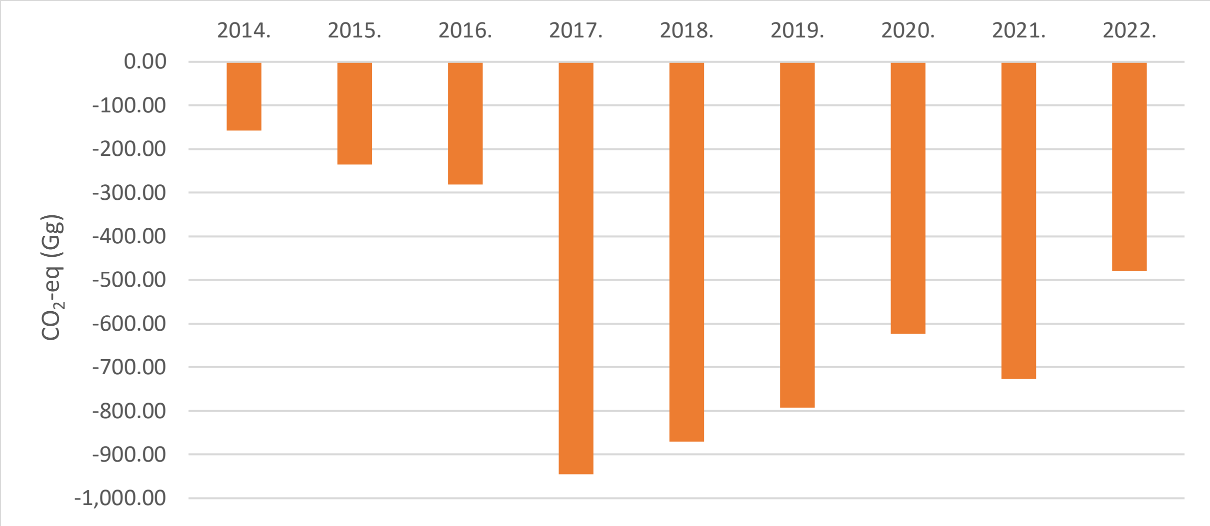

Chart 81: CO_2 sinks - eq in the CRT sector 3.D.1 Products made of felled wood in the period 2014 - 2022 in BiH

CO_2-eq emissions from category 3.D.1 – Products made from felled wood recorded negative values throughout the observed period, indicating their role in carbon sequestration. From 2014 to 2018, sinks had a variable trend, with the highest value recorded in 2014, when they amounted to -157.92 Gg CO_2-eq. In 2022, sinks in this category amounted to -479.09 Gg CO_2-eq. The lowest value of sinks in this category was recorded in 2017 when they amounted to -944.35 Gg CO_2-eq.

(b) Data Uncertainty and Consistency Analysis

The uncertainty factors used for the input data and the emission factor for category 3.C.4, based on expert judgement, are presented below. The emissions are shown for the period 2014 – 2022.

Table 77: Uncertainty Analysis for CRT 3.D.1 Felled Wood Products

CRT 3.D.1	**Uncertainty, %**
	CO_2
Input data	10%
Emission factor	100%
Combined uncertainty	**100%**

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6 Waste (CRT 4)

6.1 Basic information about the sector

The waste sector (CRT 4) in BiH includes emissions from the following activities:

- Disposal of solid waste (4.A) for managed waste,
- Treatment and discharge of waste water (4D), including domestic waste water and industrial waste water.

For the target period (2019-2022), no emissions from waste incineration (incineration and open incineration) and biological treatment of solid waste (composting and anaerobic digestion) were estimated. Open waste incineration can occur in rural areas, but there is no data on this practice, nor estimates for the sector's emissions in the current inventory. This type of burning is sporadic and mostly comes down to biomass burning. For the Waste sector, CH_4 and N_2O emissions have been estimated and waste is particularly dominant in CH4 emissions.

Within preparation of the GHG emissions balance in BiH, a consistent methodology for the analysis of the solid waste and wastewater management process has been set. In this regard, the 2019 amendment to the IPCC Guidelines for National GHG Inventories has been fully implemented in this report. The methodology used to calculate emissions from the waste sector is according to the IPCC 2006 guidelines and amendments from 2019, and the Tier 1 approach was used for the calculation of emissions from waste.

As a source of data for the activities, the annual reports of the Agency for Statistics in the field of environment were used. The data was collected in collaboration with the Hydrometeorological Institutes.

Table 78: Subcategories in the waste sector

IPCC code	**Description**	**Availability**			**No occurence (NO)**
		Estimated	Not Rated (NO)	Included elsewhere (IE)	
4.A	Disposal of solid waste	✓			
4.B	Biological waste treatment		✓		
4.C	Incineration and open incineration of waste				✓
4.D	Wastewater treatment and discharge	✓			

Below are the GHGs for which the Waste Sector Emissions Assessment (CRT 4) has been performed.

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Table 79: Estimated GHG in the waste sector

IPCC code	IPPU sub-category	Direct emissions							Indirect emissions			
		CO_2	CH_4	N_2O	HFCs	PFC	SF6	NF3	NOx	WHAT	NMVOCs	SO2
4.A	Disposal of solid waste	ON	✓	ON	ON	ON	ON	ON	ON	ON	ON	ON
4.B	Biological waste treatment	ON	NO	NO	ON	ON	ON	ON	ON	ON	ON	ON
4.C	Incineration and open incineration of waste	NO	NO	NO	ON	ON	ON	ON	ON	ON	ON	ON
4.D	Wastewater treatment and discharge	ON	✓	✓	ON	ON	ON	ON	ON	ON	ON	ON

The total CO_2-eq emissions from the waste sector are shown below.

Table 80: Total CO_2-eq emissions in the CRT 4 Waste sector

Emission	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO_2-eq (Gg)	1,383.92	1,436.95	1,347.42	1,388.81	1,415.54	1,422.55	1,366.82	1,465.61	1,446.69

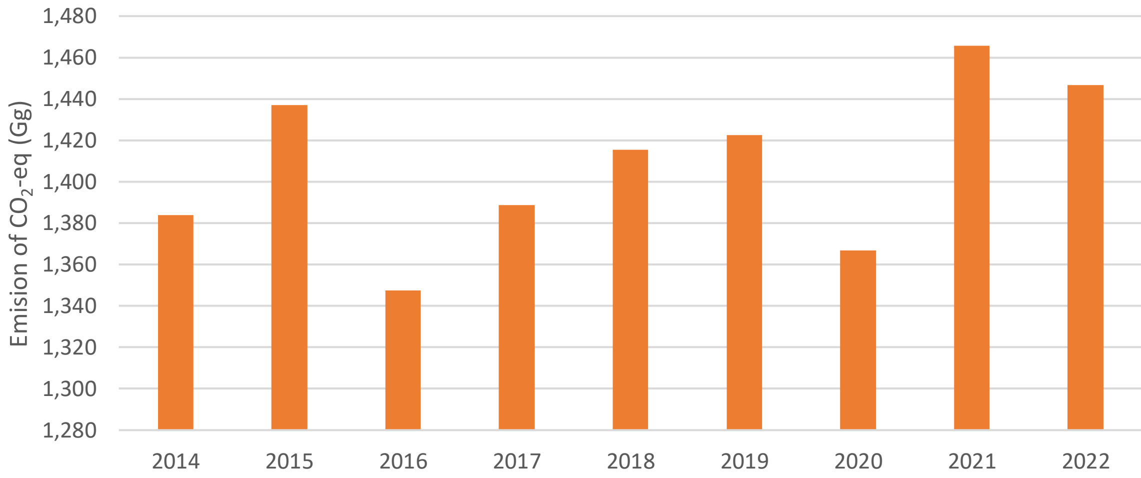

Chart 82: CO_2 - eq emissions in the CRT 4 Waste sector in the period 2014 – 2022

In the observed period, the highest amount of emissions was recorded in 2021 (1,465.61 Gg CO_2-eq), and the lowest during 2016 (1,347.42 Gg CO_2-eq).

The following chart shows the share of individual subcategories in the total emissions from the CRT 4 Waste category.

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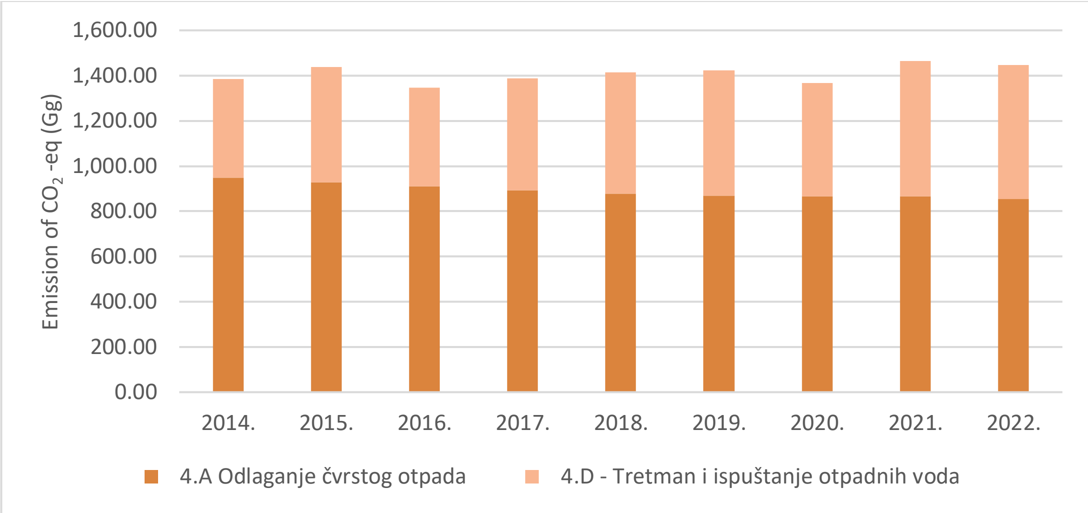

(LEGEND: Odlaganje čvrstog otpada – solid waste disposal; Tretman i ispuštanje otpadnih voda – treatment and discharge of waste waters.)

Chart 83: CO_2 - eq emissions of all categories in the CRT 4 Waste sector in the period 2014 – 2022

The chart above shows that the total CO_2-eq emissions from CRT 4 consist of emissions from solid waste disposal (subcategory 4A) and emissions from waste water treatment and discharge (subcategory 4D). Other subcategories within CRT 4 Waste have not been assessed. The majority of total emissions from the waste category belong to sub-category 4A Solid waste disposal. In 2014, subcategory 4.A participated with 68.60%, and in 2022 with 59.01% in total emissions from category 4 Waste. Emissions from the CRT 4 Waste category accounted for 4.49% of total CO_2-eq emissions in 2022.

6.2 Disposal of solid waste (CRT 4.A)

6.2.1 Basic information about the category

Category 4.A Disposal of solid waste accounts for 68.06% of emissions in 2014 and 59.01% in 2022 in category 4 Waste. This category in total GHG emissions accounts for 3.56% in 2014 and 3.05% in 2022. This category was among the key categories according to the analysis by level in 2014 and in 2022, and was also recognized as key according to the analysis by trend.

Solid waste management in BiH is mainly based on the collection, removal and disposal of municipal waste in landfills. This way of waste disposal is not sustainable and represents a negative impact on the environment, and therefore on the increase in GHG emissions and pollution from waste. In BiH, there is no organized sorting of waste at the place of origin, and therefore there is no separation of the organic component of municipal waste and its treatment in order to reduce biomethane emissions.

The total waste generated was calculated according to the statistics on the number of inhabitants and the annual rate of solid waste generated (kg/capita/year).

Table 81: Solid waste generated rate

Parameter	2014	2015	2016	2017	2018	2019	2020	2021	2022
Rate of solid waste generated (t/capita/year)	346.75	354.05	355.02	353.00	353.00	352.00	354.00	356.00	345.00

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From the previous table it is evident that, in the observed period, the rate of generated solid waste (t/capita/year) had a fairly uniform trend, with the highest value observed in 2015, when it amounted to 354.05 t/capita, while the lowest value was observed during 2017 and 2018, when it amounted to 353.00 t/capita.

Below are the data on the share of landfilled waste in the total waste generated.

Table 82: Share of landfilled waste in total waste generated

Parameter	2014	2015	2016	2017	2018	2019	2020	2021	2022
Share	0.75	0.76	0.77	0.77	0.77	0.90	0.90	0.79	0.81

From the previous table it is evident that, in the observed period, the share of landfilled waste in the total generated waste varies from 75% in 2014 to 90% in 2019 and 2020.

Estimated emissions of CH4 or CO_2-eq show a downward trend, which is mostly caused by the decrease in the number of inhabitants in the presented period.

Table 83: CH4 emissions (expressed in CO_2-eq) from solid waste disposal

Waste	2014	2015	2016	2017	2018	2019	2020	2021	2022
CH_4 emissions (Gg CO_2-eq)	949.40	927.47	909.33	893.38	878.31	869.70	867.11	865.07	853.75

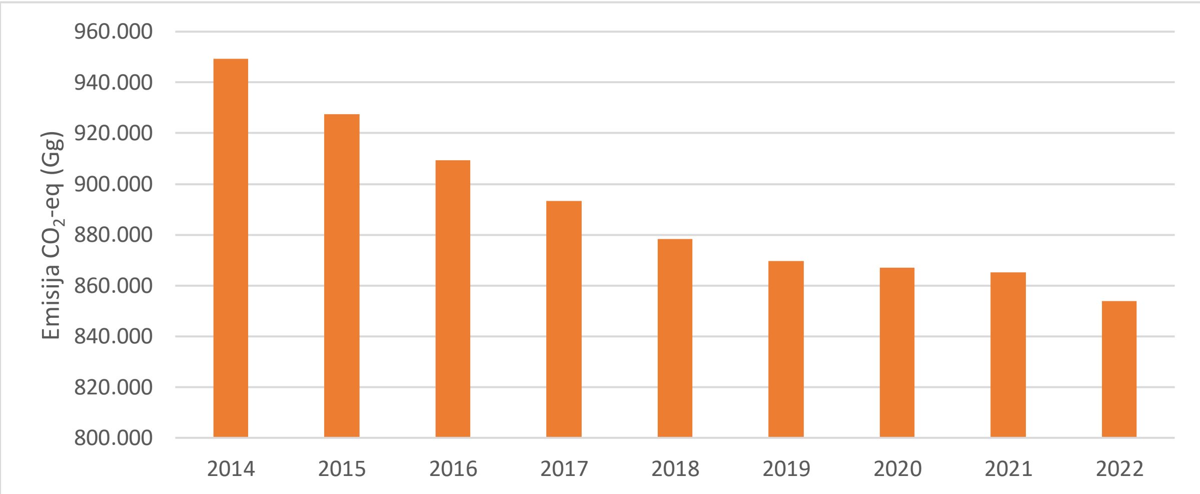

Chart 84: CO_2 - eq emissions in sector 4A Solid waste disposal in the period 2014 – 2022

From the previous table and diagram, it is evident that total emissions from the solid waste disposal process are characterized by a downward trend in the observed period, and the highest value of CO_2-eq emissions was recorded in 2014 when it amounted to 949.40 Gg CO_2-eq, and the lowest in 2022 when it amounted to 853.75 CO_2-eq. The share of CRT 4A subcategory in total emissions (excluding sinks) is 2.65%, and the share of CRT 4A Solid waste disposal in category 4A emissions is 59.01%.

6.2.2 Methodological approach

The Tier 1 method was used for estimates, which is based on IPCC guidelines and mass balance, i.e. the use of data for activity and recommended parameters. For the purpose of the calculation, the IPCC

Inventory Software was used, in which the potential for the production of CH_4 from waste that is disposed of in a given year gradually decreases over the following decades. Data from 1950 to 2022 were used.

The calculation used data from the Environment/Environment Report of the Agency for Statistics of BiH. In particular, data on the number of inhabitants, the mass of generated waste, the rate of solid waste generated (t/capita/year) were used. Data on public waste collection and disposal were a source for determining the share of deposited waste in the total waste generated. For the composition of solid waste to be disposed of in landfills, recommended values were used (64.1% for bulk waste and 35.9 for inert waste).

6.2.3 Data Uncertainty and Consistency Analysis

The same method and datasets were used to estimate emissions for each year as well as certain values of the CH4 correction factor.

For solid waste disposal and according to IPPCC guidelines for Tier 1, the recommended uncertainties were taken: for activity data ±30% for total municipal solid waste and ±20% for the correction factor for CH4. The emissions are shown for the period 2014 – 2022.

6.3 Wastewater treatment and discharge (CRT 4.D)

6.3.1 Basic information about the category

Category 4.D Wastewater treatment and discharge accounts for 31.39% of emissions in 2014 and 40.98% in 2022 in category 4. This category in total GHG emissions accounts for 1.62% in 2014 and 2.11% in 2022. Subcategory 4.D (CH_4) was the key category in the analysis by level for 2014 and 2022. Subcategory 4.D (N2O) was not a key category in the analysis by level for 2014 and 2022, but it was recognized as a key category according to the analysis by trend.

Wastewater is a source of CH4 and N_2O emissions. It comes from a variety of domestic, commercial and industrial sources and can be treated (purified) at the point of origin or discharged untreated. In this inventory, wastewater emissions from households and industry were estimated. CH_4 is produced by anaerobic decomposition in wastewater and depends on the content of degradable organic material in the wastewater, temperature and treatment method. As the temperature increases, so does the production of CH4 and this is especially important for uncontrolled wastewater management and elevated temperatures. Wastewater is defined as: domestic wastewater consisting of black water (feces, urine, and fecal sludge) and greywater (wastewater from kitchens and bathrooms), and water from commercial facilities and institutions, including hospitals, industrial wastewater, stormwater, and other urban wastewater.

The Tier 1 method was used for the calculation of emissions, and the necessary data on activities were obtained from the annual reports of the Agency for Statistics of BiH. For wastewater from households, data from annual reports related to environmental protection and public sewage were used. Furthermore, the recommended weighted emission factors and a correction factor for industrial biochemical oxygen demand discharged into the sewage system were used. Data on dietary protein amounts per capita collected from available sources (FAOSTAT and ourworldindata.org) and fractions of proteins emitted from industry were used to calculate direct N_2O emissions.

For the calculation, data on the industries in which wastewater is generated and the recommended weighted emission factors and the parameter of Chemical Oxygen Demand were collected for them.

Table 84: Overview of wastewater quantities for the period 2014 – 2022

Wastewater	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Total waste water (1000 m3)	91,962	92,894	124,002	115,916	116,531	116,977	118,250	104,812	108,261
Treated wastewater (1000 m3)	4,487	5,140	55,881	48,533	54,055	56,976	51,784	38,466	43,308
Share (%)	4.88	5.53	45.06	41.87	46.39	48.71	43.79	36.70	40.00
Protein in the diet (kg/person/year)	36.76	38.63	38.99	38.65	39.53	39.93	39.73	40.14	39.89

From the previous table, a variable trend is noticeable in the total quantities of wastewater, but also in the shares of treated water in the total wastewater. The lowest share of treated wastewater was observed in 2014 (5%) and the highest in 2019 (49%).

Table 85: Annual production by industry (t)

In tons	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Refined alcohol	798	1,082	1,670	2,273	3,708	2,518	1,916	2,242	4,784
Beer & Malt	80,843	88,172	93,780	95,031	95,353	90,574	82,191	73,270	68,919
Dairy products	253,122	246,182	254,375	407,794	423,556	407,173	479,979	441,990	417,932
Fish processing	1,848	1,662	1,686	1,660	1,438	2,357	2,339	4,584	5,969
Meat and poultry	122,212	115,249	113,528	122,349	112,768	149,615	146,957	154,449	190,627
Organic Chemicals	28,486	30,571	36,923	34,955	33,998	32,620	37,087	52,840	39,264
Petroleum products	1,044,768	991,771	916,990	941,350	714,490	86,662	18,416	281,821	18,132
Plastics and resins	13,962	17,009	19,533	21,958	24,309	24,223	27,618	28,135	32,376
Pulp and paper	237,257	312,955	234,508	288,039	327,702	263,037	220,627	316,305	327,565
Soap and detergents	12,174	14,952	17,044	21,181	23,277	32,712	30,645	30,628	29,217
Starch production	703,100	656,056	744,458	770,711	638,355	761,082	646,048	679,621	380,611
Refined sugar	53,431	61,903	99,575	70,972	42,954	89,230	77,222	63,547	127,070
Vegetable oils	152,605	218,266	235,424	259,306	214,108	248,950	236,456	191,227	202,528
Vegetables, fruits and juices	48,937	59,955	72,117	68,427	78,768	95,478	66,578	68,300	60,183
Wine and wine vinegar	5,620	8,776	5,579	6,825	6,562	11,879	5,800	7,507	4,719

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CH4 emissions, shown in CO_2-eq (Gg) from wastewater are shown below.

Table 86: Emission from category CRT 4.D Treatment and discharge of waste water

Wastewater	2014	2015	2016	2017	2018	2019	2020	2021	2022
Emissions (Gg CO_2-eq)	434.52	509.48	438.09	495.44	537.23	552.85	499.70	600.54	592.94

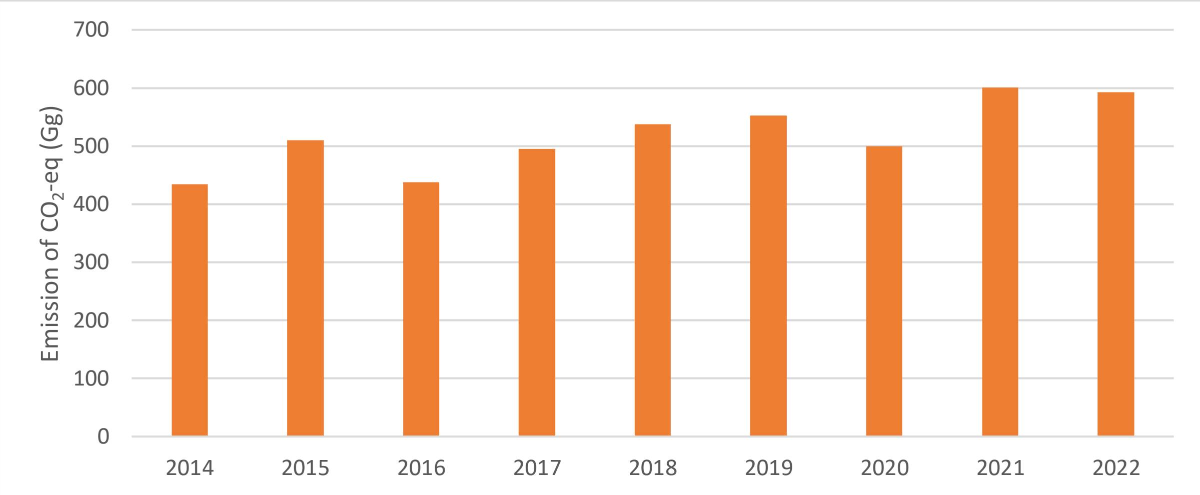

Chart 85: CO_2 - eq emissions in sector 4.D Wastewater treatment and discharge in the period 2014 – 2022

The previous chrt shows a variable trend in emissions from wastewater treatment and discharge. The highest value of emissions was observed in 2021, when it amounted to 600.54 Gg CO_2-eq, while the lowest value of emissions was recorded in 2014, when it amounted to 434.52 Gg CO_2-eq. Emissions from CRT 4.D account for 1.84% of total emissions (excluding sinks), and 40.91% of CRT 4 Waste emissions.

6.3.2 Methodological approach

The Tier 1 method for assessments was used, which is based on IPCC guidelines and the use of recommended parameters. For the purpose of the calculation, the IPCC Inventory Software was used, in which CH_4 and N_2O emissions from wastewater were calculated using recommended values and weighted emission factors.

Input data obtained from the Environment/Environment Report of the Agency for Statistics of BiH were used. Data on the number of inhabitants and the amount of wastewater were used in particular.

6.3.3 Data Uncertainty and Consistency Analysis

The same method and datasets were used to estimate emissions for each year as well as certain values of the CH4 correction factor.

According to the IPCC guidelines for Tier 1, the following uncertainties have been adopted: for emission factor ±30 for maximum production capacity CH4 and ±50 for fractions treated anaerobically; for activity data number of inhabitants ±5%, BOD per person ±30%). The emissions are shown for the period 2014 – 2022.

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7 Attachments

Attachment I: Overview of emissions for 2019-2022

Attachment II: Analysis of uncertainties (with and w/o LULUCF)

Attachment III.I: Proposal of the QA/QC plan

Attachment III.II: QA/QC questionnaires

Attachment IV: PoređeComparison of sectoral and reference approach

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