NATIONAL INVENTORY DOCUMENT
NATIONAL INVENTORY REPORT
ON THE GHG EMISSIONS AND REMOVALS
OF THE KYRGYZ REPUBLIC
FOR THE PERIOD 1990–2023

Bishkek, 2025

The National Inventory Document of the Kyrgyz Republic was prepared as part of the National Inventory Report on the Greenhouse Gas Emissions and Removals for the period 1990–2023, within the framework of the preparation of the Kyrgyz Republic's First Biennial Transparency Report under the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement. The work was carried out with the support of a project financed by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP), entitled "Support to the Kyrgyz Republic in the Preparation of the First and Second Biennial Transparency Reports and the Fifth National Communication under the UNFCCC", in close coordination and under the guidance of the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic.

Document reference

Title	National Report on the Greenhouse Gas Emissions and Removals Inventory: National Inventory Document of the Kyrgyz Republic for 1990–2023
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Foreword

Dear colleagues, we are pleased to present to your attention the National Inventory Document of the Kyrgyz Republic, prepared in accordance with the decisions of the UNFCCC. This document presents the results of the next cycle of the National Greenhouse Gas Inventory (GHG) for the period 1990–2023, carried out in full compliance with the internationally accepted methodology of the Intergovernmental Panel on Climate Change (IPCC).

Climate change has a serious impact on Kyrgyzstan and increases the risks of achieving the Sustainable Development Goals (SDGs). Therefore, the main focus of climate action today is on reducing the risks of adverse climate impacts and adapting to them.

Kyrgyzstan is a country with a low level of GHG emissions, as historical data confirm. However, the positive dynamics of the country's socio-economic development in recent decades have been accompanied by a significant increase in GHG emissions. Therefore, along with adaptation to climate change, Kyrgyzstan pays great attention to climate change mitigation.

Monitoring GHG emissions and maintaining the National GHG Inventory by sources and removals by sinks is one of the priorities of the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic (MNRETS). This provides the necessary information for making decisions related to the preparation of our Nationally Determined Contributions (NDCs) and achieving carbon neutrality by 2050.

The National Inventory Document (NID) and the Common Reporting Tables, which together constitute the National Inventory Report (NIR), are an important part of Kyrgyzstan's climate reporting under the UNFCCC. They provide information on greenhouse gas emissions and removals for the reporting period 2021–2023, as well as recalculated time series of emissions and removals from 1990 to 2023.

This document was prepared in the process of developing the First Biennial Transparency Report (BTR1) and serves as an informative supplement to it.

With respect and best wishes,

Meder Mashiev
National Focal Point for the United Nations Framework Convention on Climate Change in the Kyrgyz Republic
Minister of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic

Abbreviation

AD	Activity Data
ADB	Asian Development Bank
AR 2 / 5	Assessment Reports 2 / 5 by IPCC
BOD	Biochemical Oxygen Demand
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CHHP	Combined Heat and Power Plant
CMA	Conference of Parties serving as the meeting of the Parties to the Paris Agreement
COD	Chemical Oxygen Demand
COP	Conference of Parties
CRT	Common Reporting Tables
CTF	Common Tabular Formats
EEA	European Environment Agency
EMEP	European Monitoring and Evaluation Program
EF	Emission Factor
ES	Executive Summary
FEC	Fuel and Energy Complex
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GWP	Global Warming Potential
ICE	Internal Combustion Engines
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
KR	Kyrgyz Republic
LULUCF	Lan Use, Land Use Change and Forestry
ME	Ministry of Energy
MEnt	Municipal Enterprise
MEC	Ministry of Economy and Commerce
MCF	Methane Correction Factor
MNRETS	Ministry of Natural Resources, Ecology and Technical Supervision
MPG	Modalities, Procedures and Guidelines
MRV	Monitoring, Reporting and Verification
MSW	Municipal Solid Waste
MTC	Ministry of Transport and Communications
MWRAPI	Ministry of Water Resources, Agriculture and Processing Industry
NCV	Net Calorific Value
NC	National Communication
NDC	Nationally Determined Contribution
NGHGI	National Greenhouse Gas Inventory
NID	National Inventory Document
NIR	National Inventory Report
NSC	National Statistic Committee

QA/QC	Quality Assurance and Quality Control
SAAC&CU	State Agency for Architecture, Construction and Communal Utilities under the Government of the Kyrgyz Republic
SAR	Second Assessment Report by IPCC
SE	State Enterprise
TOW	Total organically degradable waste
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change

Chemical Formulas of GHG Gases, Precursors and Units of Measurement

CO_2	Carbon dioxide
CH_4	Methane
N_2O	Nitrous oxide
HFC	Hydrofluorocarbon
PFC	Perfluorocarbon
SF_6	Sulphur hexafluoride
NF_3	Nitrogen trifluoride
CO	Carbon monoxide
NOx	Nitrogen oxides
NMVOC	Non-methane volatile organic compounds
SO_2	Sulphur dioxide
kt	kiloton
TCE	Tons of coal equivalent
TOE	Tons of oil equivalent
J	Joule – a unit of energy and heat in the International System of Units (SI)

Decimal Prefixes of Units of Measurement

Multiplier	**Prefix**		**Symbol**		**Action**
	Russian	**International**	**Russian**	**International**	
10^1	дека	deca	да	da	Increase by a factor of 10
10^2	гекто	hecto	г	h	Increase by a factor of 100
10^3	кило	kilo	к	k	Increase by a factor of 1,000
10^6	мега	mega	М	M	Increase by a factor of one million (10^6)
10^9	гига	giga	Г	G	Increase by a factor of one billion (10^9)
10^{12}	тера	tera	Т	T	Increase by a factor of one trillion (10^{12})
10^{15}	пета	peta	П	P	Increase by a factor of one quadrillion (10^{15})

Multiplier	Prefix		Symbol		Action
	Russian	International	Russian	International	
10^{18}	экса	exa	Э	E	Increase by a factor of one quintillion (10^{18})
10^{21}	зетта	zetta	З	Z	Increase by a factor of one sextillion (10^{21})
10^{24}	иотта	yotta	И	Y	Increase by a factor of one septillion (10^{24})

Executive Summary

ES.1. Background Information on Greenhouse Gas Inventories and Climate Change

ES 1.1. Background Information on Climate Change

An analysis of historical data indicates a significant increase in air temperature across the territory of the Kyrgyz Republic. The average annual temperature for the period 1901–2020 has risen markedly. While from the beginning of the last century the growth rate of the average annual temperature was 0.013°C per year (or 0.1°C every 10 years), during the period 1976–2017 the rate of increase almost doubled and reached 0.024°C per year (or 0.2°C per 10 years).

In terms of seasonal variation, the highest (statistically significant) warming trends across the country are observed in spring, amounting to 0.45°C per 10 years. In winter, summer, and autumn, the temperature increase is statistically insignificant and amounts to 0.22°C, 0.12°C, and 0.14°C per 10 years, respectively. On a monthly scale, the highest temperature increase nationwide is recorded in March – 0.85°C per 10 years, and in February – 0.42°C per 10 years.[1]

The precipitation regime in the Kyrgyz Republic, in addition to significant spatial and seasonal variability, is also characterized by interannual fluctuations and cyclicity. Overall, since the beginning of the last century, there has been a slight upward trend in annual precipitation of 0.11% per year (or 1% every 10 years). Since the mid-1970s, the rate of increase has accelerated to 0.2% per year (or 2% every 10 years). However, both trends are statistically insignificant.

According to climate projections based on the CMIP6 multi-model ensemble, further warming is expected throughout the 21st century in Kyrgyzstan under all five SSP scenarios. Under the intermediate scenario SSP2-4.5, the temperature in Kyrgyzstan is projected to increase by 1.1°C above the baseline (1995–2014 average) by 2030, by 1.8°C by 2050, by 2.5°C by 2070, and by 2.9°C by the end of the century. Under a high-emission scenario, the increase in mean annual temperature will be more pronounced: by 1.2°C within the next 20 years, by 2.5°C by 2050, by 4.1°C by 2070, and by 5.8°C by 2090.[2]

According to the CMIP6 multi-model ensemble, precipitation in Kyrgyzstan during the 21st century is generally expected to remain at current levels, with a slight upward trend. Under the intermediate scenario SSP2-4.5, annual precipitation is projected to increase by 3% compared to the baseline period 1995–2014 in the next 20 years. In 2040–2059, precipitation is expected to rise by 4%, in 2060–2079 by 6%, and by 8% by the end of the century. Under the “fossil-fueled development” scenario, precipitation is expected to remain stable for the next 20 years, then increase by 6% by 2050, by 8% by 2070, and by 11% by the end of the century.

Under both scenarios, the greatest increase in precipitation is expected in winter, with a slightly smaller increase in spring, while in summer a decrease in precipitation is projected. However, at present, the largest increase in precipitation across the country is observed in summer, with a somewhat smaller increase in winter, while in spring precipitation shows almost no trend of change.[3]

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[1] MNRETS. 2024. Fourth National Communication of the Kyrgyz Republic to the UNFCCC.
[2] Ibid.
[3] MNRETS. Fourth National Communication of the Kyrgyz Republic to the UNFCCC. 2024

As a result of the Climate Risk and Vulnerability Assessment, the most vulnerable sectors and the effects of these impacts were identified:

- Water resources
- Agriculture
- Energy
- Public health
- Disaster risk reduction
- Forests and biodiversity
- Settlements and territories

Adaptation measures for these sectors were developed in 2023 within the framework of the NDC Implementation Plan, as well as in sectoral adaptation plans and the National Adaptation Plan (NAP).

ES 1.2. Background Information on GHG Inventories

The National Inventory of greenhouse gas (GHG) emissions and removals provides the information basis for decision-making in the planning and monitoring of Kyrgyzstan's climate policy. However, due to national circumstances and insufficient technical capacity, Kyrgyzstan does not have a national GHG inventory system that continuously accounts for emissions and removals, nor a national system of measurement, reporting, and verification (MRV). Each new round of the national inventory has been carried out thanks to the financial support of the UNFCCC financial mechanism, represented by the Global Environment Facility, which provides resources for the preparation of national climate reporting.

The 2025 National Inventory Document (NID), submitted to the UNFCCC, presents the results of the fifth cycle of the National GHG Inventory (NGHGI)[4], covering the period 2021–2023. It includes data on anthropogenic emissions by sources and removals by sinks for all greenhouse gases not controlled by the Montreal Protocol, namely: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

The NID also includes an assessment of the so-called precursor gases, which include carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC), and sulphur dioxide (SO_2). Precursor gases do not have a direct warming effect, but they influence the formation or destruction of direct GHGs, such as tropospheric ozone.

The assessment of emissions by gases and source categories is presented through 2023. The full time series presents GHG emissions and removals starting from 1990 (except for HFCs, which are assessed beginning in 1995).

The recalculation of the GHG emissions time series for the period 1990–2023 was carried out using the Global Warming Potential (GWP) values from the IPCC Fifth Assessment Report.

ES.2. Summary of National Trends in GHG Emissions and Removals

Emission trends for the period 1990–2023 are presented by describing total and net emissions, as well as the dynamics of emissions for seven types of direct greenhouse gases (CO_2, CH_4, N_2O, HFCs,

[4] NGHGI 1 was presented in NC 1 and covered 1990–2000; NIR 2 was presented in NC 2 and covered the period 2001–2005; NIR 3 was presented in NC 3 – 2006–2010; NIR 4 was presented in BUR 1 (2011–2018) and NC 4 (2019–2020).

PFCs, SF_6, NH_3) and four precursor greenhouse gases (NOx, CO, NMVOC, and SO_2). Emissions and removals are also disaggregated by source sectors:

- Energy
- Industrial Processes and Product Use (IPPU)
- Agriculture
- Land Use, Land-Use Change and Forestry (LULUCF)
- Waste

In 2023, carbon dioxide (CO_2) emissions amounted to 11,284.78 kt, or 58.2% of total GHG emissions. This represents a 19.4% increase compared to the last inventory year 2020, but a 44.4% decrease compared to 1990. Methane (CH_4) emissions amounted to 5,611.58 kt CO_2 eq., or 29.0% of total GHG emissions, which is 9% higher than in 2020 and 11.3% higher than in 1990. Nitrous oxide (N_2O) emissions totaled 1,951.69 kt CO_2 eq., or 10.1% of total GHG emissions, representing a 10.4% increase compared to 2020, but a 23.4% decrease compared to 1990. Emissions of hydrofluorocarbons (HFCs) included in the inventory amounted to 526.11 kt CO_2 eq., or 2.7% of total GHG emissions, which is 14.2% higher than in 2020. No HFC emissions were reported in the base year 1990.

Total GHG emissions from all sources and for all gases in 2023 amounted to 19,374.16 kt CO_2 eq., which is 15.1% higher than in 2020, but 30.5% lower than in 1990. Removals by GHG sinks amounted to 10,308.89 kt CO_2, representing a 0.1% increase compared to 2020 and a 6.9% increase compared to 1990. Net GHG emissions totaled 9,065.27 kt CO_2 eq., which is 38.6% higher than in 2020 but 50.3% lower than the 1990 net GHG emissions level.

ES.3. Overview of Emission Estimates and Trends by Source and Sink Categories

The largest share of GHG emissions was from the Energy sector, totaling 10,651.90 kt CO_2 eq., or 55% of Kyrgyzstan's total GHG emissions in 2023. This is 48.8% lower than the 1990 level.

Within the Energy sector, the largest share of emissions was from the Transport category – 3,601.42 kt CO_2 eq., or 33.8% of sectoral emissions. Emissions from the Energy Industries category amounted to 3,318.00 kt CO_2 eq., or 31.1% of sectoral emissions. Emissions from the Other Sectors category (boiler houses and residential sector) were 2,558.55 kt CO_2 eq., or 24% of sectoral emissions. Fugitive emissions from fuels accounted for 644.28 kt CO_2 eq., or 6% of sectoral emissions. Emissions from the Manufacturing Industries and Construction category amounted to 531.15 kt CO_2 eq., or 5% of sectoral emissions.

The second largest source of GHG emissions after the Energy sector in 2023 was Agriculture, with emissions amounting to 5,754.41 kt CO_2 eq., or 29.7% of Kyrgyzstan's total emissions. This is 3.8% higher than in 2020 and 0.1% higher than in 1990. The largest share of emissions in agriculture came from the category Enteric fermentation, totaling 3,783.69 kt CO_2 eq., or 65.8% of sectoral emissions, which is 13% higher than in 1990. Another significant category was Direct N_2O emissions from managed soils, which amounted to 876.29 kt CO_2 eq., or 15.2% of the sector's emissions, representing a 47.5% decrease compared to 1990. Manure management emissions totaled 505.15 kt CO_2 eq., or 8.8% of sectoral emissions, which is 85.7% higher than in 1990. Indirect N_2O emissions from managed soils were 311.42 kt CO_2 eq., or 5.4% of sectoral emissions, 16.2% lower than in 1990. Indirect N_2O emissions from manure management amounted to 192.32 kt CO_2 eq., or 3.3% of sectoral emissions, 144.3% higher than in 1990. Rice cultivation accounted for 70.62 kt CO_2 eq., or 1.2% of sectoral emissions, while emissions from urea application were 14.92 kt CO_2 eq., or 0.3% of sectoral emissions.

The third largest source of GHG emissions was Industrial Processes and Product Use (IPPU), with emissions in 2023 amounting to 2,008.04 kt CO_2 eq., or 10.4% of Kyrgyzstan's total emissions. This is 31.5% higher than in 2020 and 130.4% higher than in 1990. The largest share of emissions in the IPPU sector came from Cement production, which in 2023 amounted to 1,396.18 kt CO_2 eq., or 69.5% of the sector's emissions. This represents a 37.4% increase compared to 2020 and a 136% increase compared to 1990. Refrigeration and air conditioning contributed 491.26 kt CO_2 eq., or 24.5% of the sector's emissions, which is 32.4% higher than in 2020 and 136 times higher than in the first inventory year for this category (1995). Foam blowing agents accounted for 34.85 kt CO_2 eq., or 1.7% of sectoral emissions, 8.3% higher than in 2020. GHG emissions from mineral product production also increased during this period: emissions from Ceramics (brick production) amounted to 29.49 kt CO_2 eq., or 1.5% of the sector's emissions, 151.4% higher than in 2020 but 79.6% lower than in 1990. Emissions from Lime production totaled 20.26 kt CO_2 eq., or 1% of sectoral emissions, which is 348.3% higher than in 2020 but 69.1% lower than in 1990. Emissions from Glass production were 20.12 kt CO_2 eq., or 1% of sectoral emissions, 10.4% lower than in 2020 and 71% lower than in 1990. Lubricant use emissions amounted to 15.63 kt CO_2 eq., or 0.8% of the sector's emissions, 37% higher than in 2020. Emissions from Pig iron and steel production were 0.19 kt CO_2 eq., or 0.01% of the sector's emissions, and emissions from Paraffin use were 0.06 kt CO_2 eq., or 0.003% of sectoral emissions.

The fourth largest source of GHG emissions in 2023 was the Waste sector, with emissions totaling 959.80 kt CO_2 eq., or 5% of Kyrgyzstan's total emissions, representing a 97.5% increase compared to 1990. The largest category within this sector was Wastewater treatment and discharge, with 562.92 kt CO_2 eq., or 58.6% of sectoral emissions, 33% higher than in 2020 and 96.5% higher than in 1990. Solid waste disposal emissions amounted to 381.91 kt CO_2 eq., or 39.8% of sectoral emissions, which is 12.8% higher than in 2020 and 109.8% higher than in 1990. Incineration and open burning of waste accounted for 13.21 kt CO_2 eq., or 1.4% of sectoral emissions, 15.8% lower than in 2020 and 14.4% lower than in 1990. Biological treatment of solid waste contributed 1.76 kt CO_2 eq., or 0.2% of sectoral emissions, 15.2% higher than in 2020 but 18.8% lower than in 1990.

The Land Use, Land-Use Change and Forestry (LULUCF) sector acted as a CO_2 sink, with removals in 2023 amounting to 10,208.89 kt CO_2, which is 0.1% higher than in 2020 and 6.9% higher than in 1990. Removals occurred across three categories: Forest land – 8,213.66 kt CO_2, or 79.7% of all removals, 0.1% higher than in 2020 and 5.5% higher than in 1990; Cropland – 1,767.18 kt CO_2, or 17.1% of sectoral removals, 14.5% higher than in 2020 and 35.3% higher than in 1990; Grassland – 328.37 kt CO_2, or 3.2% of sectoral removals, 39.5% lower than in 2020 and 40.2% lower than in 1990.

GHG emissions from the LULUCF sector under the category Biomass burning on forest land in 2023 were caused by natural wildfires affecting 79.3 ha, amounting to 0.315 kt CO_2 eq.

ES.4. Other Information

The NID of Kyrgyzstan also presents emissions of precursor gases:

- Nitrogen oxides (NOx)
- Carbon monoxide (CO)
- Non-methane volatile organic compounds (NMVOC)
- Sulphur dioxide (SO_2)

In 2023, nitrogen oxide (NOx) emissions amounted to 11.19 kt, or 5% of total precursor GHG emissions, which is 77.6% lower than in 1990. Carbon monoxide (CO) emissions were 139.90 kt, or 57% of total precursor GHG emissions, 61.2% lower than in 1990. Emissions of non-methane volatile organic compounds (NMVOC) in 2023 totaled 35.84 kt, or 14% of total precursor GHG emissions, 41.2% lower than in 1990. Sulphur dioxide (SO_2) emissions amounted to 59.81 kt, or 24% of total precursor GHG emissions, 41% lower than in 1990.

1. National Circumstances, Institutional Arrangements and Cross-Cutting Information

1.1. Background Information on GHG Inventories and Climate Change

1.1.1. Background Information on Climate Change

The information provided below summarizes the results of the analysis of historical climate change dynamics and future climate projections in the territory of Kyrgyzstan, available at the time of preparation of BTR1. More detailed methodology of the new analysis and projections, new data and detailed results, as well as a description of the climate risk and vulnerability assessment, national adaptation planning and adaptation measures will be presented in the Adaptation Communication, which will be included as a separate chapter in the Fifth National Communication of Kyrgyzstan to the UNFCCC.

1.1.1.1. Analysis of Historical Climate Change and Its Impacts

The territory of Kyrgyzstan is characterized by complex high-mountain relief, with deeply dissected terrain, varying orientation of mountain slopes to the sun and air flows, which creates exceptional diversity of climatic conditions and determines a pronounced vertical climatic zonation. The country's climate is sharply continental and predominantly arid. Four altitudinal climatic zones are distinguished: valley-foothill (up to 1200 m), mid-mountain (1200–2200 m), high-mountain (2200–3500 m), and nival (above 3500 m above sea level). Geographically, the country is divided into four climatic regions: the northern and northwestern region, the Issyk-Kul basin, the Inner Tien Shan, and the southwestern region.

In the Kyrgyz Republic, rising temperatures are leading to more frequent and intense extreme events, such as droughts, unpredictable seasonal weather, and an increasing number of natural disasters, including floods, landslides, mudflows, and avalanches. These consequences result in loss of human lives and livelihoods and negatively affect key economic sectors of the country, including agriculture and energy, leading to economic losses and persistent poverty. Climate change poses a serious challenge to achieving the Sustainable Development Goals, and therefore urgent action is needed on climate change through reducing greenhouse gas emissions and adapting to its impacts.[5]

The analysis of air temperature change across Kyrgyzstan indicates a statistically significant increase. The average annual air temperature for the period 1901–2021 has been rising at a rate of 0.13°C per decade. It should be noted that over the last 46 years (1976–2021), the rate of increase has nearly doubled, reaching 0.22°C per decade (both trends are statistically significant at the 95% confidence level). When assessing changes in the average annual temperature by thirty-year climatic periods (norms), an upward trend is observed starting from the period 1931–1960, with an increase of 0.6°C every 30 years.

Within seasons, temperatures in Kyrgyzstan are rising fastest in spring. During the assessment period 1976–2019, the spring temperature increased by 0.47°C per decade. In winter, the air temperature

[5] Ilyasov Sh., Zabenko O., Gaidamak N., Kirilenko A., Myrsaliyev N., Shevchenko V., Penkina L. Climate Profile of the Kyrgyz Republic. – Bishkek, 2013. – 99 pp. UNDP: https://www.undp.org/ru/kyrgyzstan/publications/klimaticheskiy-profil-kyrgyzskoy-respubliki

increased somewhat more slowly – by 0.25°C per decade, while the slowest growth rates were observed in summer and autumn – 0.096°C and 0.08°C per decade, respectively. Temperature trends for the annual average and for spring are statistically significant at the 95% confidence interval, with the trend contributing 26% to the total variance of mean annual temperatures, 27% for spring, and from 1% to 5% for the other seasons.[6]

The precipitation regime in Kyrgyzstan is characterized by extreme irregularity: spatial, seasonal, and interannual. Overall, for the period 1901–2021, a weak upward trend in precipitation is observed in Kyrgyzstan (statistically insignificant). Since the beginning of the last century through 2021, the rate of increase in precipitation has been about 5 mm per decade. Since 1976, precipitation has increased at a rate of 2 mm per decade. It is important to note that since the 1970s, interannual variability has intensified. Between 2016 and 2021, precipitation levels in Kyrgyzstan were below normal.

When assessing changes in the average amount of precipitation for 30-year climatic periods (norms), no significant changes are observed between successive periods. In general, the current average precipitation in Kyrgyzstan is 51 mm higher compared to the beginning of the last century.

An analysis of seasonal precipitation changes shows that the most significant changes occur in summer and winter. During the period 1976–2019, precipitation increased by 5.3% per decade in summer and by 3.7% per decade in winter. In spring and autumn, no significant trends are observed. All seasonal trends are statistically insignificant. Since 2010, with the exception of 2014 and 2015, precipitation in Kyrgyzstan has been below normal, ranging from 2% to 13% lower than the norm.%.[7]

1.1.1.2. Projections of Future Climate Change and Its Impacts

Under the intermediate scenario SSP2-4.5, which assumes continued current levels of GHG emissions, the temperature in Kyrgyzstan is projected to increase by 1.1°C above the baseline (average for 1995–2014) by 2030, by 1.8°C by 2050, by 2.5°C by 2070, and by 2.9°C by the end of the century. Under the high-emission scenario, the mean annual temperature will rise at a more intensive rate: by 1.2°C over the next 20 years, by 2.5°C by 2050, by 4.1°C by 2070, and by 5.8°C by 2090. Under both scenarios, the greatest increases are expected in summer and autumn. In spring, according to projections, the increase will be smaller, which contradicts current observed trends (at present, temperatures in spring are rising faster than in other seasons).[8]

According to precipitation projections based on the intermediate scenario SSP2-4.5, annual precipitation in Kyrgyzstan is expected to increase slightly – by 3% compared to the baseline period 1995–2014 – in the next 20 years. In 2040–2059, precipitation is expected to rise by 4% compared to the current period, in 2060–2079 by 6%, and by 8% by the end of the century. Under the “fossil-fueled development” scenario, precipitation is projected to remain at the current level for the next 20 years, then increase by 6% by 2050, by 8% by 2070, and by 11% by the end of the century.[9]

It should be noted that precipitation projections have a higher degree of uncertainty and model variability than temperature projections. The positive projected values of precipitation indicate that the majority of models project an increase. Overall, it is expected that precipitation in Kyrgyzstan will retain its variability from year to year.

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[6] MNRETS. 2024. *Fourth National Communication of the Kyrgyz Republic to the UNFCCC*.
[7] Ibid.
[8] Ibid.
[9]. MNRETS. 2024. *Fourth National Communication of the Kyrgyz Republic to the UNFCCC*.

1.1.1.3. Sectoral Impacts of Climate Change on the Economy

As a result of the climate risk and vulnerability assessment conducted during the preparation of Kyrgyzstan's 2021 NDC, the following impacts were identified for the most vulnerable sectors of the country:

Water resources sector:

- Changes in river basin water availability;
- Reduction in water supply for the population and the economy;
- Deterioration of surface and groundwater quality.

Agriculture sector:

- Degradation of soil biochemical regulation processes;
- Changes in the productive potential of pastures and the resilience of livestock to meteorological fluctuations;
- Increased vulnerability of food self-sufficiency.

Energy sector:

- Changes in the gross hydropower potential of rivers;
- Increased critical load on energy infrastructure due to temperature fluctuations;
- Increased vulnerability of energy facilities and infrastructure to hydrological emergencies.

Health sector:

- Increased morbidity and mortality from non-communicable diseases;
- Increased morbidity and mortality from infectious, vector-borne, and parasitic diseases;
- Damage or destruction of healthcare infrastructure due to climatic events.

Disaster risk management sector:

- Increased vulnerability of infrastructure and population and higher levels of damage from hydrometeorological emergencies;
- Increased vulnerability of infrastructure and population to emergencies caused by climate-related natural disasters.

Forestry and biodiversity sector:

- Ecosystem degradation and biodiversity loss;
- Shifts in habitats and ranges of animal and plant species;
- Increased risk of forest fires and outbreaks of mass pest infestations.

Settlements and territories:

- Expansion of urban heat islands;
- Decline in air quality;
- Increased overall vulnerability of territories.[10]

[10] MNRETS. Updated Nationally Determined Contribution of the Kyrgyz Republic to the Paris Agreement. 2021.

1.1.2. Background Information on GHG Inventories

1.1.2.1 International Commitments

The Kyrgyz Republic acceded to the United Nations Framework Convention on Climate Change (UNFCCC) in 2000 and ratified the Kyoto Protocol in 2003. In 2016, Kyrgyzstan signed the Paris Agreement and ratified it in 2019.

As a Party to the UNFCCC, the Kyrgyz Republic directs all of its climate actions toward achieving the ultimate objective of the Convention, which is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

According to Article 4, paragraph 1(a) on Party commitments, and Article 12, paragraph 1(a) on the provision of information relating to the implementation of the Convention, it is required that each Party shall regularly submit national communications to the Conference of the Parties (COP).

The primary mechanism for reporting on a country's activities under the UNFCCC is the National Communication (NC). The guidelines for preparing national communications from non-Annex I Parties were adopted at COP-2 in Geneva in 1996 (Decision 10/CP.2). COP-8 (Delhi, 2002) adopted new guidelines for the national communications of non-Annex I Parties (Decision 17/CP.8).

In accordance with these UNFCCC guidelines, and within the framework of the United Nations Development Programme (UNDP) project "Assistance to Kyrgyzstan in Preparing its First National Communication in Response to Commitments under the UNFCCC", with financial support from the Global Environment Facility (GEF), the Kyrgyz Republic prepared its First National Communication in 2003, including the national GHG inventory of emissions and removals for the period 1990–2000, which resulted from the first cycle of the National Greenhouse Gas Inventory (NGHGI). This document was approved by Government Resolution of the Kyrgyz Republic No. 200 of 10 April 2003.

The Second National Communication of the Kyrgyz Republic to the UNFCCC, including the national GHG inventory for the period 2000–2005, prepared as part of the second NGHGI cycle, was also developed under a UNDP project with GEF financial support in 2009 and approved by Government Resolution of the Kyrgyz Republic No. 274 of 6 May 2009. The Third National Communication, including the GHG inventory for the period 2005–2010, was prepared in 2016 with the support of a GEF and United Nations Environment Programme (UNEP) project. This document was approved by Government Resolution of the Kyrgyz Republic No. 546 of 13 October 2016.

The First Biennial Update Report (BUR1) of the Kyrgyz Republic, prepared in accordance with the "UNFCCC Reporting Guidelines on Biennial Update Reports for Non-Annex I Parties" (Annex III to Decision 2/CP.17), adopted at COP-17 (Durban, 2011), including a standalone National Inventory Report of GHG emissions and removals for the period 2011–2018 with recalculated emissions and removals for the period 1990–2018 due to the transition to the 2006 IPCC Guidelines, was submitted to the UNFCCC Secretariat in 2022.

Finally, the Fourth National Communication (NC 4) of the Kyrgyz Republic to the UNFCCC, taken into consideration by the Coordination Council on Climate Change, Ecology and Green Economy under the chairmanship of the Prime Minister, was submitted to the UNFCCC in 2024. This document supplemented the country's climate reporting with GHG emissions and removals inventory data for the period 2018–2020. Additionally, along with the NC 4, the National Inventory Report on emissions by sources and removals by sinks for the period 1990–2020 was submitted to the Convention Secretariat, completing the fourth cycle of Kyrgyzstan's NGHGI.

The present First Biennial Transparency Report (BTR1) includes data obtained from the launch of the fifth NGHGI cycle in the Kyrgyz Republic for the period 2020–2023, as well as recalculations of emissions and removals for the period 1990–2023 using Global Warming Potential (GWP) values from the IPCC Fifth Assessment Report (AR5).

BTR1 was prepared in accordance with Article 13 of the Paris Agreement and the decisions adopted at the first session of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA) (Decision 18/CMA.1 and Decision 5/CMA.3). The report was prepared in line with the Modalities, Procedures and Guidelines (MPGs) for the enhanced transparency framework for action and support referred to in Article 13 of the Paris Agreement, as set out in the Annex to the above-mentioned Decision 18/CMA.1.[11] As well as in accordance with the Guidelines for the operationalization of the modalities, procedures and guidelines for the enhanced transparency framework referred to in Article 13 of the Paris Agreement (Decision 5/CMA.3).[12]

In accordance with Decisions 18/CMA.1 and 5/CMA.3, the estimates of greenhouse gas emissions and removals in this NID were conducted based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

[11] UNFCCC website: https://unfccc.int/resource/tet/bg/bg1-01_decision_18_CMA.1.pdf
[12] UNFCCC website: https://unfccc.int/sites/default/files/resource/CMA2021_L10a2E.pdf

1.2. Description of National Mechanisms for the National Greenhouse Gas Inventory

1.2.1. Institutional, Legal, and Procedural Mechanisms

The National Inventory of greenhouse gas (GHG) emissions and removals provides the informational foundation for decision-making in the planning and monitoring of Kyrgyzstan's climate policy. However, due to national circumstances and insufficient technical capacity, Kyrgyzstan does not have a permanent national institution specifically responsible for GHG inventory compilation and continuous accounting of emissions and removals. Instead, a project-based approach is applied to the process of developing the national inventory. An expert team for preparing the inventory is recruited for each new cycle. Each new round of the national inventory is carried out with financial support from the UNFCCC financial mechanism, represented by the Global Environment Facility, provided for the preparation of national climate reporting.

The Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic (MNRETS) is the authorized state executive body responsible for developing and implementing state policy and coordination in the fields of environmental protection, ecology, and climate.[13] The functions of MNRETS include coordinating actions to implement the UNFCCC and the Paris Agreement, mobilizing financing from the Green Climate Fund and other funds and organizations, developing the national climate change strategy, and preparing national communications and climate change reports.[14]

Thus, MNRETS serves as the focal point and ensures the implementation of the commitments of the Kyrgyz Republic under the UNFCCC, including the preparation and submission of national climate reporting on the national GHG emissions and removals inventory.

To guide and coordinate the activities of state executive bodies, local self-government bodies, and other stakeholders, and to develop a coherent state policy in the field of climate change and the "green" economy, Kyrgyzstan established the Coordination Council on Climate Change, Ecology and Sustainable Development (Coordination Council).[15] The Coordination Council is an advisory and consultative body coordinated by the Cabinet of Ministers of the Kyrgyz Republic, which develops and provides recommendations and proposals to state bodies on climate change, ecology, and the development of the "green" economy. The main purpose of the Coordination Council is to discuss and adopt coordinated decisions for the development and effective implementation of policies on climate change, ecology, and the "green" economy by state executive bodies, local self-government bodies, as well as non-governmental and international organizations.[16] Country reporting documents, including National Inventory Reports of GHG emissions and removals, are discussed and agreed upon at the meetings of the Coordination Council.

After receiving GEF funding, the implementing organization recruits experts on NGHGI across all necessary sectors. These experts study the IPCC methodological guidelines and prepare draft request letters for information and data on activities addressed to all relevant ministries and agencies,

[13] Regulation on the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic, approved by Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 263 of 15 November 2021.

[14] Regulation on the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic, approved by Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 263 of 15 November 2021.Tier 4.

[15] Resolution of the Government of the Kyrgyz Republic No. 46 of 30 January 2020.

[16] Ibid. Chapter 1.

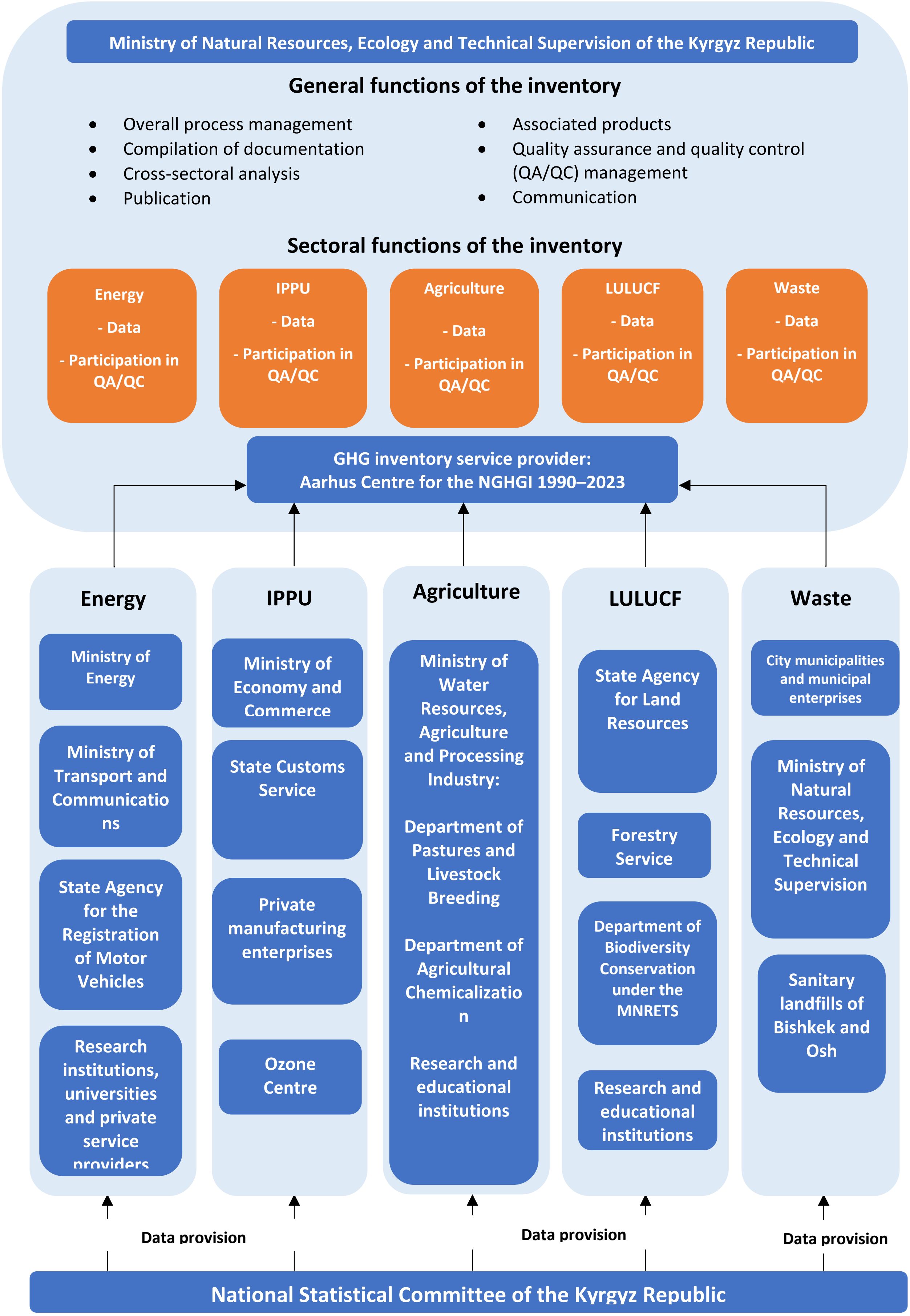
administrative bodies, scientific and educational institutions. These letters are distributed by the focal point to the addressees. All information received is collected by the implementing organization and used by the NGHGI expert group.

To ensure the involvement of all stakeholders in the NGHGI process and to guarantee the quality of inventory results obtained at each stage of the work process, MNRETS initiates the establishment of an Interagency Working Group (IWG) consisting of specialists from line ministries and agencies to hold validation meetings for the outputs produced. The NGHGI experts work in close collaboration with members of the IWG for their respective sectors.

The main distinction of the current NGHGI round is that in the previous, fourth NGHGI cycle, the project was funded by the GEF and implemented by the United Nations Environment Programme (UNEP), while the implementing organization was the national institution – the Department of State Regulation in the Field of Environmental Protection and Ecological Safety, a subordinate body of the State Agency for Environmental Protection and Forestry under the Government of the Kyrgyz Republic, which at that time served as the UNFCCC focal point. Within the Department, a Project Implementation Unit (PIU) was established, which organized the creation of the National Project Steering Committee and the IWG. The role of the PIU was to ensure the full scope of operational activities.

The current NGHGI is being conducted with GEF funding under a project implemented by the UNDP, which independently hires the project implementers. For the NGHGI and preparation of BTR1, UNDP engaged the Aarhus Centre in Bishkek, which, in close cooperation with MNRETS and with the support of information-providing institutions and organizations, is carrying out the NGHGI process in 2025.

The organizational scheme of the current NGHGI cycle for the preparation of the National Inventory Report is presented in Figure 1.1.



Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic
General functions of the inventory
Overall process management
Compilation of documentation
Cross-sectoral analysis
Publication
Associated products
Quality assurance and quality control (QA/QC) management
Communication
Sectoral functions of the inventory
Energy - Data - Participation in QA/QC
IPPU - Data - Participation in QA/QC
Agriculture - Data - Participation in QA/QC
LULUCF - Data - Participation in QA/QC
Waste - Data - Participation in QA/QC
GHG inventory service provider:
Aarhus Centre for the NGHGI 1990–2023
Energy
Ministry of Energy
Ministry of Transport and Communications
State Agency for the Registration of Motor Vehicles
Research institutions, universities and private service providers
IPPU
Ministry of Economy and Commerce
State Customs Service
Private manufacturing enterprises
Ozone Centre
Agriculture
Ministry of Water Resources, Agriculture and Processing Industry:
Department of Pastures and Livestock Breeding
Department of Agricultural Chemicalization
Research and educational institutions
LULUCF
State Agency for Land Resources
Forestry Service
Department of Biodiversity Conservation under the MNRETS
Research and educational institutions
Waste
City municipalities and municipal enterprises
Ministry of Natural Resources, Ecology and Technical Supervision
Sanitary landfills of Bishkek and Osh
Data provision
Data provision
Data provision
National Statistical Committee of the Kyrgyz Republic

Figure 1.1. Institutional Arrangements for the National Greenhouse Gas Inventory for the Period 1990–2023

The legal basis for conducting national greenhouse gas inventories in Kyrgyzstan is provided by the Law of the Kyrgyz Republic "On State Regulation and Policy in the Field of Greenhouse Gas Emissions and Removals", which defines the necessity of maintaining the state GHG emissions inventory and designates the responsible body coordinating the inventory process.[17]

In addition, climate action issues are reflected in a number of development policy documents of the Kyrgyz Republic, among which the following are notable:

- National Development Strategy of the Kyrgyz Republic for 2018–2040.[18]
- National Development Program of the Kyrgyz Republic until 2026.[19]
- Decree of the President of the Kyrgyz Republic "On Measures to Ensure Environmental Security and Climate Resilience of the Kyrgyz Republic".[20]

1.2.2. Overview of Planning, Preparation, and Management of the Inventory

Planning for the NGHGI of Kyrgyzstan for the period 1990–2023 was carried out under the leadership of MNRETS and in close cooperation with UNDP, resulting in the development of a plan and schedule for the NGHGI and the preparation of BTR1 as a whole.

Preparation for the NGHGI began with a self-assessment workshop on the implementation of the previous NGHGI (1990–2018) and the National Inventory Report for 1990–2020. The self-assessment was conducted by Kyrgyz GHG inventory experts based on the comments and recommendations received from UNFCCC experts. The purpose of this event was to analyze the consistency of the previous NGHGI with the 2006 IPCC Guidelines and the MPGs in line with the Paris Agreement. Summarizing the results of the assessment, lessons learned were formulated, and recommendations for improvements for the upcoming NGHGI were prepared—both of a general nature and for each inventory sector.

In preparation for the workshop, a detailed review was conducted of the comments from the first Technical Analysis carried out by UNFCCC experts on Kyrgyzstan's BUR1 and NGHGI for the period 1990–2018, according to the report of the UNFCCC international expert team (2023).[21] All sectoral comments were analyzed, and actions were outlined for the implementation of the recommendations.

Management of the current NGHGI is divided between the Aarhus Centre (AC) and UNDP. The Aarhus Centre provides technical expertise, collection, systematization, and normalization of data, execution of national inventory calculations, and preparation of the National Inventory Report, as well as all related information and documentation. In addition, the Aarhus Centre carried out the stakeholder consultation process for ensuring quality and preliminary validation of NGHGI results.

Furthermore, NGHGI experts of the Aarhus Centre, with the support of an international UNDP consultant, carried out quality assurance and quality control (QA/QC) procedures. Additionally,

[17] No. 71 of May 25, 2007
[18] Decree of the President of the Kyrgyz Republic No. 221 of 31 October 2018.
[19] Decree of the President of the Kyrgyz Republic UP No. 435 of 12 October 2021
[20] No. 77 of March 19, 2021
[21] https://unfccc.int/sites/default/files/resource/tasr1_2023_KGZ.pdf

NGHGI experts from the Aarhus Centre assisted MNRETS staff in uploading the NGHGI Common Reporting Tables to the online platform of the UNFCCC Enhanced Transparency Framework.

UNDP ensured capacity building for NGHGI experts and supported QA/QC procedures by engaging international experts and organizing validation events for the final documents prepared by the Aarhus Centre experts.

1.2.3. Quality Assurance, Quality Control, and Verification Plan

The Quality Assurance and Quality Control (QA/QC) Plan is a fundamental element of the national QA/QC system being established. This plan describes the QA/QC activities carried out, the personnel responsible for these activities, the schedule of their implementation, and a list of future planned improvements to the QA/QC system.

The QA/QC Plan of Kyrgyzstan is reviewed and updated within each cycle of GHG inventory preparation. A key point is ensuring the efficiency and effectiveness of the QA/QC system, which supports and guides the improvement of the inventory.

The QA/QC Plan includes the following elements:

- Personnel responsible for coordinating QA/QC activities;
- General quality control procedures;
- Category-specific QC procedures;
- QA review procedures;
- Reporting, documentation, and archiving procedures;
- A prioritized list of QA/QC improvements, which is regularly reviewed and enhanced over time.

Category-specific QC procedures complement the general QC procedures for sectoral inventories. Category-specific QC is designed for particular types of data used in methods for individual source or sink categories. These procedures require knowledge of the specific category, the types of available data, and the parameters related to emissions or removals, and are carried out in addition to the general QC checks.

This plan was developed jointly with all experts and stakeholders involved in the process and was communicated to each sectoral responsible expert.

The person responsible for QA/QC and the coordinator of the process is the Head of the Technical Expert Group (TEG), who is responsible for the development, maintenance, and implementation of the QA/QC Plan and possesses sufficient knowledge of all GHG inventory sectors to ensure that other responsible experts understand the importance of quality assurance in each sector. Sectoral experts of the NGHGI serve as those responsible for QA/QC of the sectoral GHG inventories.

Quality assurance was carried out by the Interagency Working Group on the preparation of the NGHGI and BTR1 through regular sessions for the discussion and validation of the outputs of experts at each stage of the NGHGI.

Quality assurance and quality control were implemented at every stage of the inventory process (see Figure 1.2 below).

1.2.4. Changes in the Mechanisms of the National Inventory Compilation Since the Submission of the Previous Annual GHG Inventory

The main change in the mechanisms of the NGHGI was the full involvement of the focal point in the process of preparing the national inventory of emissions by sources and removals by sinks, the engagement of a national service provider for conducting the GHG inventory, as well as the involvement of international expertise to ensure the quality of the NGHGI for 1990–2023.

1.3. Inventory Process: Data Collection, Processing, and Storage

The process of conducting the national GHG inventory for 1990–2023 was carried out in stages, including the following:

1. Analysis and planning of the NGHGI. At this stage, all tasks were identified in accordance with the GEF–UNEP–UNDP project implementation plan, terms of reference for the expert team were prepared, and the work plan and schedule were developed by the NGHGI group, along with the QA/QC plan.
2. Launch of activities and stakeholder engagement. At this stage, contracts with experts were signed. The experts analyzed the recommendations of the international review of the previous NGHGI and conducted an inception workshop to present the analysis results and the new NGHGI work plan. An Interagency Working Group (IWG) on NGHGI was established. This was the first quality assurance activity for the NGHGI.
3. Data collection, methodological selection, preliminary calculations, QA/QC. Data collection was conducted through official data and information requests prepared by the Aarhus Centre and distributed by MNRETS. The collected data were processed, gaps were filled, and long time series were developed. The methodology (tier level and emission factors) was selected. At this stage, national consultations on data, methodology, and emission factors for each target sector were organized and held. In addition, the new version of IPCC software (v. 2.97) was installed and calculations were initiated.
4. Drafting chapters, finalizing GHG emission calculations, QA/QC. Draft chapters of BTR1 and the National Inventory Document (NID) were prepared and discussed during QA sessions at IWG validation meetings with the participation of all stakeholders.
5. Preparation of cross-sectoral chapters and CRTs, compilation of the NIR, QA/QC, uploading CRTs into the ETF online tool, preparation of the Improvement Plan, and publication. At this stage, all cross-sectoral chapters and Common Reporting Tables (CRTs) for the NGHGI for 1990–2023 were prepared and uploaded to the UNFCCC Enhanced Transparency Framework online tool. All chapters were presented at a validation workshop of the IWG and to all stakeholders for QA. In addition, the NGHGI team developed an Inventory Improvement Plan, and the National Inventory Report (NIR) was published.
6. Submission to the UNFCCC, Technical Expert Analysis (TEA), and Facilitative Multilateral Consideration of Progress (FMCP). At this stage, the NIR and the finalized CRTs were submitted to the UNFCCC for the Technical Expert Analysis and the FMCP procedure.

The step-by-step process of conducting the fifth round of Kyrgyzstan's NGHGI is presented in Figure 1.2.

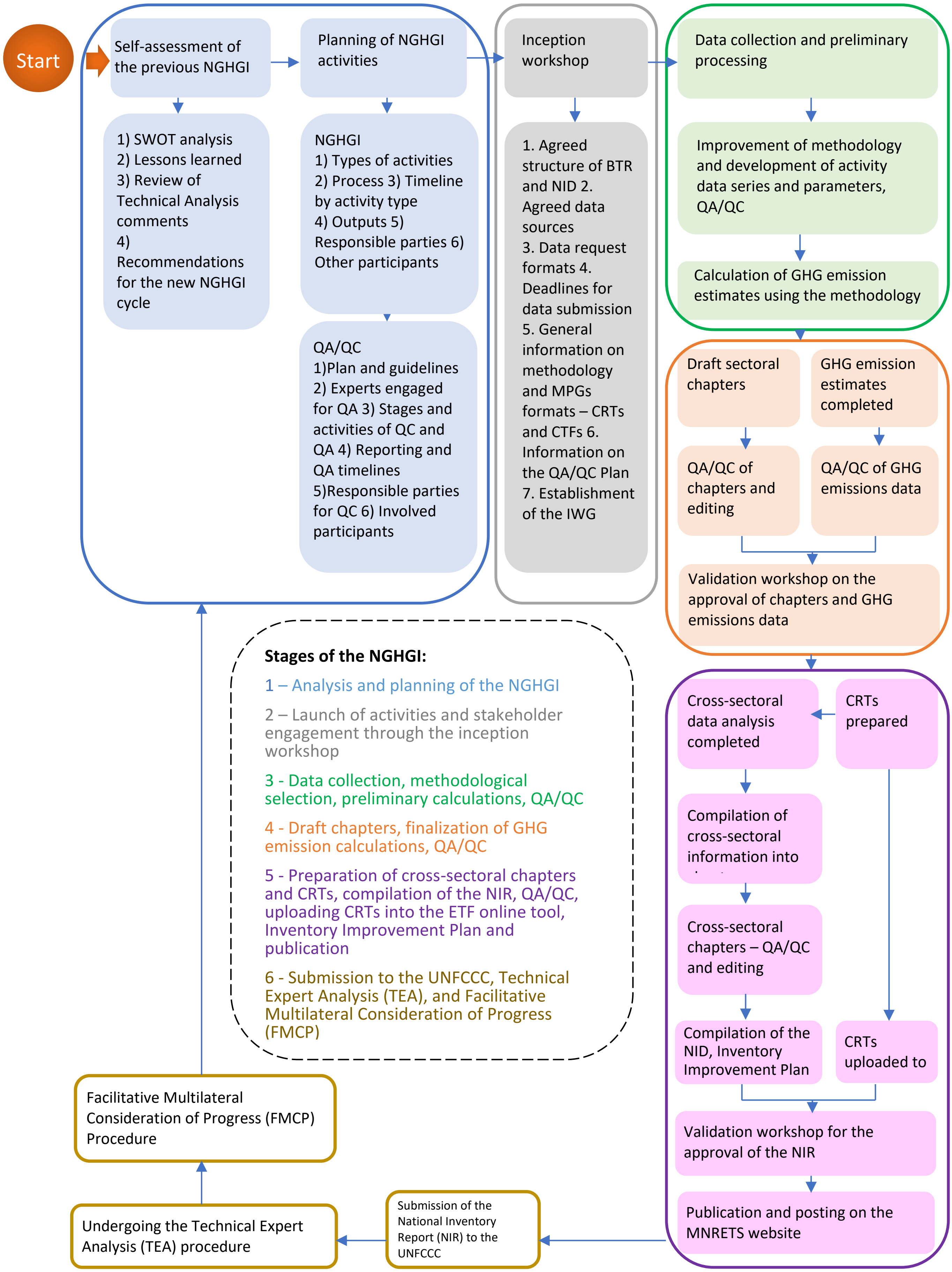

Start
Self-assessment of the previous NGHGI
Planning of NGHGI activities
Inception workshop
Data collection and preliminary processing
1) SWOT analysis
2) Lessons learned
3) Review of Technical Analysis comments
4) Recommendations for the new NGHGI cycle
NGHGI
1) Types of activities
2) Process 3) Timeline by activity type
4) Outputs 5) Responsible parties 6) Other participants
QA/QC
1)Plan and guidelines
2) Experts engaged for QA 3) Stages and activities of QC and QA 4) Reporting and QA timelines
5)Responsible parties for QC 6) Involved participants
1. Agreed structure of BTR and NID 2. Agreed data sources
3. Data request formats 4. Deadlines for data submission
5. General information on methodology and MPGs formats – CRTs and CTFs 6. Information on the QA/QC Plan
7. Establishment of the IWG
Improvement of methodology and development of activity data series and parameters, QA/QC
Calculation of GHG emission estimates using the methodology
Draft sectoral chapters
GHG emission estimates completed
QA/QC of chapters and editing
QA/QC of GHG emissions data
Validation workshop on the approval of chapters and GHG emissions data
Cross-sectoral data analysis completed
CRTs prepared
Compilation of cross-sectoral information into
Cross-sectoral chapters – QA/QC and editing
Compilation of the NID, Inventory Improvement Plan
CRTs uploaded to
Validation workshop for the approval of the NIR
Publication and posting on the MNRETS website
Stages of the NGHGI:
1 – Analysis and planning of the NGHGI
2 – Launch of activities and stakeholder engagement through the inception workshop
3 - Data collection, methodological selection, preliminary calculations, QA/QC
4 - Draft chapters, finalization of GHG emission calculations, QA/QC
5 - Preparation of cross-sectoral chapters and CRTs, compilation of the NIR, QA/QC, uploading CRTs into the ETF online tool, Inventory Improvement Plan and publication
6 - Submission to the UNFCCC, Technical Expert Analysis (TEA), and Facilitative Multilateral Consideration of Progress (FMCP)
Facilitative Multilateral Consideration of Progress (FMCP) Procedure
Undergoing the Technical Expert Analysis (TEA) procedure
Submission of the National Inventory Report (NIR) to the UNFCCC

Figure 1.2. Stages and key actions of the NGHGI process for the period 1990–2023

1.4. Brief General Description of Methodologies (Including Applied Tiers) and Data Sources Used

The greenhouse gas (GHG) inventory in this BTR1 covers the year 2023 with a time series for 2021–2022 and the base year 1990. The NGHGI was conducted and the National Inventory was prepared on the basis of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and using the IPCC software version 2.97, including key category analysis, uncertainty assessment, and trend identification.

One of the main challenges in preparing the GHG inventory for BTR1 was the transfer of data from IPCC software version 2.54 to the new version 2.95/6/7, which led to significant data losses and increased processing time. Due to time constraints, the full time series for 1990–2023 was not fully transferred, with gaps remaining for the waste sector and specifically for LULUCF.

In addition to the 2006 IPCC Guidelines, other methodological sources were also used in the NGHGI process:

1. 2013 IPCC Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands
2. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
3. 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (LULUCF)
4. 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.[22]

This list was compiled in accordance with the Modalities, Procedures and Guidelines (MPGs) for the Enhanced Transparency Framework, as defined in UNFCCC Decisions 18/CMA.1 and 5/CMA.3. The following sectors were covered:

1. Energy (including transport)
2. Industrial Processes and Product Use (IPPU)
3. Agriculture
4. Land Use, Land-Use Change and Forestry (LULUCF)
5. Waste (including wastewater)

Tier 1 methods were applied for GHG emission estimates across all sectors, using standard emission factors, with activity data obtained from national sources, international organizations, and other literature identified within each sector. Where data were missing, indirect data, bridging methods, interpolation, extrapolation, and expert judgment-based estimates were applied.

Tier 2 methodologies were used for the categories “Cement Production” and “Glass Production” in the IPPU sector, and for the category “Grassland remaining Grassland” in the LULUCF sector.

The main source of activity data for the present NGHGI is the database of the National Statistical Committee of the Kyrgyz Republic (https://stat.gov.kg/), as well as information obtained from all relevant ministries and agencies, research and educational institutions, and private companies and enterprises (see Figure 1.1 above).

[22] IPCC website: https://www.ipcc-nggip.iges.or.jp/public/index.html

In the absence of national data, international sources were used (World Bank Open Data, FAOSTAT, EUROSTAT, IEA, etc.).

The data collection process was carried out through official correspondence (over 150 letters) with information-holding organizations, which were prepared by the inventory experts and distributed by the UNFCCC focal point – the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic.

1.5. Brief Description of Key Categories

According to paragraph 25 of the MPGs, each Party determines key categories for the base year and the latest reporting year, both including and excluding the Land Use, Land-Use Change and Forestry (LULUCF) sector, using Approach 1 for both level and trend assessment, by conducting key category analysis in accordance with the 2006 IPCC Guidelines.

The assessment of key source categories was carried out by levels of GHG emissions/removals using the Tier 1 basic approach in accordance with the 2006 IPCC Guidelines.

By IPCC definition, a key category is a category that is prioritized within the national inventory system because its estimation has a significant influence on the overall national greenhouse gas inventory in terms of absolute level, the trend of emissions and removals, or both.

Sources considered key for the GHG inventory are those which, in sum, account for 95% under at least one criterion (level or trend), ranked in descending order of their percentage contribution to total cumulative emissions. Key source categories by level of emissions are determined for the beginning and the end of the reporting period.

The key category analysis included:

- Greenhouse gases: CO_2, CH_4, N_2O, and HFCs (PFCs and SF_6 were not included due to lack of data for estimating emissions of these gases);
- All assessed source categories excluding emissions and removals in the LULUCF sector;
- All assessed source categories including emissions and removals in the LULUCF sector.

The assessment of emission levels and emission trends was carried out for 1990 and 2023.

Key categories were ranked by their absolute contribution to total emissions/removals or to the emission trend in the national greenhouse gas inventory, using CO_2-equivalent emissions calculated with Global Warming Potential values for each gas.

Key Categories in 1990

In 1990, excluding the LULUCF sector, 20 key source categories of emissions were identified. Of these, 13 in the Energy sector, 1 in the Industrial Processes and Product Use (IPPU) sector, 4 in Agriculture, and 2 to Waste. The largest contributions to total GHG emissions in 1990 were made by the following categories:

1.A.4 Other sectors – Solid fuels. CO_2 emissions (18.1%);
3.A. Enteric fermentation. CH_4 emissions (12.0%);
1.A.1 Energy industries – Solid fuels. CO_2 emissions (10.4%);
1.A.3.b Road transport – Liquid fuels. CO_2 emissions (10.1%);
1.A.1 Energy industries – Gaseous fuels. CO_2 emissions (9.5%);
1.A.1 Energy industries – Liquid fuels. CO_2 emissions (9.3%);

3.D.1 Direct N_2O emissions from managed soils. N_2O emissions (6.0%);
1.A.3.e Other transport – Liquid fuels. CO_2 emissions (4.0%);
1.A.2. Manufacturing industries and construction. CO_2 emissions (2.9%);
2.A.1. Cement production. CO_2 emissions (2.1%).

These sources together accounted for 84.3% of total GHG emissions in 1990.

In 1990, including the LULUCF sector, 21 categories of GHG sources and sinks were identified as key categories. Among them, 12 categories belonged to the Energy sector, 1 category to the Industrial Processes and Product Use (IPPU) sector, 4 categories to Agriculture, 1 category to Waste, and 3 categories to CO_2 removals in LULUCF. The largest contributions to emissions in 1990, including LULUCF removals, came from the following categories:

4.A.1. Forest land remaining forest land. CO_2 removals (20.7%)
1.A.4 Other sectors – Solid fuels. CO_2 emissions (13.5%)
3.A. Enteric fermentation. CH_4 emissions (8.9%)
1.A.1 Energy industries – Solid fuels. CO_2 emissions (7.7%)
1.A.3.b Road transport – Liquid fuels. CO_2 emissions (7.5%)
1.A.1 Energy industries – Gaseous fuels. CO_2 emissions (7.1%)
1.A.1 Energy industries – Liquid fuels. CO_2 emissions (6.9%)
3.D.1 Direct N_2O emissions from managed soils. N_2O emissions (4.4%)
4.B.1. Cropland remaining cropland. CO_2 removals (3.5%)
1.A.3.e Other transport – Liquid fuels. CO_2 emissions (3.0%)
1.A.2 Manufacturing industries and construction – Gaseous fuels. CO_2 emissions (2.1%)

Altogether, these sources and sinks accounted for 85.3% of total GHG emissions in 1990.

Key Categories in 2023

In 2023, excluding the LULUCF sector, 26 key emission source categories were identified. Of these, 17 categories belonged to the Energy sector, 3 to the IPPU sector, 4 to Agriculture, and 2 to Waste.

The key categories by GHG emission levels excluding LULUCF were as follows:

3.A. Enteric fermentation. CH_4 emissions (19.5%)
1.A.3.b Road transport – Liquid fuels. CO_2 emissions (16.0%)
1.A.1 Energy industries – Solid fuels. CO_2 emissions (10.3%)
1.A.4 Other sectors – Solid fuels. CO_2 emissions (8.8%)
2.A.1 Cement production. CO_2 emissions (7.2%)
1.A.1 Energy industries – Liquid fuels. CO_2 emissions (5.4%)
3.D.1 Direct N_2O emissions from managed soils. N_2O emissions (5.4%)
3.B. Manure management. N_2O emissions (3,0%);
2.F.1 Refrigeration and air conditioning. HFC emissions (2.5%);
5.D. Waste water treatment and discharge. CH_4 emissions (2.5%);
5.A. Solid waste disposal. CH_4 emissions (2.0%);
1.A.4 Other sectors – Gaseous fuel. CO_2 emissions (2.0%);
1.A.3.e Other Transport. CO_2 emissions (1.8%).

In total, emissions from these categories in 2023 accounted for 85.6% of all GHG emissions.

Key categories by GHG emission levels including LULUCF were identified as 24 categories, including 13 categories in the Energy sector, 2 categories in IPPU, 4 categories in Agriculture, 2 categories in the Waste sector, and 3 categories of GHG removals in LULUCF.

The following categories contributed the most to emissions by level, including LULUCF, in 2023:

4.A.1. Forest land remaining forest land. CO_2 removals (27.7%)
3.A. Enteric fermentation. CH_4 emissions (12.7%)
1.A.3.b Road transport – Liquid fuels. CO_2 emissions (10.4%)
1.A.1 Energy industries – Solid fuels. CO_2 emissions (6.8%)
4.B.1. Cropland remaining cropland. CO_2 removals (6.0%)
1.A.4 Other sectors – Solid fuels. CO_2 emissions (5.7%)
2.A.1 Cement production. CO_2 emissions (4.7%)
1.A.1 Energy industries – Liquid fuels. CO_2 emissions (3.5%)
3.D.1 Direct N_2O emissions from managed soils. N_2O emissions (3.0%)
3.B. Manure management. N_2O emissions (2.0%);
2.F.1. Refrigerating and air conditioning. HFC emissions (1.7%);
5.D. Wastewater treatment and discharge. CH_4 emissions (1.6%).

The combined emissions from these categories in 2023 accounted for 85.7% of total GHG emissions.

Key categories by trend for the period 1990–2023, excluding LULUCF, include 26 key categories: 16 categories in the Energy sector, 3 in IPPU, 5 in Agriculture, and 2 in Waste. The largest contributors to the trend were the following key categories:

1.A.4 Other sectors – Solid fuels. CO_2 emissions (15.5%);
1.A.1 Energy industries – Gaseous fuels. CO_2 emissions (13.5%);
3.A. Enteric fermentation. CH_4 emissions (12.5%);
1.A.3.b Road transport – Liquid fuels. CO_2 emissions (9.7%);
2.A.1 Cement production. CO_2 emissions (8.4%);
1.A.1 Energy industries – Liquid fuels. CO_2 emissions (6.4%)
2.F.1. Refrigerating and air conditioning. HFC emissions (4.2%);
1.A.2 Manufacturing industries and construction – Gaseous fuels. CO_2 emissions (3.9%)
3.B. Manure management. N_2O emissions (3.6%);
1.A.3 Other transport – Liquid fuels. CO_2 emissions (3.5%)
5.D. Wastewater treatment and discharge. CH_4 emissions (2.8%)
3.D.1 Direct N_2O emissions from managed soils. N_2O emissions (2.4%)

The combined contribution of these categories to the GHG emissions trend over 1990–2023 was 86.6%.

In 2023, when including the LULUCF sector, 24 key categories by trend were identified: 13 categories in the Energy sector, 2 in IPPU, 4 in Agriculture, 2 in Waste, and 3 categories of removals in LULUCF.

The largest key categories by GHG emission trends over 1990–2023, whose contribution to trends including LULUCF accounted for 85.5% of total emmisions, were:

4.A.1. Forest land remaining forest land. CO_2 removals (22.5%);
3.A. Enteric fermentation. CH_4 emissions (13.7%);
1.A.3.b Road transport. CO_2 emissions (10.9%);
2.A.1 Cement production. CO_2 emissions (7.1%);

1.A.1 Energy industries – Gaseous fuels. CO_2 emissions (6.8%);
1.A.4 Other sectors – Solid fuels. CO_2 emissions (5.2%);
1.A.1 Energy industries – Solid fuels. CO_2 emissions (5.2%);
1.A.1 Energy industries – Liquid fuels. CO_2 emissions (3.7%);
2.F.1. Refrigerating and air conditioning. HFC emissions (3.2%);
4.C.1. Grassland remaining grassland. CO2 removal (3.2%);
3.B. Manure management. N_2O emissions (3.6%);
5.D. Wastewater treatment and discharge. CH_4 emissions (2.4%)
5.A. Solid waste disposal. CH_4 emissions (1.9%);
1.A.2 Manufacturing industries and construction – Gaseous fuels. CO_2 emissions (1.9%).

The results of the key category analysis will be applied in the preparation of the next inventory, with the aim of reducing uncertainties in estimates and ensuring optimal resource allocation. In key categories, priority will be given to improving emission/removal estimates by applying higher-tier IPCC methodologies, refining and disaggregating activity data, and developing national emission factors.

1.6. Overall Assessment of Uncertainty, Including Data on Total Uncertainty for Inventory Results

Uncertainty estimates are an important element of a complete NGHGI. The purpose of uncertainty information is not to challenge the reliability of the NGHGI estimates, but rather to help identify priority areas for improving the accuracy of inventories and to guide methodological choices.[23] NGHGIs prepared in accordance with the 2006 IPCC Guidelines typically contain a wide range of emission estimates, varying from carefully measured and seemingly complete data to order-of-magnitude estimates for highly variable emissions.

The uncertainties of calculation results are determined by the uncertainty of the underlying data — activity data that generate greenhouse gas emissions — and by the uncertainty of the emission factors applied.

Activity data were taken from the National Statistical Committee of the Kyrgyz Republic as well as from line ministries, agencies, organizations, and enterprises. The uncertainty of statistical data is estimated in the range of 3–15%.

In the absence of national emission factors, the values provided by the 2006 IPCC Guidelines were used in the NGHGI. The uncertainty of the greenhouse gas emission factors adopted in this document ranges from 3% to 223%.

For the 2022 inventory of GHG emissions and removals, uncertainty was assessed using Approach 1 of the 2006 IPCC Guidelines across all sectors, including LULUCF, and was based on default emission factor uncertainties combined with expert judgment–based activity data uncertainties. Sector-specific uncertainties are described in detail in the respective chapters.

[23] IPCC. 2006. Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Prepared by the National Greenhouse Gas Inventories Programme. Japan: IGES, Japan: Institute for Global Environmental Strategies for IPCC.

Detailed information on uncertainty is provided in Annex 1 to this report. The results of uncertainty assessments are used to further improve emission/removal calculations. For those sources and sink categories that contribute most significantly to overall uncertainty, higher-tier GHG estimation methodologies, as well as refinement and disaggregation of activity data, are planned for future application.

1.7. Overall Assessment of Completeness

The completeness of the NGHGI is assessed in accordance with the IPCC methodology using the following notation keys: NO (Not Occurring), NE (Not Estimated), NA (Not Applicable), IE (Included Elsewhere), and C (Confidential).

A detailed description of the status of emission estimates by categories and gases is provided in the respective CRT tables. Overall, completeness has been achieved in line with the capacity of the Kyrgyz Republic to collect adequate and acceptable activity data. Issues related to data gaps are described, where necessary, in the sectoral chapters.

The inventory of emissions presented under the UNFCCC in this report covers the period 1990–2022, with an annual time step. The base year for all gases and categories is 1990. In accordance with IPCC requirements, the inventory provides an assessment of the completeness of the underlying data, as well as of greenhouse gas emissions and removals, and of national territorial coverage.

The inventory covers the entire territory of the Kyrgyz Republic and the main sources of emissions and removals in the country. Natural (non-anthropogenic) emissions and removals are not included in the inventory.

The “IE” (Included Elsewhere) notation key is applied to the Energy sector. Specifically, in category 1.A.3.b Road Transport, where a detailed breakdown of emissions by passenger cars, vans, heavy-duty trucks, buses, and motorcycles was not possible during the preparation of this inventory.

1.7.1. Description of Insignificant Categories

Paragraph 32 of the MPGs (Decision 18/CMA.1) under the Enhanced Transparency Framework stipulates that a Party may consider that collecting data on emissions of a gas from a given category, which would be insignificant in terms of overall level and trends of national emissions, would require disproportionately high efforts. In such cases, the notation key NE may be used.

The list of categories not estimated for GHG emissions and marked with the notation key NE is as follows:

The NE key was also applied to categories where emissions occur but activity data for their estimation were unavailable. Some of these categories, such as 2.D.2, 2.D.3, and 2.F.4, may be insignificant; however, due to time constraints, emissions from these categories were not estimated, and their significance was not analyzed. As a result, the flexibility option was not applied, since it would not have solved the issue. It is expected that emissions related to the LULUCF and Agriculture sectors will exceed the significance threshold. Therefore, estimating emissions from these categories will be a priority for the next BTR submission and has been included in the Improvement Plan.

1.7.3. Aggregate Emissions Considered Insignificant

Aggregate emissions considered insignificant for the Kyrgyz Republic were not assessed.

1.8. Metrics

The results of the NGHGI of the Kyrgyz Republic are presented as total emissions of individual greenhouse gases by sector, and subsequently as emissions of all greenhouse gases expressed in CO_2 equivalent by sector. Since individual greenhouse gases have different radiative properties and therefore contribute differently to the greenhouse effect, the emissions of each gas must be multiplied by its corresponding Global Warming Potential (GWP). Global Warming Potential is a measure of the impact of a given gas on the greenhouse effect compared to the impact of CO_2, which is defined as the reference value. In this context, greenhouse gas emissions are expressed as carbon dioxide equivalent emissions (CO_2-eq). When the removal of greenhouse gases occurs (for example, CO_2 uptake through increased carbon stock in forests), this is accounted for as a sink, and the quantity is represented as a negative value. The GWPs used for the calculation of CO_2-equivalent emissions were taken from the Fifth Assessment Report (AR5) of the IPCC.

1.9. Flexibility

In the estimation of emissions and removals in the Kyrgyz Republic's NGHGI, flexibility was not applied.

2. Trends in Greenhouse Gas Emissions

2.1. Description and Interpretation of Emission Trends for Aggregated GHG Emissions

The National Greenhouse Gas Inventory includes assessments of total and net emissions and the dynamics of emissions for the following greenhouse gases: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3, and four indirect greenhouse gas precursors (NO_x, CO, NMVOCs, and SO_2). The assessment was carried out across all GHG source and sink sectors:

- Energy
- Industrial Processes and Product Use (IPPU)
- Agriculture
- Land Use, Land-Use Change and Forestry (LULUCF)
- Waste.

Total emissions (excluding LULUCF)

Total GHG emissions from all sources and gases in 2023 amounted to 19,374.16 kt CO_2 eq., which is 30.6% lower than the base year 1990. At the same time, GHG removals by sinks amounted to 10,308.89 kt CO_2, which is 6.9% higher than in 1990. Net GHG emissions totaled 9,065.27 kt CO_2 eq., or 50.4% of the 1990 net GHG emission level (18,259.00 kt CO_2 eq.).

In 2023, emissions of carbon dioxide (CO_2) amounted to 11,284.78 kt CO_2-eq (58.2%); methane (CH_4) emissions amounted to 5,611.58 kt CO_2-eq (29.0%); nitrous oxide (N_2O) emissions amounted to 1,951.69 kt CO_2-eq (10.1%); and emissions of all reported hydrofluorocarbons (HFCs) amounted to 526.11 kt CO_2-eq (2.7%). (See Figure 2.1).

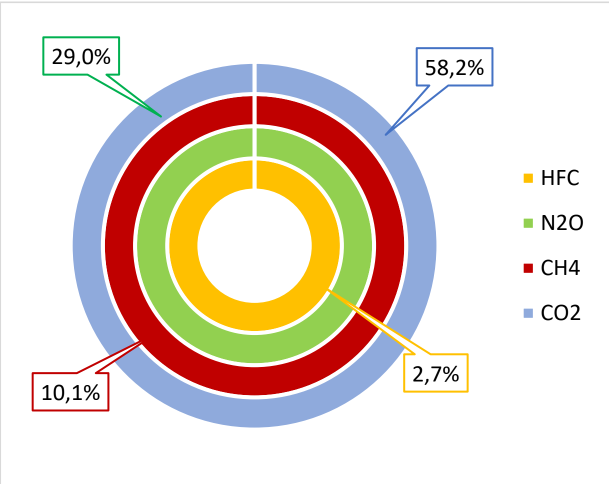


Figure 2.1. GHG Emissions by Gas Type in 2023

Net emissions (including LULUCF)

Net emissions are defined as the difference between the level of total emissions and the level of total removals. In simpler terms, net GHG emissions = total emissions minus total removals.

Net emissions include emissions from the Energy, IPPU, Agriculture, and Waste sectors (total emissions), together with emissions and removals from the LULUCF sector.

In 1990, the net GHG emissions of the Kyrgyz Republic amounted to 18,259.00 kt CO_2 eq. During the period 1990–2023, net GHG emissions decreased by 50.4% (9,193.27 kt CO_2 eq.), amounting to 9,065.27 kt CO_2 eq. in 2023.

The dynamics of total and net GHG emissions and removals for 1990–2023, along with corresponding linear trends, are presented in Figure 2.2.

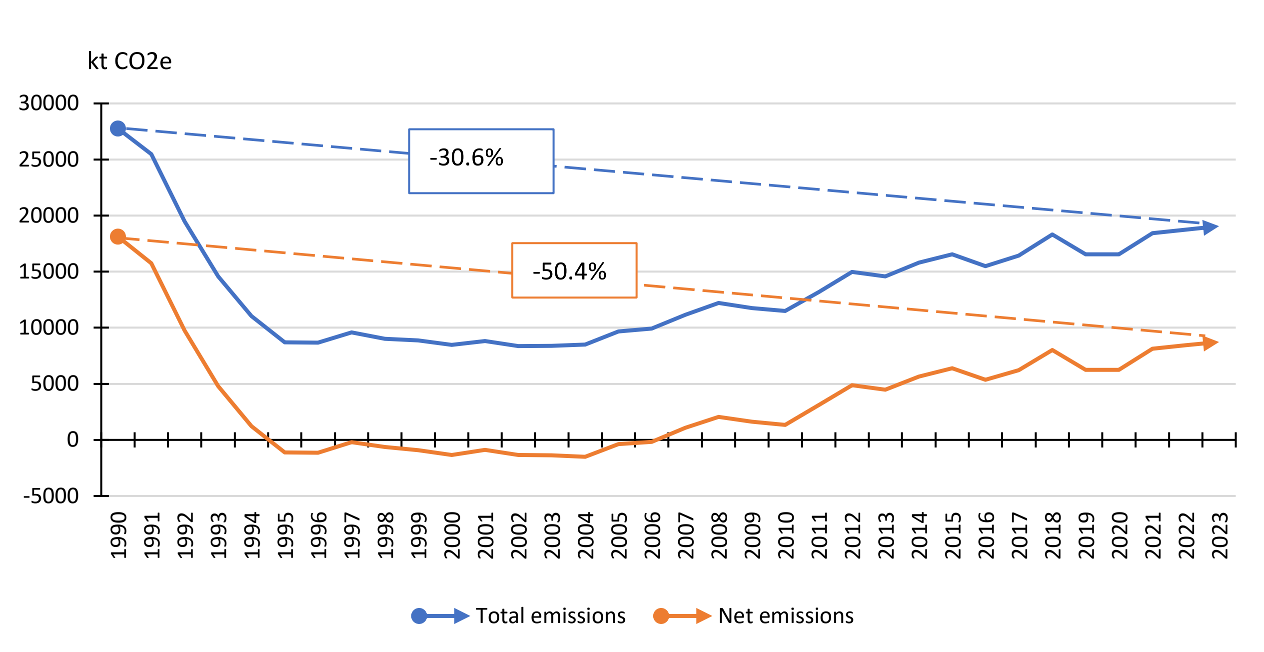
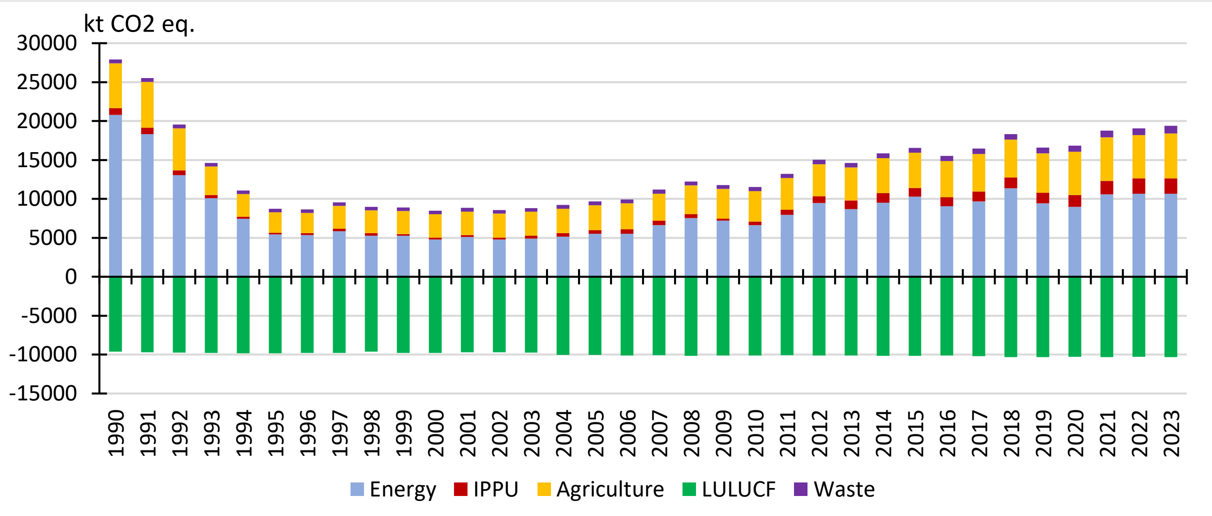


Figure 2.2. Trends in Total and Net Emissions during 1990–2023.[24]

Figure 2.3 shows the contribution of each inventory sector to net emissions since 1990. The Energy and Agriculture sectors dominate the total emissions of the Kyrgyz Republic. Together, these sectors accounted for 86–95% of the country's annual total GHG emissions during the period 1990–2023. The IPPU and Waste sectors produced relatively small amounts of GHGs, within the range of 3–11% and 2–5% of annual total emissions, respectively, across the entire time series. Conversely, the LULUCF sector was a net sink of GHG emissions during 1990–2023.



[24] MNRETSN. National Inventory Document. National Report on the Greenhouse Gas Emissions and Removals Inventory. 2025.

Note: IPPU = Industrial Processes and Product Use; kt CO_2 eq.= kilotons of carbon dioxide equivalent; LULUCF = Land Use, Land-Use Change and Forestry.

Figure 2.3. Greenhouse Gas Emission Trends in the Kyrgyz Republic by Sectors for 1990–2023

Dynamics of Total Emissions

In 1990, the total greenhouse gas (GHG) emissions in the Kyrgyz Republic amounted to 27,898.91 kt CO_2 eq. During the period from 1990 to 2023, the total GHG emissions in the Kyrgyz Republic decreased by 30.56%, reaching 19,374.16 kt CO_2 eq. The average annual decline in emissions was 1.6%. The table 2.1 presents emissions in kilotons of CO_2 eq. by major sources in the time series 1990–2023.

Table 2.1. Greenhouse Gas Emissions in the Kyrgyz Republic in 1990 and 2023

Sources	1990	2023	Changes (kt CO_2 eq.)	Changes (%)
Energy	20,794.91	10,651.90	-10,143.01	-48.78
IPPU	871.64	2,008.04	1,136.40	130.38
Agriculture	5,746.39	5,754.41	8.02	0.14
Waste	486.04	959.80	473.76	97.47
Total Emissions	**27,898.97**	**19,374.16**	**-8,524.81**	**-30.56**
LULUCF	-9,639.98	-10,308.89	-668.91	6.94
Net Emissions	**18,259.00**	**9,065.27**	**-9,193.72**	**-50.35**

Table 2.2. presents emissions by type of greenhouse gases in kt CO_2 eq. for the time series 1990–2023.

Table 2.2. Greenhouse gas emissions by type for the period 1990–2023 excluding LULUCF.

Gases	1990	2023	Changes (kt CO_2 eq.)	Changes (%)
CO_2	20,310.36	11,284.78	-9,025.58	-44.44
CH_4	5,040.23	5,611.58	571.35	11.34
N_2O	2,548.39	1,951.69	-596.70	-23.41
HFC	NO	526.11	562.61	-
PFC	NO	NO	NA	NA
SF_6	NO	NO	NA	NA
Total (all gases)	27,898.97	19,374.16	-8,488.32	-56.52

Note: CH_4 = methane; CO_2 = carbon dioxide; HFCs = hydrofluorocarbons; kt CO_2 eq.= kilotons of carbon dioxide equivalent; N_2O = nitrous oxide; PFCs = perfluorocarbons; SF_6 = sulfur hexafluoride. Total emissions do not include net emissions from the LULUCF sector. Percentage change for HFCs is not applicable (NA), since there were no HFC emissions (NO) in 1990. There were no PFC or SF_6 emissions (NO) in either 1990 or 2023.

During the period 1990–2023, overall GHG emissions in the Kyrgyz Republic generally showed a downward trend. Total GHG emissions decreased by 30.6%, from 27,898.97 kt CO_2 eq. in 1990 to 19,374.16 kt CO_2 eq. in 2023. However, the distribution of these changes across individual sectors and historical periods was uneven.

This was primarily due to the political and socio-economic transformation that occurred in 1990–1991, when the Soviet Union collapsed and Kyrgyzstan became an independent country. The breakdown of economic ties and the end of centralized support plunged the country into a severe socio-economic crisis, from which Kyrgyzstan has still not fully recovered, even 34 years later.

In Soviet times, Kyrgyzstan was an industrial-agrarian republic that hosted major enterprises of the defense industry, instrument engineering, radio electronics, non-ferrous metallurgy, and light industry. Many of these enterprises had the status of enterprises of national (Union-wide) importance.

The agro-industrial complex of Kyrgyzstan produced fine-fleeced wool from local Merino sheep (of which there were about one million head), supplying not only the local worsted mill with wool and yarn but also textile enterprises in central Russia, the Baltic republics, and Europe.

At the same time, during the Soviet period, all Central Asian republics were subsidized. For example, in 1991 subsidies from the Union center accounted for 44% of Tajikistan's budget, 42% of Uzbekistan's, 34% of Kyrgyzstan's, 23% of Kazakhstan's, and 22% of Turkmenistan's[25] [26]. However, some experts argue that these figures were underestimated. For Kyrgyzstan, for instance, there are references suggesting that subsidies covered up to 62.5% of the state budget.[27].

The first years of Kyrgyzstan's independence, from 1991 to 1995/6, were marked by a rapid decline in GDP, industrial and agricultural production, reduced energy consumption, rising poverty, and increased migration.

The economic collapse affected all sectors. According to the World Bank, the annual GDP growth rate at market prices, based on constant local currency, fell by as much as 20% in the early years of independence, and recovery from this negative trend occurred only in 1996 (see Fig. 2.4).

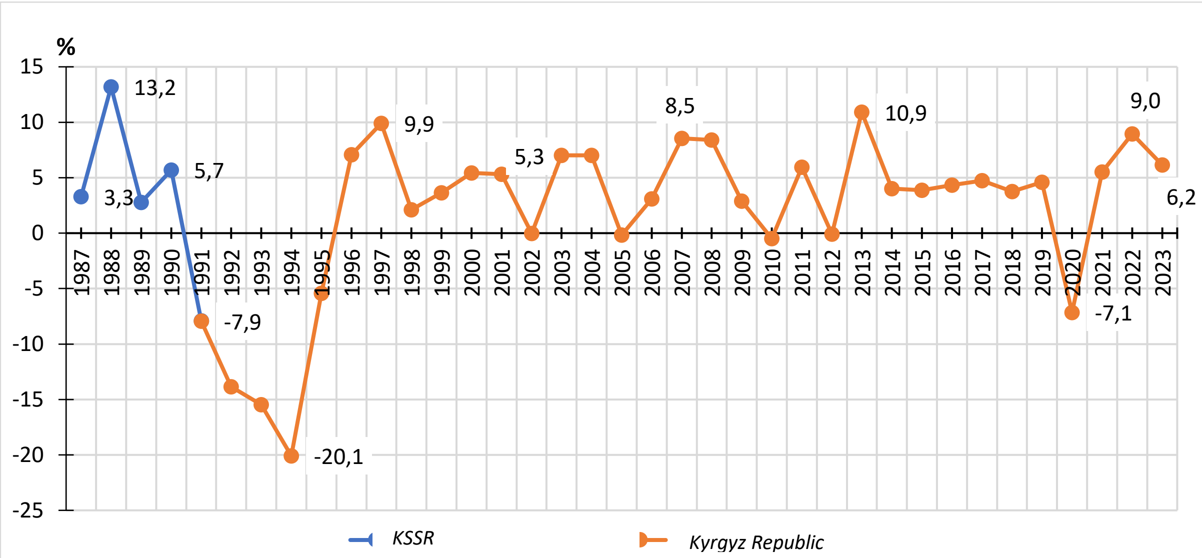


Figure 2.4. GDP Growth Dynamics in Kyrgyzstan, 1987–2023 [28]

In different historical periods, the dynamics of GDP in terms of purchasing power parity (PPP) fluctuated significantly; however, the initial period of Kyrgyzstan's statehood is particularly illustrative for understanding the collapse of economic development, which in turn became a decisive factor influencing the overall level of greenhouse gas (GHG) emissions (see Fig. 2.5 below).

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[25] Energy Dimensions of International Relations in Security in East Asia. Moscow: MGIMO University, 2007. p. 392.

[26] Marnie Sh., Whitlock E. Central Asia and Economic Integration // RFE/RL Research Report. Vol. 2. № 14. 1993. 2 Apr. p. 34.

[27] Sitnyansky, G. Kyrgyzstan. Independence Achieved. What Next? // Asia and Africa Today. 1995, No. 6, p. 9.

[28] World Bank Group. Data. World Development Indicators. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=KG

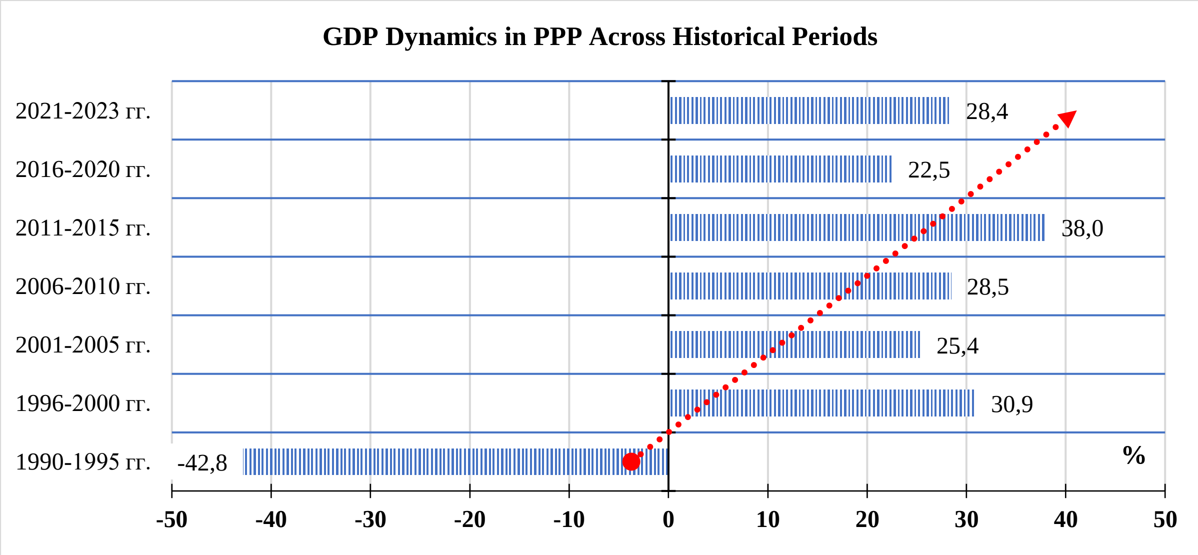


Figure 2.5. GDP Dynamics in PPP Across Historical Periods, 1990–2023[29]

<u>*Dynamics of Net Emissions*</u>

The main reason for the decline in net emissions was the sharp drop in total emissions, the causes of which were described above, while absorption levels remained nearly unchanged.

At the same time, the dynamics of net emissions in the Kyrgyz Republic have been significantly influenced by cycles of forest planting and harvesting, which directly affect the LULUCF sector. Carbon dioxide absorption in the LULUCF sector has been increasing since 1990. Current harvesting and logging rates are close to historically low levels, largely due to the establishment of significant plantation forests in the 1980s and early 1990s. Forests planted during that period are now gradually reaching maturity, a process expected to continue throughout the 2020s. Logging volumes are decreasing, while the average age of forest stands increases each year. Younger forest stands have lower growth rates compared to older and fast-growing ones. In the future, as logging volumes decrease and growth rates of replanted forest stands increase, net removals are likely to grow further.

In addition, the dynamics of net emissions have also been significantly affected by Kyrgyzstan's traditionally developed horticulture and perennial plantations, including fruit orchards and shrubs. The areas of these plantations have been preserved through constant reconstruction of old orchards and fruit plantations, replacing old tree and shrub species. Natural pasture lands with shrub vegetation have also played a role.

2.2 Emission Trends by Gas

2.2 1 Dynamics of Greenhouse Gas Emissions by Gas Type

The main greenhouse gas (GHG) associated with anthropogenic activities in Kyrgyzstan in 2023 was carbon dioxide (CO_2), accounting for 58% of the total GHG emissions. The largest source of CO_2 and overall GHG emissions was the combustion of fossil fuels, primarily in the transport and energy sectors. Methane (CH_4) made up 29% of total emissions, mainly from livestock in the agricultural

[29] World Bank Group. Data. World Development Indicators. https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD?end=2023&locations=KG&start=1990

sector. Nitrous oxide (N_2O), produced mostly from the use of synthetic nitrogen fertilizers in agriculture, accounted for 10% of total emissions. Fluorinated gases (F-gases, including HFCs, PFCs, and SF_6), generated in the industrial sector, contributed 3% of total emissions. Figure 2.6 illustrates how the composition of total emissions in 2023 changed compared to 1990.

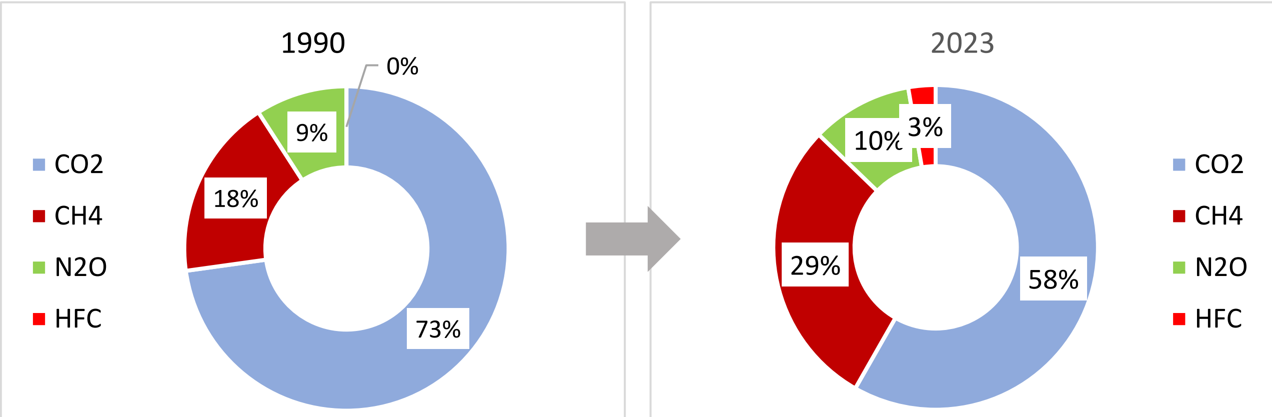


Figure 2.6. Share of Greenhouse Gases by Gas Type in Total Emissions in 2023 in the Kyrgyz Republic.

Carbon Dioxide (CO_2)

In 1990, total CO_2 emissions were estimated at 20,310.36 kt, representing 73% of the total GHG emissions in the Kyrgyz Republic. By 2023, CO_2 emissions had decreased by 44.4% (9,025.58 kt) compared to the base year, amounting to 11,284.78 kt or 58.3% of total GHG emissions (Figure 2.7).

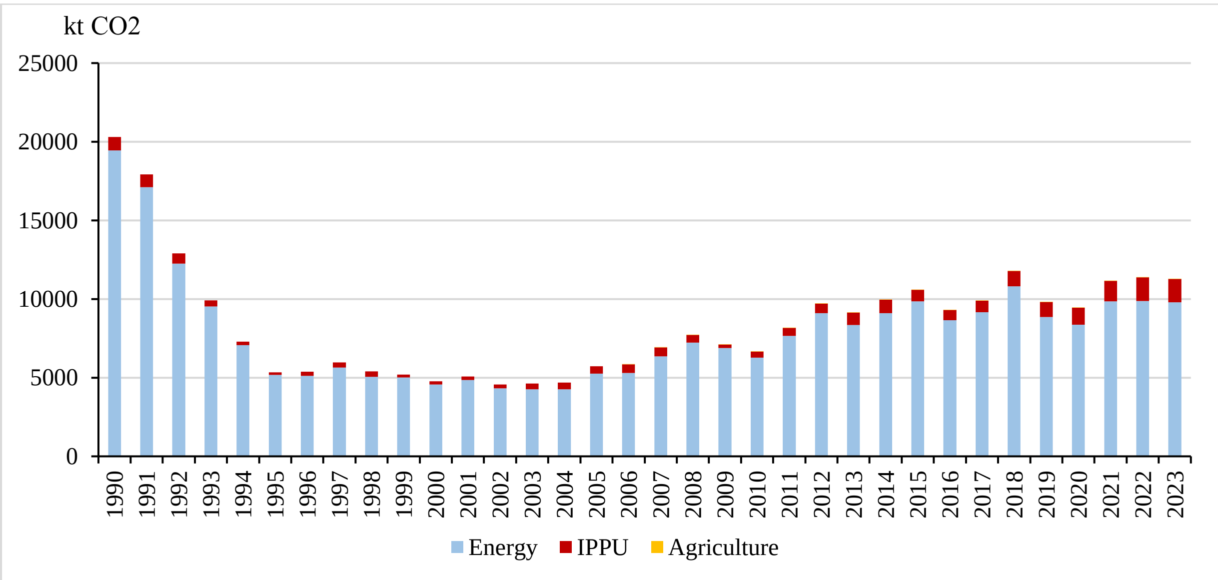


Figure 2.7. Carbon Dioxide Emissions in the Kyrgyz Republic by Sector, 1990–2023.

The energy sector was the main source of CO_2 emissions in 2023, accounting for 86.7% of total emissions, primarily from fossil fuel combustion in transport and in electricity and heat production. This was followed by the industrial sector with 13.1% and agriculture with 0.13%, according to the NID data.

The LULUCF sector in the Kyrgyz Republic acted as a net sink of CO_2 during the period 1990–2023. In 1990, CO_2 absorption by LULUCF was estimated at 9,639.979 kt. By 2023, CO_2 absorption had increased by 6.9% compared to the base year, reaching 10,308.89 kt. The main reason for the increase was the update of the national forest inventory. Thus, CO_2 absorption by the LULUCF sector offset approximately 34.6% of total CO_2 emissions in 1990 and 53.2% of total emissions in 2023. Consequently, net CO_2 emissions declined from 18,123.583 kt CO_2 eq. in 1990 to 9,065.27 kt CO_2 eq. in 2023 (Figure 2.8, rounded values).

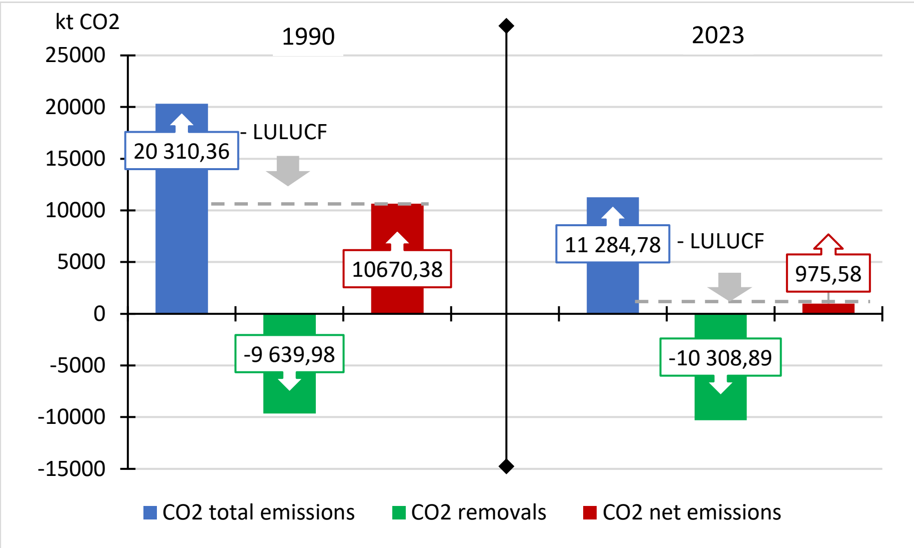


Figure 2.8. Carbon Dioxide Emissions and Removals in the Kyrgyz Republic, 1990–2023

Methane (CH_4)

In 2023, methane (CH_4) emissions in the Kyrgyz Republic amounted to 5,611.58 kt CO_2 eq., or 29% of the country's total emissions. The main source of methane emissions was agriculture, which accounted for 70.6% of methane emissions, primarily from livestock (enteric fermentation). Compared to 1990, methane emissions increased by 11.3%, or 571.35 kt CO_2 eq. (Figure 2.9).

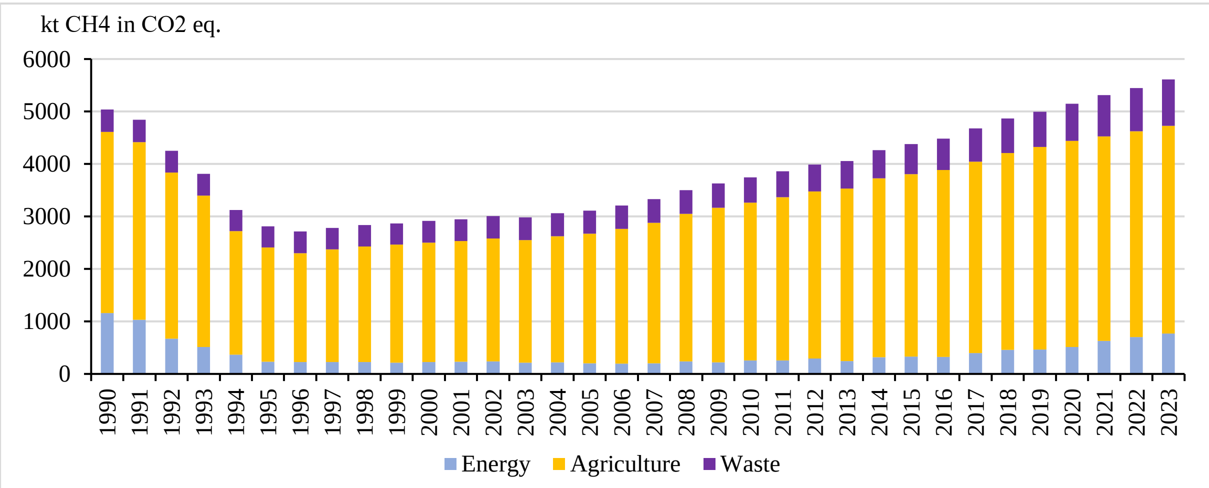


Figure 2.9. Methane Emissions and Removals in the Kyrgyz Republic by Sector, 1990–2023.

The waste sector accounted for about 15.7% of methane emissions, mainly from unmanaged solid waste disposal at landfills and wastewater discharges. The energy sector contributed 13.74%, primarily from fuel combustion and fugitive fuel emissions. Overall, methane emissions in 2023 increased by 11.3% from the 1990 level. This increase can be explained by the growth in livestock numbers, especially cattle, whose population exceeded the 1990 national herd by 28.7%. This is because cattle today serve as the only reliable means of income capitalization for rural households due to their high liquidity, combined with steadily increasing waste volumes resulting from population growth and rising living standards.

Nitrous Oxide (N_2O)

In 2023, nitrous oxide (N_2O) emissions in the Kyrgyz Republic amounted to 1,951.69 kt CO_2 eq. or 10.07% of the country's total GHG emissions. The main contributor was agriculture, which accounted for 1,485.89 kt CO_2 eq., or 91% of total N_2O emissions. The main sources of agricultural N_2O emissions were soil management practices, such as fertilizer application and manure use. The energy sector contributed 96.79 kt CO_2 eq. or 5% of N_2O emissions, mainly from solid fuel combustion in the category combined heat and power generation. The waste sector accounted for 77.95 kt CO_2 eq., or 4% of total N_2O emissions.

The overall trend of N_2O emissions from 1990 to 2023 shows a clear pattern: a sharp decline between 1990 and 1996, followed by a gradual increase up to 2023. Overall, N_2O emissions decreased by 596.79 kt CO_2 eq., or 23.4%, compared to the 1990 level (Figure 2.10).

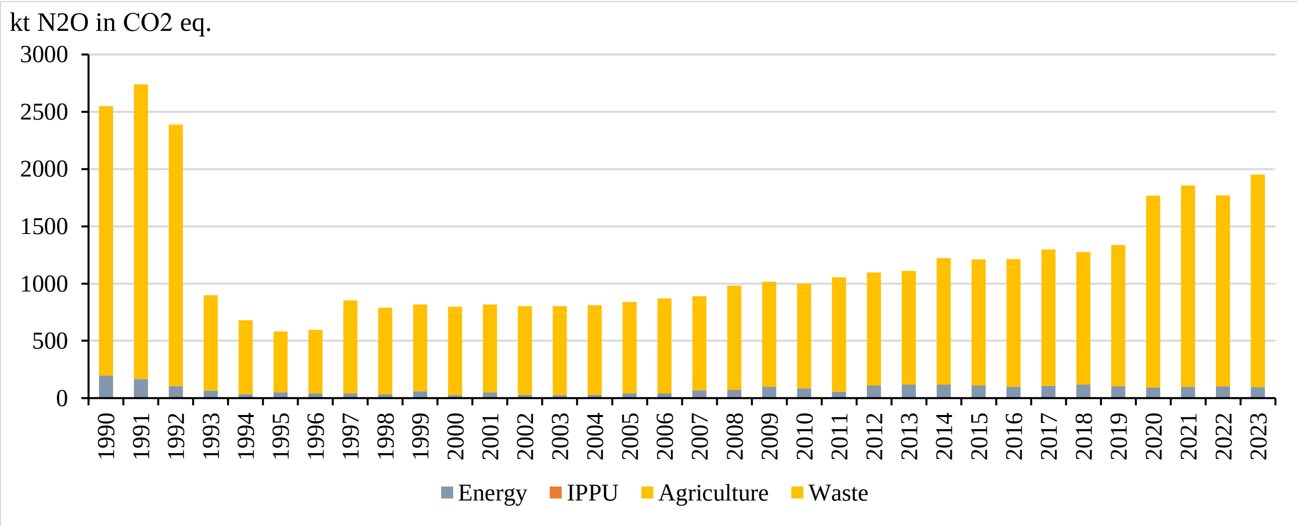


Figure 2.10. Nitrous Oxide (N_2O) Emissions in the Kyrgyz Republic by Sector, 1990–2023

Fluorinated Gases (F-gases)

Fluorinated gases (F-gases) in the Kyrgyz Republic, including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6), are mainly emitted from industrial activities. In 2023, total F-gas emissions were approximately 526.11 kt CO_2 eq. or 2.7% of the country's total emissions. In the Kyrgyz Republic, HFCs are used in refrigeration systems, air conditioning, foam blowing agents, and some industrial processes.

HFCs began to be used in the country in 1995 as substitutes for CFCs. Among these, the following were identified: HFC-32, HFC-125, HFC-134a, HFC-143a, and HFC-227ea (up to 2020), with HFC-245fa and HFC-365mfc added in 2023.

In 2023, HFCs accounted for about 3% of total GHG emissions in the Kyrgyz Republic. The increase in HFC emissions is closely linked to the country's overall industrial development and the growing demand for construction and fire-suppression gas-containing materials, as well as refrigeration and air conditioning systems. This demand is driven by factors such as population growth, improved housing conditions, and more widespread and intensive use of refrigeration and air conditioning equipment in residential, commercial, and administrative buildings, as well as in transport, along with the extensive use of foam-blowing agents. The dynamics of HFC emissions are shown in Figure 2.11 below.

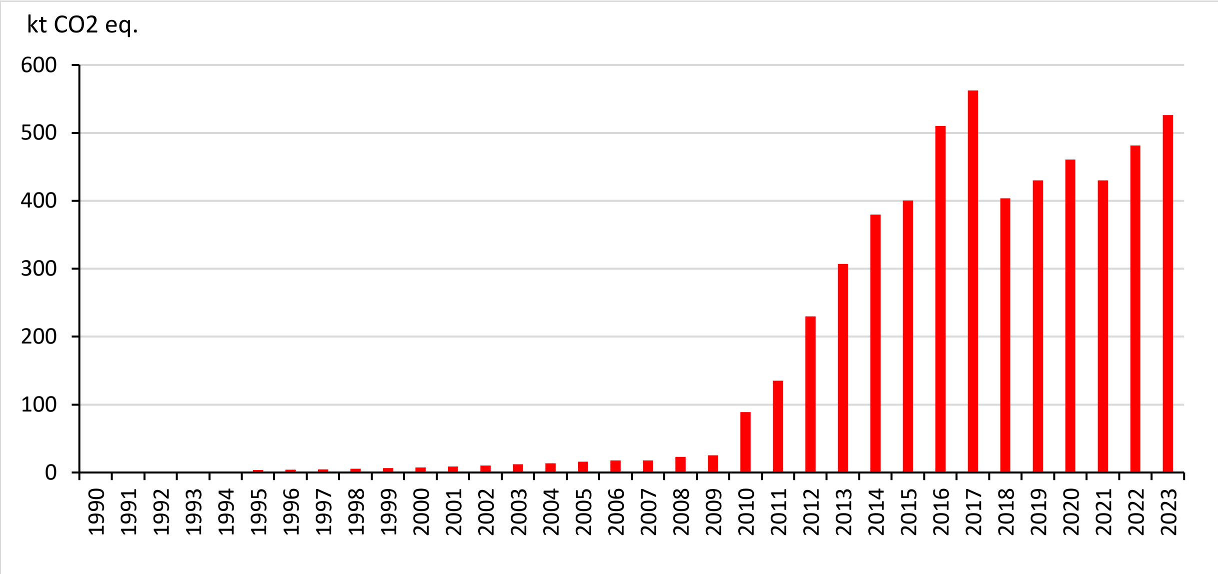


Figure 2.11. Hydrofluorocarbon Emissions in the Kyrgyz Republic by Sector, 1995–2023

2.2.2 Dynamics of Precursor Gas Emissions

As part of the fifth inventory cycle, emissions of precursor gases were also assessed: nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), and sulfur dioxide (SO_2).

In 2023, NOx emissions amounted to 11.192 kt, which is 77.6% lower than in 1990. CO emissions were 139.899 kt, a 61.2% decrease compared to 1990. NMVOC emissions were 35.843 kt, 41.2% lower than in 1990. SO_2 emissions totaled 59.809 kt, which is 41% lower than in 1990 (see Figure 2.12).

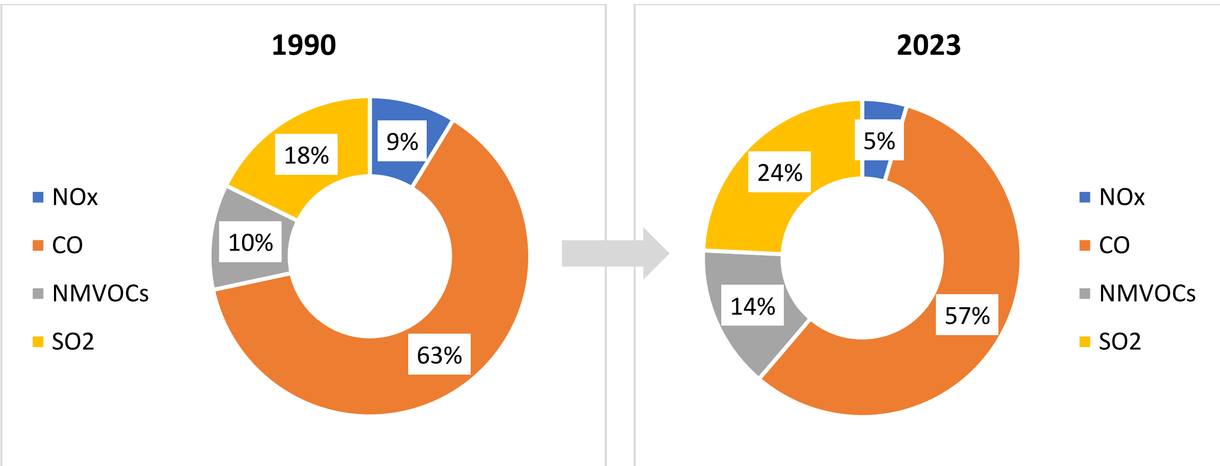


Figure 2.12. Structure of Precursor Gas Emissions in 1990 and 2023

The dynamics of precursor gas emissions over the period 1990–2023 are presented in Figure 2.13.

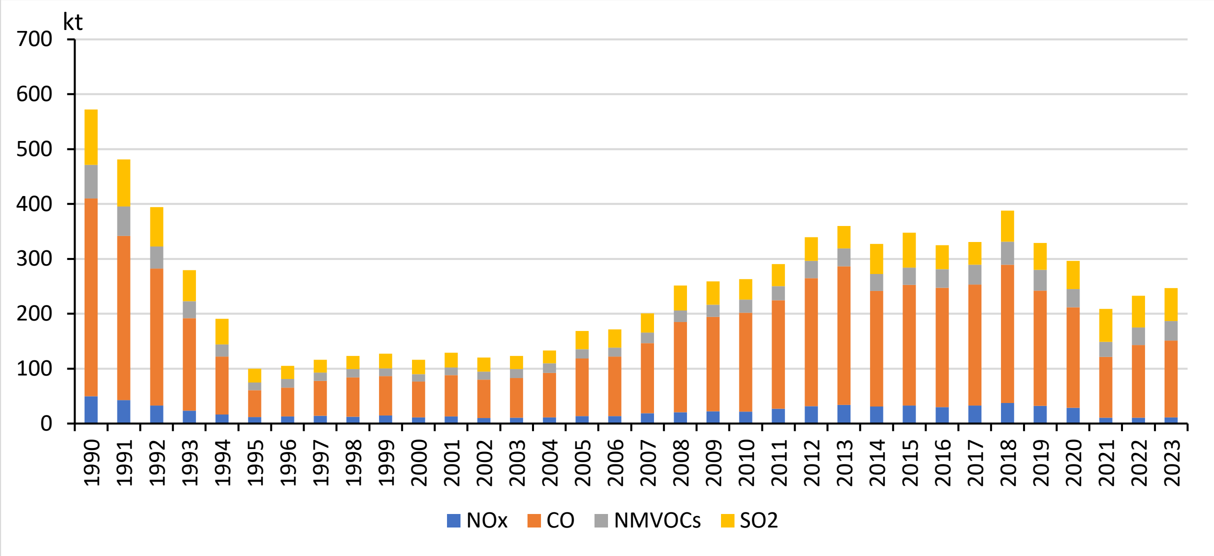


Figure 2.13. Dynamics of Precursor Gas Emissions, 1990–2023

2.3 Trends in Emissions by Sector

According to the MPG, the Kyrgyz Republic's inventory includes emissions and removals for the following sectors: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Land Use, Land-Use Change, and Forestry (LULUCF), Waste.

2.3.1 Emissions by Sector in 2023

The values of GHG emissions in the Kyrgyz Republic reflect changes in the country's economy.

The largest amount of GHG emissions came from the Energy sector – 10,653.384 11 kt CO_2 eq., or 55.0% of the total GHG emissions of the Kyrgyz Republic in 2023, which is 48.8% lower than the 1990 level.

Within the sector, the largest share of emissions came from the category Transport – 3,601.42 kt CO_2 eq. or 34% of sectoral emissions. In the category Energy Industries, emissions amounted to 3,318.00 kt CO_2 eq. or 31% of the sector's emissions. In the category Other Sectors (emissions from boiler facilities and the residential sector), emissions amounted to 2,558.55 kt CO_2 eq. or 24% of the sector's emissions. In the category Fugitive Emissions from Fuels, emissions amounted to 644.28 kt CO_2 eq. or 6% of the sector's emissions. In the category Manufacturing Industries and Construction, GHG emissions amounted to 531.15 kt CO_2 eq. or 5% of the sector's emissions.

The second largest GHG-emitting sector after Energy in 2023 was Agriculture, whose emissions amounted to 5,754.41 kt CO_2 eq. or 29.7% of total emissions in the Kyrgyz Republic, which is 0.1% higher than in 1990. The largest emissions in agriculture came from the category Enteric Fermentation, which amounted to 3,783.69 kt CO_2 eq. or 70% of sectoral emissions, as well as emissions from the category Direct N_2O Emissions from Managed Soils, which amounted to 889.67 kt CO_2 eq. or 16% of total agricultural emissions. Emissions from the category Indirect N_2O Emissions from Managed Soils amounted to 317.15 kt CO_2 eq. or 5% of sectoral emissions, while indirect N_2O emissions from manure management amounted to 197.40 kt CO_2 eq. or 4% of sectoral emissions. Emissions from the category Manure Management amounted to 189.79 kt CO_2 eq. or 3% of sectoral emissions. Rice Cultivation accounted for 32.15 kt CO_2 eq. or 1%, and emissions from Urea Application amounted to 14.92 kt CO_2 eq. or 0.28% of total agricultural emissions.

The third largest GHG-emitting sector was Industrial Processes and Product Use (IPPU), whose emissions in 2023 amounted to 2,008.04 kt CO_2 eq. or 10.4% of total emissions in the Kyrgyz Republic, which is 130.4% higher than in 1990. Emissions in the category Cement Production in 2023 amounted to 1,396.18 kt CO_2 eq. or 70% of all sectoral emissions. Emissions in the category Refrigeration and Air Conditioning amounted to 491.26 kt CO_2 eq. or 24% of sectoral emissions. Emissions in the category Foam Blowing Agents amounted to 34.85 kt CO_2 eq. or 2% of sectoral emissions. In the category Ceramics, emissions amounted to 29.49 kt CO_2 eq. or 1% of all sectoral emissions. Emissions in the category Lime Production amounted to 20.26 kt CO_2 eq. or 1.1% of sectoral emissions. Also, 1% of all sectoral emissions came from the category Glass Production, amounting to 20.12 kt. CO_2 eq. Emissions from the category Lubricant Use amounted to 15.63 kt CO_2 eq. or 0.8% of sectoral emissions. Emissions from the Metal Industry amounted to 0.19 kt CO_2 eq. or 0.01%, while emissions from Paraffin Use amounted to 0.06 kt CO_2 eq. or 0.003% of total sectoral emissions.

The fourth largest GHG-emitting sector in 2023 was Waste, whose emissions amounted to 959.80 kt CO_2 eq. or 5% of total emissions in the Kyrgyz Republic, which is 97.5% higher than in 1990. The largest share of emissions was in the category Wastewater Treatment and Discharge, amounting to 562.92 kt CO_2 eq. or 59% of total sectoral emissions. Emissions in the category Solid Waste Disposal amounted to 381.91 kt CO_2 eq. or 40% of total sectoral emissions. Emissions in the category Incineration and Open Burning of Waste amounted to 13.21 kt CO_2 eq. or 1% of total sectoral emissions, while emissions in the category Biological Treatment of Solid Waste amounted to 1.76 kt CO_2 eq. or 0.18% of total sectoral emissions.

The Land Use, Land-Use Change, and Forestry (LULUCF) sector was a CO_2 sink, whose removal in 2023 amounted to 10,308.89 kt CO_2, which is 6.9% higher than in 1990. Removals occurred across three categories: in the category Forest Land, the sink in 2023 amounted to 8,213.66 kt CO_2 or 80% of all removals; in the category Cropland, the sink amounted to 1,767.18 kt CO_2 or 17% of all removals; and in the category Grassland, the sink amounted to 328.37 kt CO_2 or 3% of all CO_2 removals in the sector.

Emissions in the LULUCF sector under the category Biomass Burning on Forest Land in 2023 occurred as a result of natural fires over an area of 79.3 hectares, amounting to 0.315 kt CO_2, while removals increased by 6.9%, from 9,639.979 kt CO_2 in 1990 to 10,308.89 kt CO_2 in 2023 (see Figure 2.14).

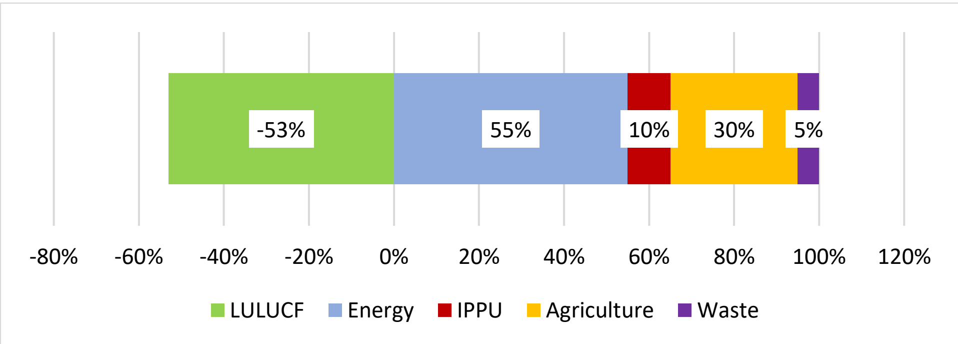


Figure 2.14. Emissions and Removals of GHGs in 2023 by Source Categories

The structure of emissions by type of greenhouse gases, as well as emissions and removals by sources in 2023, are presented in Figure 2.15.

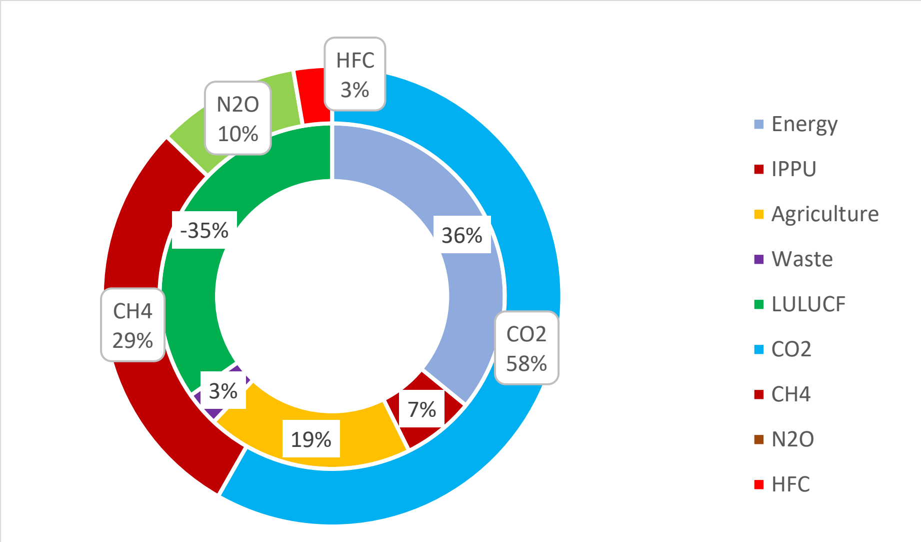


Figure 2.15. Greenhouse gas emissions and removals by type and source in 2023.

2.3.2. Emission Trends in the Energy Sector

Greenhouse gas emissions in the Energy sector decreased by 48.8%, from 20,794.91 kt CO_2 eq. in 1990 to 10,651.90 kt CO_2 eq. in 2023. The Energy sector is the source of CO_2 (87% of national emissions), CH_4 (14%), and N_2O (5%).

Overall, emissions from the Energy sector reflect the structure of the economy and the energy profile of the Kyrgyz Republic (see Figure 2.16).

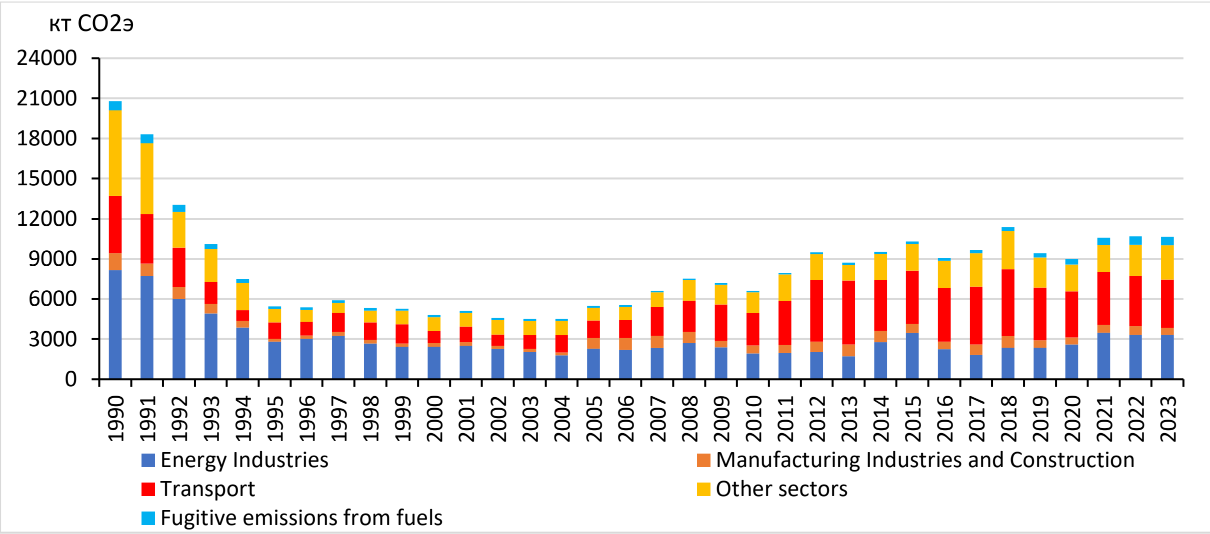


Figure 2.16. Emissions in the Energy sector of the Kyrgyz Republic by categories for the period 1990–2023.

The reason for the reduction was the decline in emissions in the category Fuel Combustion, due to the reduction in volumes and the change in the structure of consumption of major energy resources (ERs) (see Table 2.3).

Table 2.3. Changes in the consumption of major types of energy resources by historical periods.[30]

[30] NSC. Distribution of Fuel and Energy Resources.

Types of ERs	1990-1995, %	1995-2013, %	2013-2023, %	2020-2023,%	1990-2023, %
Gasoline	-68,7	278	-24,3	11,9	-10,5
Diesel	-75,3	345	-27,2	-3,9	-19,9
Fuel Oil	-84,8	-67	-4,2	-20,0	-95,1
Coal	-78,3	99	10,9	34,1	-52,0
Gas	-59,0	-69	62,7	39,4	-79,0
Electricity	-9,9	47	40,2	15,3	85,9

As can be seen from the table, the sharp decline in consumption of the main ERs during the period 1990–1995 had a significant impact on the overall consumption trend, even despite the considerable growth during the period 1995–2013 (see Figure 2.17).

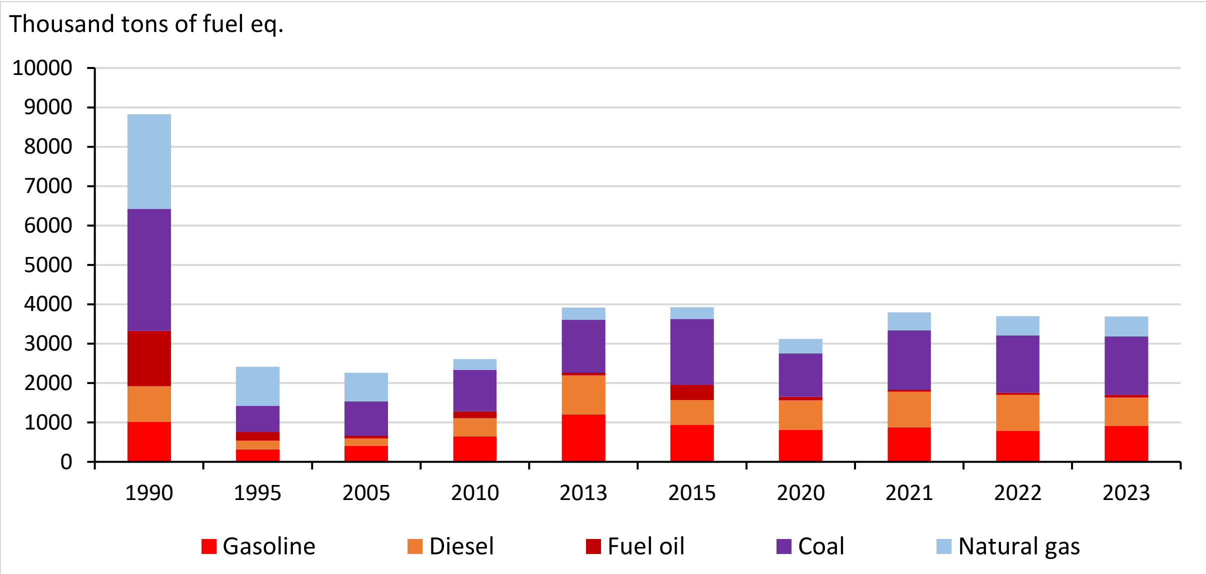


Figure 2.17. Dynamics of consumption of main types of ERs in the period 1990–2023. [31]

In addition to the volume of consumption, the structure of ER consumption also changed. Compared to 1990, in 2023 electricity consumption (from hydropower) sharply increased by 25 percentage points, while coal consumption decreased by 10 percentage points, natural gas by 15 percentage points, and fuel oil by 14 percentage points, i.e., fossil fuels (see Figure 2.18).

https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fstat.gov.kg%2Fru%2Fstatistics%2Fdownload%2Fdynamic%2F348%2F&wdOrigin=BROWSELINK

[31] NSC. Distribution of Fuel and Energy Resources. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fstat.gov.kg%2Fru%2Fstatistics%2Fdownload%2Fdynamic%2F348%2F&wdOrigin=BROWSELINK

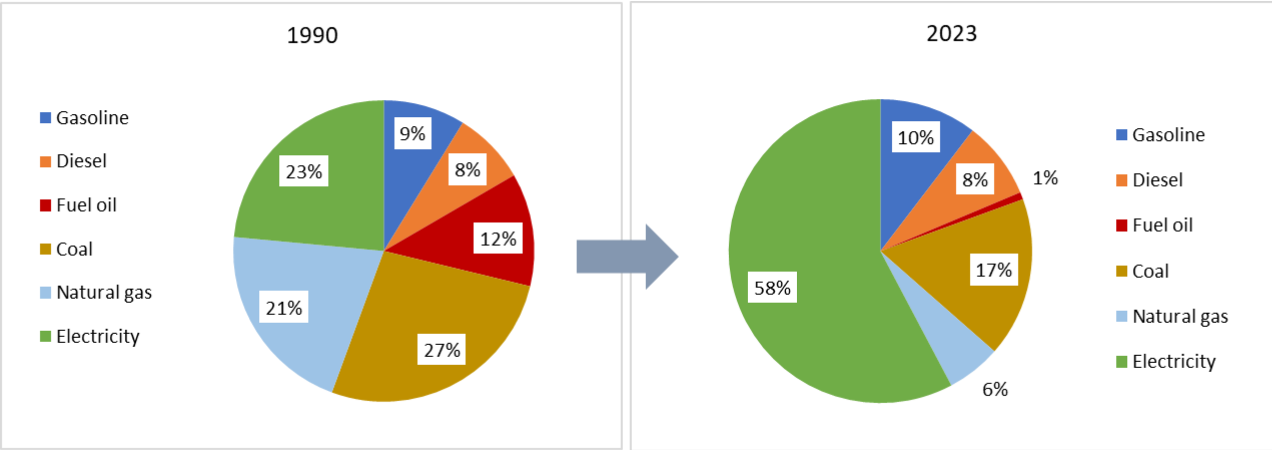


Figure 2.18. Consumption of main types of ERs in 1990 and 2023.[32]

2.3.4. Emissions in the IPPU Sector

GHG emissions from the Industrial Processes and Product Use (IPPU) sector increased by 130.4%, from 871.64 kt CO_2 eq. in 1990 to 2,008.04 kt CO_2 eq. in 2023. The IPPU sector is the source of 10.4% of all CO_2 emissions in the Kyrgyz Republic and 100% of HFC emissions.

Overall, the IPPU sector in the Kyrgyz Republic is becoming an increasingly significant source of emissions, mainly due to the mineral industry and the expansion of HFC use (see Figure 2.19).

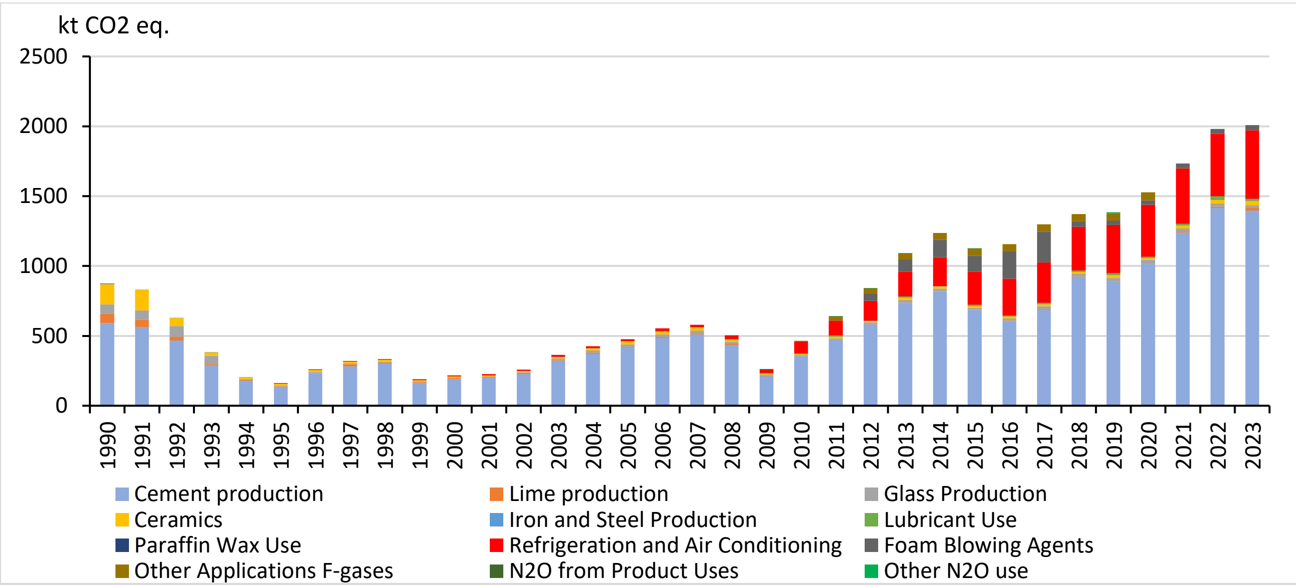


Figure 2.19. Emissions in the IPPU sector of the Kyrgyz Republic by categories for the period 1990–2023.

The main reasons for the increase in GHG emissions from this sector were the construction of several new cement plants and private smelting shops, a construction boom and expansion of brick production, as well as the beginning of active use of refrigerants and other HFC-containing materials and equipment. This led to steady growth in emissions in the relevant categories Cement Production,

[32] NSC. Distribution of Fuel and Energy Resources. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fstat.gov.kg%2Fru%2Fstatistics%2Fdownload%2Fdynamic%2F348%2F&wdOrigin=BROWSELINK

Glass Production, Ceramics Production, as well as in the category Refrigeration and Air Conditioning (stationary and mobile).

According to the National Statistics Committee of the Kyrgyz Republic, industrial production also showed a decline: of 500 once successful enterprises in machine building and electrical and electronic production, only about 50 remain in operation today. For example, during the period from 1965 to 1979, GDP in the Kyrgyz Republic increased 2.5 times. In 1979, industry accounted for 70% of all national economic output[33], but after the near-total collapse of industrial production due to the cessation of raw material and component supplies, the loss of export opportunities, and the lack of working capital, the share of industry in the country's GDP dropped to 12% in 1995, and was 12.6% in 2023.[34] Nevertheless, despite various obstacles, industrial production has gradually regained a steady growth dynamic (see Figure 2.20).

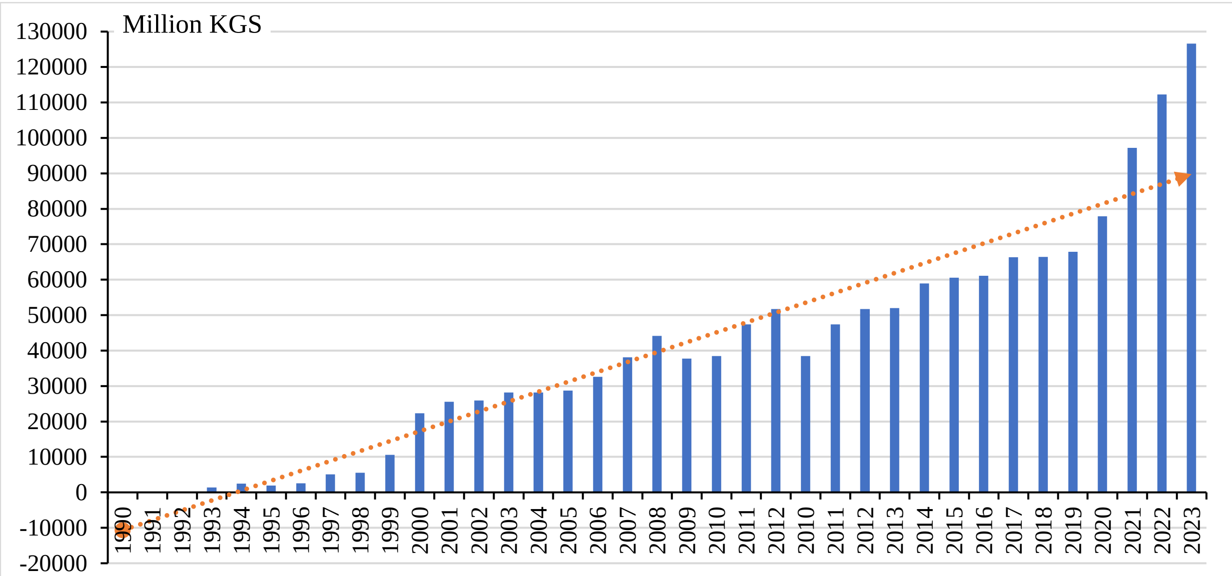


Figure 2.20. Dynamics of the Contribution of Industrial Production to GDP of the Kyrgyz Republic in the Period 1990–2023 [35]

2.3.5 Agriculture

In 2023, greenhouse gas emissions from the second-largest emitting sector — Agriculture — increased by 0.1%, from 5,746.39 kt CO_2 eq. in 1990 to 5,754.41 kt CO_2 eq. The agriculture sector is the main source of methane (CH_4) emissions. In 2023, methane emissions accounted for 70.6% of the country's methane emissions. In addition, agriculture is the main source of nitrous oxide (N_2O) emissions, which in 2023 amounted to 91% of all emissions in the Kyrgyz Republic.

The dynamics of GHG emissions in agriculture by emission source categories are presented in Figure 2.21.

[33] Minskaya Pravda. https://dzen.ru/a/YkwGNUth3hMCTq05?ysclid=ma9ouedogp56616401

[34] NSC. GDP by type of economic activity. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fstat.gov.kg%2Fru%2Fstatistics%2Fdownload%2Fdynamic%2F333%2F&wdOrigin=BROWSELINK

[35] NSC Data. GDP by industry of origin at current prices. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fstat.gov.kg%2Fru%2Fstatistics%2Fdownload%2Fdynamic%2F340%2F&wdOrigin=BROWSELINK

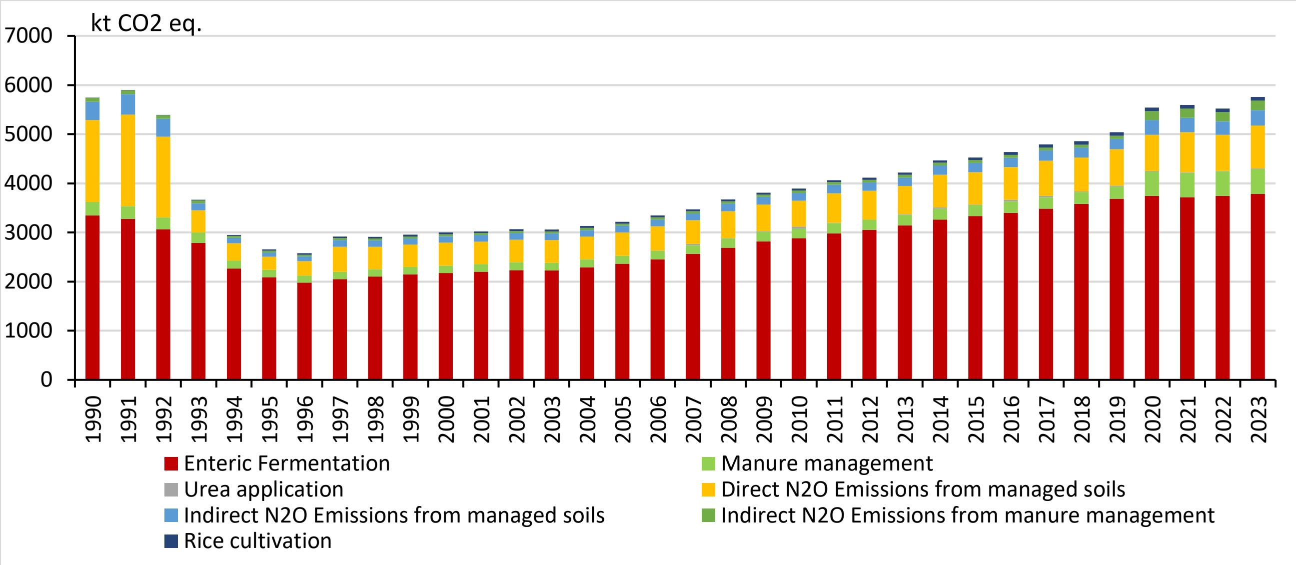


Figure 2.21. Emissions in the Agriculture sector of the Kyrgyz Republic by categories, 1990–2023

During the period 1990–1995, there was a decline in emissions in the category Enteric Fermentation (due to a reduction in livestock numbers) and in the category Direct N_2O emissions from soils (due to a sharp decline in imports of nitrogen fertilizers). This was mainly driven by the collapse of agricultural production in the period 1991–1995, the decline in living standards, and reduced purchasing power of the population, caused by the processes of political transition to market relations and socio-economic transformation of the country.

In the Soviet period, the republic had about 700 collective and state farms. Each of them managed up to 2,500 hectares of arable land. The republic was 90% self-sufficient in food products—half of which was processed within the republic itself. Of the one million hectares of irrigated arable land that once existed, only 750,000 hectares remain. In addition, the humus content in the soil was 2%, and now it is 1%, which could lead to a situation where even wild rye will soon no longer grow on our land. Many soils are saline and subject to erosion.[36]

According to data from the National Statistical Committee, out of nearly 10 million sheep that the republic had in 1991, by 1996 only 3.7 million remained. The dynamics of livestock and poultry numbers for the period 1990–2023 are presented in Figure 2.22 below.

[36] Orlov, D. Agriculture — from Dawn to Dusk. https://marx.kz/hystory/292-kak-unichtozhali-kyrgyzstan-selskoe-hozjajstvo-ot-rassveta-do-zakata.html

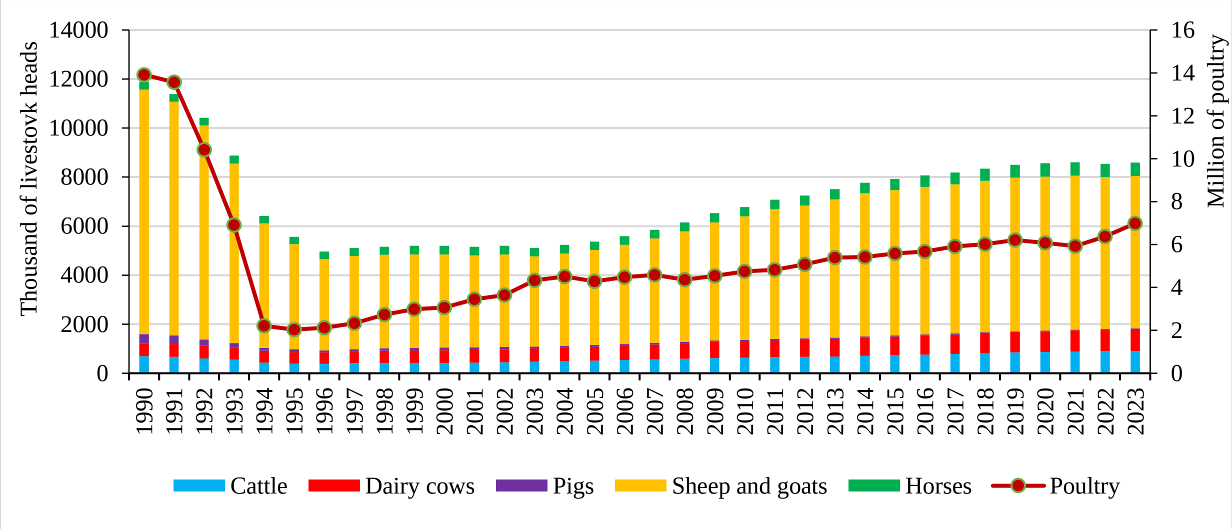


Figure 2.22. Dynamics of livestock and poultry numbers in the period 1990–2023[37]

The production of the main types of crop products in the Kyrgyz Republic during the period 1990–1995 was also characterized by a sharp decline. Thus, production of grain decreased by 39.2%, legumes by 80.0%, cotton by 7.8%, tobacco by 67.3%, melons by 67.4%, fruits and berries by 52.2%, and grapes by 54.5% (see Figure 2.23).

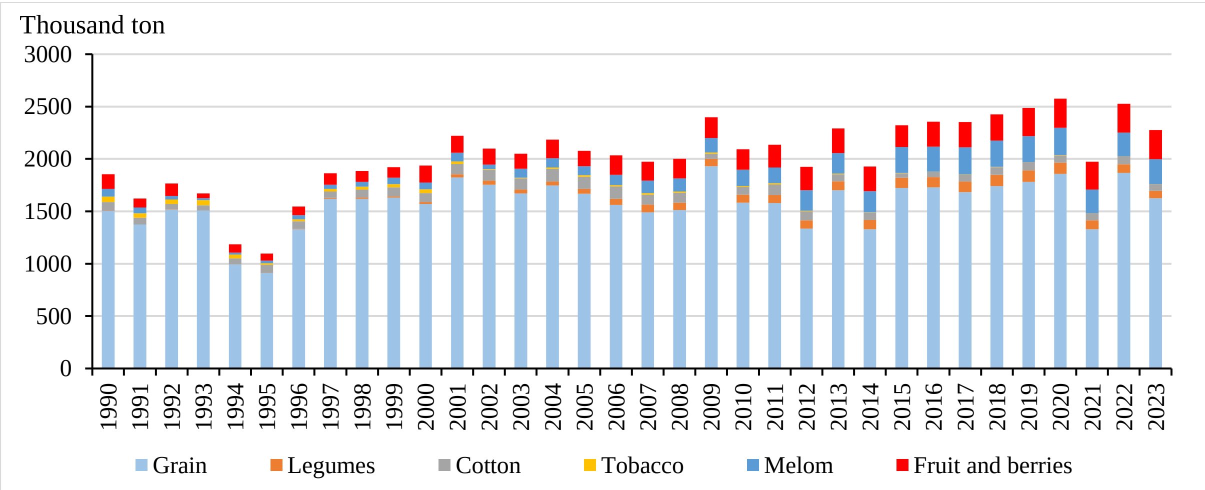


Figure 2.23. Production of main crop products in the period 1990–2023[38]

At the same time, it should be noted that in crop production, output recovered by 2000. In contrast, livestock production was able to reach the 1990 level only in 2008/2009, after the decline in 1990–1995, when meat production dropped by 29.2%, milk by 27.1%, eggs by 79.4%, and wool by 62.1% (see Figure 2.24).

[37] NSC. Livestock and poultry population. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fstat.gov.kg%2Fru%2Fstatistics%2Fdownload%2Fdynamic%2F362%2F&wdOrigin=BROWSELINK

[38] NSC. Production of main types of agricultural products of the Kyrgyz Republic. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fstat.gov.kg%2Fru%2Fstatistics%2Fdownload%2Fdynamic%2F1281%2F&wdOrigin=BROWSELINK

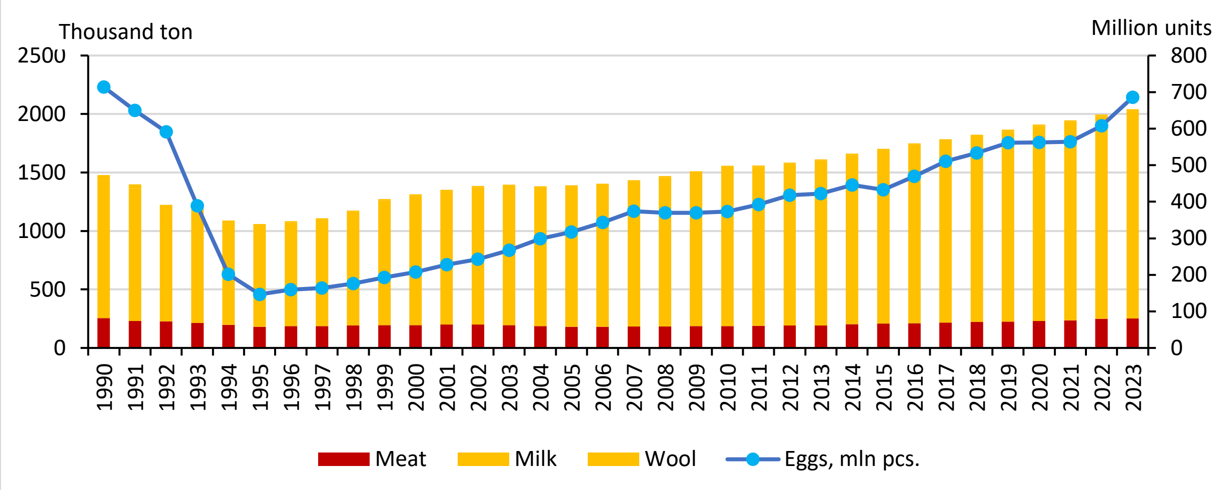


Figure 2.24. Production of main livestock products in the period 1990–2023

2.3.6 Trends in Emissions from the Waste Sector

GHG emissions from the Waste sector increased by 97.5%, from 486.040 kt CO_2 eq.in 1990 to 959.804 kt CO_2 eq.in 2023. The Waste sector is a source of carbon dioxide (CO_2) emissions, which in 2023 amounted to 14.924 kt or 0.13% of the country's total CO_2 emissions; methane (CH_4) emissions, which amounted to 881.854 kt CO_2 eq. or 16% of all methane emissions in the country; and nitrous oxide (N_2O) emissions, which amounted to 77.950 kt CO_2 eq. or 4% of all nitrous oxide emissions in the Kyrgyz Republic.

The dynamics of GHG emissions in the Waste sector by source for the period 1990–2023 are presented in Figure 2.25.

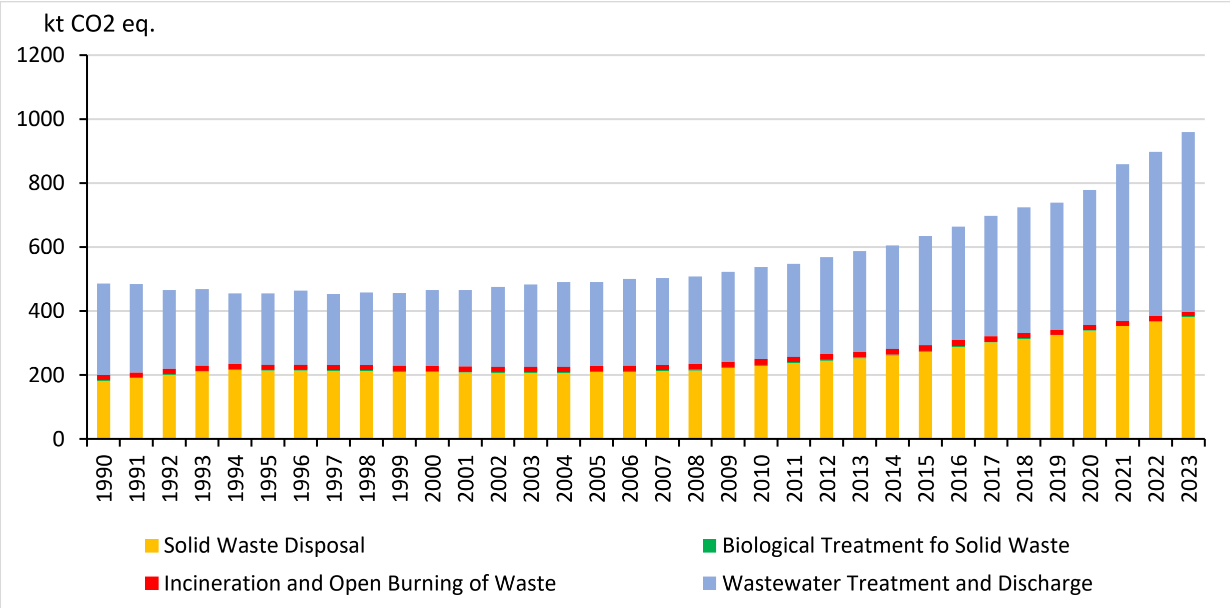


Figure 2.25. Dynamics of GHG emissions in the Waste sector by source for the period 1990–2023

As a result of high annual population growth rates (1.5–2%), the population of the Kyrgyz Republic increased from 4,357,594 in 1990 to 7,037,590 in 2023 (see Figure 2.26).

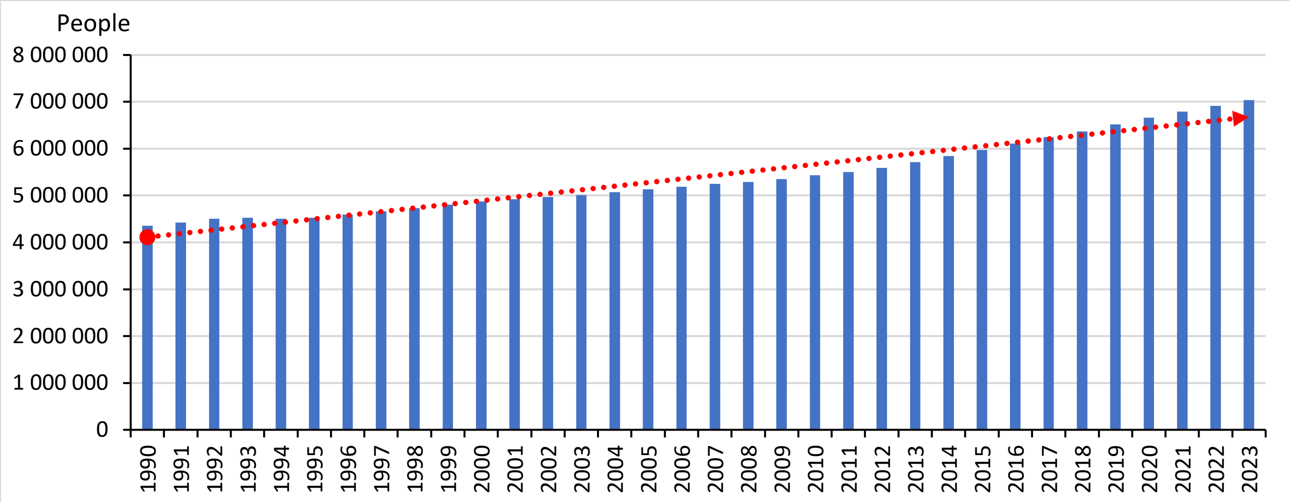


Figure 2.26. Permanent population of the Kyrgyz Republic in the period 1990–2023[39]

Accordingly, the volumes of solid household waste and wastewater also grew (see Figures 2.27 and 2.28), and in turn, emissions from the two main categories of the sector — Solid Waste Disposal and Wastewater Treatment and Discharge — also increased.

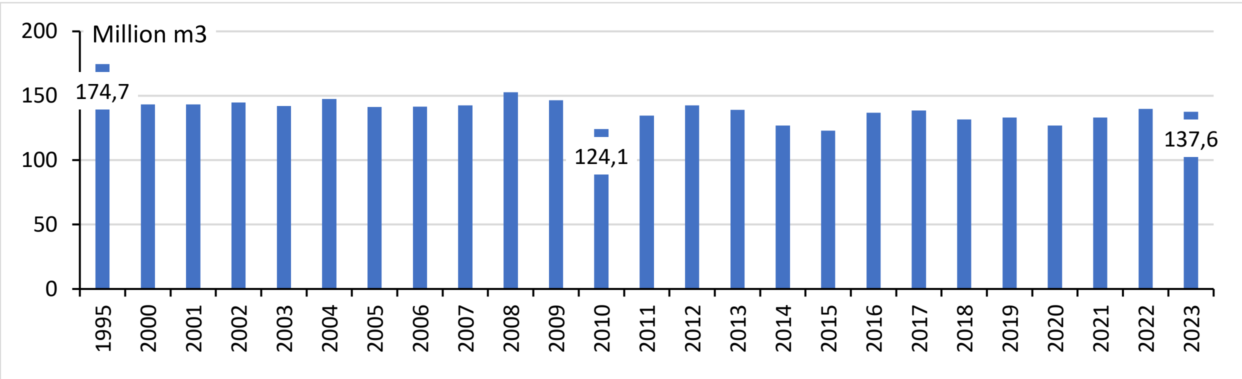
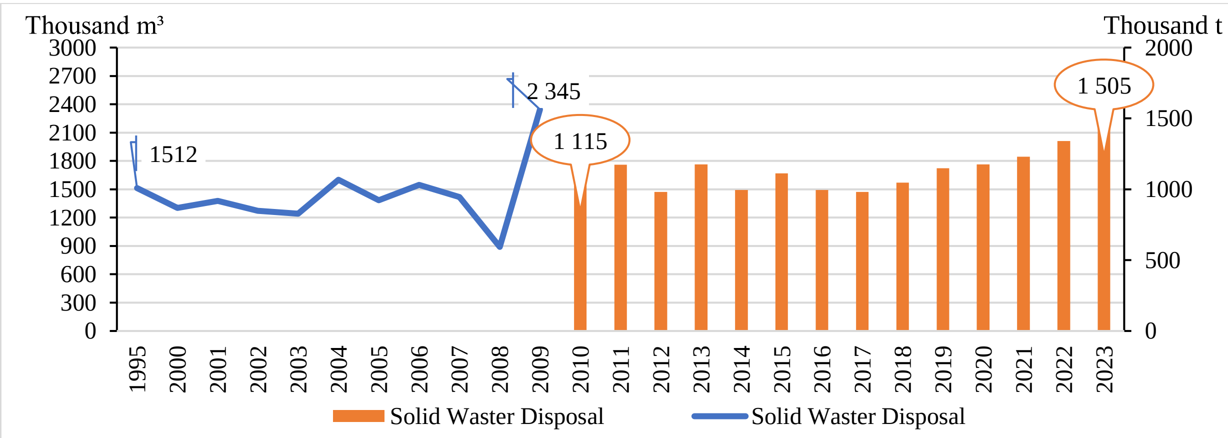


Figure 2.27. Total volume of wastewater treated through treatment facilities.[40]



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[39] NSC Data. Resident population of the Kyrgyz Republic. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fstat.gov.kg%2Fru%2Fstatistics%2Fdownload%2Fdynamic%2F315%2F&wdOrigin=BROWSELINK

[40] NSC Data. Statistical Compendiums. Environment in the Kyrgyz Republic. 2000-2006;2008-2012; 2009-2013; 2010-2014; 2011-2015; 2012-2016; 2013-2017; 2014-2018; 2015-2019; 2016-2020; 2017-2021; 2018-2022; 2019-2023.

Figure 2.28. Household waste (solid waste) removed in the Kyrgyz Republic for the period 1995–2023[41]

2.3.7. Trends in Emissions and Removals in the LULUCF Sector

The volume of removals in the LULUCF sector increased by 6.9%, from 9,639.98 kt CO_2 in 1990 to 10,308.89 kt CO_2 in 2023. Net emissions in 2023 amounted to 9,065.27 kt CO_2 eq. compared to 18,259.00 kt CO_2 eq. in 1990, which corresponds to a 53.2% reduction. In the LULUCF sector, emissions of methane (CH_4) and nitrous oxide (N_2O) occur during wildfires. In 2023, wildfires affected 79 hectares of forest, and total emissions amounted to 0.315 kt CO_2 eq., including methane (CH_4) – 66% and nitrous oxide (N_2O) – 34%. The dynamics of GHG emissions in the LULUCF sector for the period 1990–2023 are presented in Figure 2.29.

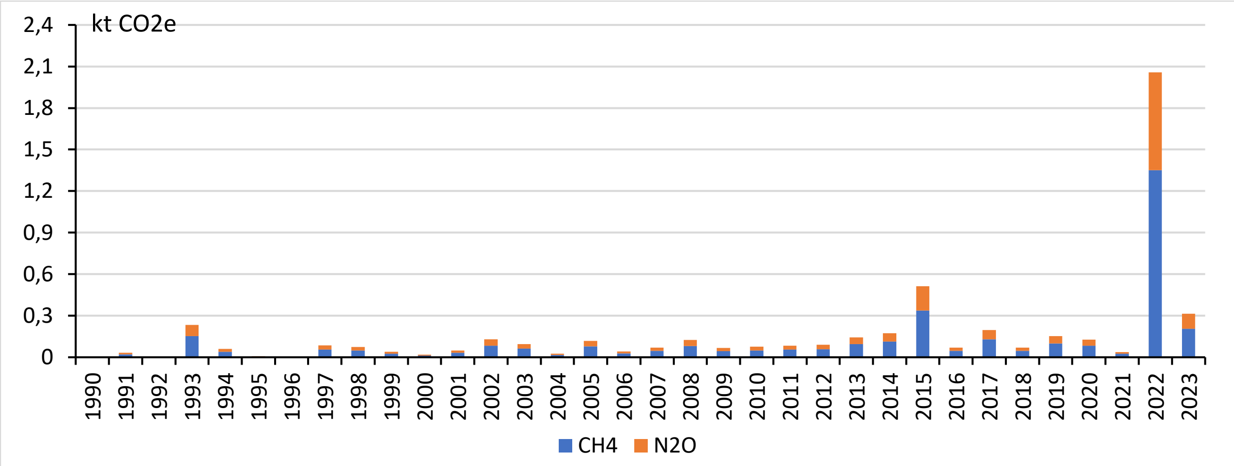
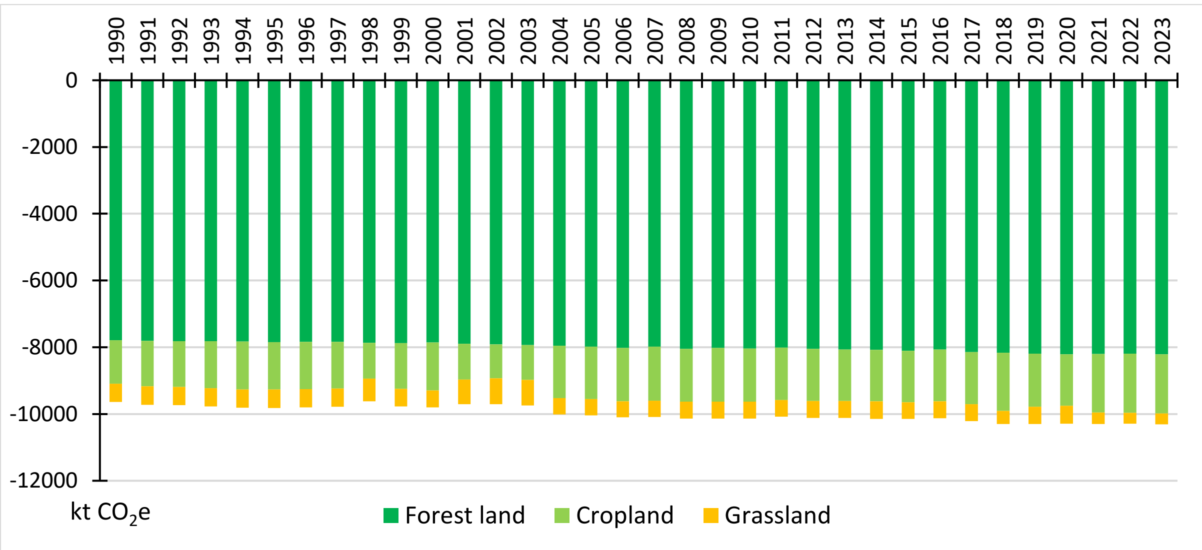


Figure 2.29. Dynamics of GHG emissions in the LULUCF sector by type of greenhouse gas for the period 1990–2023.

The dynamics of removals in the LULUCF sector from forest lands, perennial croplands, cultivated lands, and pastures for the period 1990–2023 are presented in Figure 2.30.



[41] NSC Data. Statistical Compendiums. Environment in the Kyrgyz Republic. 2000-2006;2008-2012; 2009-2013; 2010-2014; 2011-2015; 2012-2016; 2013-2017; 2014-2018; 2015-2019; 2016-2020; 2017-2021; 2018-2022; 2019-2023.

Figure 2.30. Dynamics of removals from sinks in forests and perennial plantations of cultivated lands and pastures.

1.3.2.3 Dynamics of Greenhouse Gas Emissions by Sectors

In 1990, the energy sector of the Kyrgyz Republic dominated greenhouse gas (GHG) emissions, accounting for 74% of the total emissions. Agriculture was the second-largest emitting sector, accounting for 21%, mainly due to emissions from livestock and fertilizer use. Industrial processes accounted for 3% of total emissions, with the largest contribution from cement production. The waste sector accounted for 2% of total emissions in 1990, mainly due to emissions from sanitary landfills and wastewater management. As mentioned above (see, for example, section 1.2.2.2), the LULUCF sector was a net sink in 1990 with net removals of 9,639.98 kt CO_2 eq.

It should be noted that in the period 1990–1995, the trend in emissions differed significantly from the subsequent period for two reasons: changes in the intersectoral balance and production volumes in the post-Soviet period, and the practical absence of fluorinated gas emissions, which began to be actively used in the national market only from 1995.

In 2023, the energy sector of the Kyrgyz Republic dominated (continued to dominate) GHG emissions, accounting for 55% of the total volume. This reflects the country's strong dependence on fossil fuels for electricity generation, road transport, and other energy needs. Agriculture ranked second, accounting for 20% of total GHG emissions, mainly due to emissions from livestock and fertilizer use. Emissions from industrial processes and product use accounted for 10% of total emissions, with the largest contribution from cement production and the use of cooling systems. In the waste sector, GHG emissions amounted to 5% of total GHG emissions in 2023, mainly due to emissions from sanitary landfills and wastewater management. As mentioned above (see, for example, section 1.3.2.1), the LULUCF sector remained a net sink in 2023 with total removals of 10,308.89 kt CO_2. The distribution of emissions by sectors is presented in Figure 2.31.

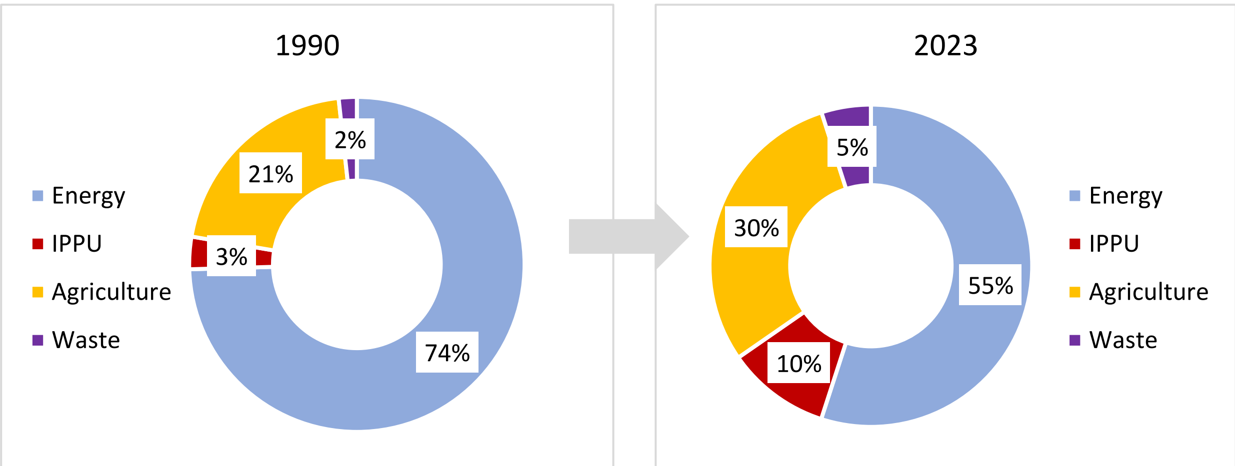


Figure 2.31. Share of greenhouse gas emissions by sectors in total emissions in 2023 in the Kyrgyz Republic

3. Energy (CRT 1)

3.1. Sector Overview (e.g., quantitative overview and description, including trends and methodological tiers by categories)

The energy sector occupies one of the leading positions in the country's economy. Energy is the main source of greenhouse gas emissions in the Kyrgyz Republic. In 2023, GHG emissions from the sector accounted for 55% of all GHG emissions in the country.

The "Energy" sector provides calculations of GHG emissions from activities covering the extraction, processing, storage, distribution, and use (combustion) of fossil and organic fuels.

According to the methodology and the 2006 IPCC Guidelines, the "Energy" sector (CRT 1) includes:

Category 1.A. "Fuel combustion activities" including the following subcategories:

- Energy industries (1.A.1 CRT)
- Manufacturing industries and construction (1.A.2 CRT)
- Transport (1.A.3 CRT)
- Other sectors (1.A.4 CRT) (Commercial, Residential, Agriculture).

Category 1.B "Fugitive emissions from fuels" (1.B CRT) including the subcategories:

- Coal mining and handling (1.B.1.a)
- Oil (1.B.2.a)
- Natural gas (1.B.2.b).

The GHG inventory of the Kyrgyz Republic includes all of the listed categories. Features of disaggregation for individual categories are described in the lower sections of this chapter.

For the assessment of emissions and data processing, the IPCC 2006 Inventory Software was used. For the main categories of the "Energy" sector, emissions of the main types of greenhouse gases were taken into account: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). In addition, GHG emissions were also assessed in CO_2 equivalent, according to GWP values of AR5.

In 2023, total GHG emissions in the "Energy" sector amounted to 10,651.90 kt CO_2 eq., which is 18.6% higher than the 2020 value (the last year of the previous inventory), but 48.8% lower than the 1990 level.

The estimates of GHG emissions in the "Energy" sector for the period 1990–2023 in kt CO_2 eq. by categories are presented in Table 3.1.

Table 3.1. GHG emissions in the "Energy" sector for the period 1990–2023.

Categories	1990	1991	1992	1993	1994	1995	1996
1 – Energy	**20,794.91**	**18,302.92**	**13,038.40**	**10,106.93**	**7,475.52**	**5,457.40**	**5,337.47**
1.A – Fuel combustion activities	20,088.94	17,634.46	12,530.06	9,738.22	7,221.24	5,258.91	5,141.51
1.A.1 – Energy industries	8,145.84	7,730.66	5,997.49	4,931.84	3,876.08	2,829.84	3,028.21
1.A.2 – Manufacturing industries and construction	1,270.31	915.03	894.65	700.50	506.34	215.15	251.28
1.A.3 – Transport	4,296.43	3,709.32	2,963.78	1,647.53	773.41	1,216.59	1,020.29
1.A.4 – Other sectors	6,376.36	5,279.44	2,674.14	2,458.35	2,065.41	997.33	841.72
1.B – Fugitive emissions from fuels	705.97	668.46	508.34	368.70	254.28	198.49	195.97
1.B.1 – Solid fuels	370.94	345.05	240.60	171.53	92.21	34.80	30.75
1.B.2 – Oil and natural gas	335.03	323.41	267.75	197.17	162.07	163.69	165.22
Categories	1997	1998	1999	2000	2001	2002	2003
1 – Energy	**5,83372**	**5,277.20**	**5,271.36**	**4,800.18**	**5,114.27**	**4,766.63**	**4,913.61**
1.A – Fuel combustion activities	5,644.90	5,100.61	5,118.72	4,638.91	4,954.30	4,595.99	4,767.22
1.A.1 – Energy industries	3,243.75	2,673.66	2,425.25	2,444.97	2,500.57	2,265.16	2,030.05
1.A.2 – Manufacturing industries and construction	282.79	267.08	251.37	260.47	276.46	251.64	236.82
1.A.3 – Transport	1,432.25	1,306.39	1,421.26	900.60	1,159.01	831.28	1,023.15
1.A.4 – Other sectors	686.11	853.48	1,020.85	1,032.88	1,018.26	1,247.91	1,477.20
1.B – Fugitive emissions from fuels	188.82	176.59	152.64	161.27	159.96	170.63	146.39
1.B.1 – Solid fuels	27.89	26.53	25.89	25.40	26.39	26.49	21.41
1.B.2 – Oil and natural gas	160.94	150.06	126.75	135.87	133.57	144.15	124.97
Categories	2004	2005	2006	2007	2008	2009	2010
1 – Energy	**5,154.21**	**5,505.41**	**5,540.84**	**6,624.49**	**7,537.96**	**7,195.65**	**6,619.77**
1.A – Fuel combustion activities	5,003.98	5,361.54	5,406.05	6,494.49	7,401.97	7,078.76	6,496.89
1.A.1 – Energy industries	1,794.93	2,304.00	2,206.98	2,346.20	2,709.87	2,382.11	1,936.01
1.A.2 – Manufacturing industries and construction	221.37	788.51	865.74	893.67	826.56	477.27	586.55
1.A.3 – Transport	1,278.97	1,300.42	1,353.34	2,156.62	2,343.63	2,725.88	2,431.29
1.A.4 – Other sectors	1,708.71	968.61	980.00	1,098.00	1,521.91	1,493.50	1,543.04
1.B – Fugitive emissions from fuels	150.23	143.87	134.79	130.00	135.99	116.89	122.88
1.B.1 – Solid fuels	16.90	14.08	11.97	10.64	15.17	17.11	15.38
1.B.2 – Oil and natural gas	133.33	129.79	122.82	119.37	120.81	99.78	107.50
Categories	2011	2012	2013	2014	2015	2016	2017

1 – Energy	**7,962.36**	**9,492.61**	**8,709.26**	**9,525.44**	**10,283.35**	**9,064.59**	**9,662.52**
1.A – Fuel combustion activities	7,836.77	9,350.30	8,552.55	9,351.91	10,099.42	8,845.82	9,421.42
1.A.1 – Energy industries	1,949.66	2,020.92	1,719.17	2,761.82	3,455.58	2,249.44	1,825.13
1.A.2 – Manufacturing industries and construction	597.08	802.83	874.74	848.68	683.32	571.35	780.89
1.A.3 – Transport	3,298.89	4,577.11	4,789.98	3,800.92	3,985.08	3,994.94	4,331.32
1.A.4 – Other sectors	1,991.14	1,949.43	1,168.66	1,940.50	1,975.44	2,030.10	2,484.07
1.B – Fugitive emissions from fuels	125.60	142.31	156.70	173.52	183.94	218.77	241.10
1.B.1 – Solid fuels	18.90	29.58	42.65	62.04	47.89	44.67	40.36
1.B.2 – Oil and natural gas	106.69	112.73	114.05	111.48	136.05	174.10	200.74

Categories	2018	2019	2020	2021	2022	2023	Change since 1990, %
1 – Energy	**11,379.72**	**9,426.28**	**8,977.85**	**10,573.98**	**10,672.88**	**10,651.90**	**-48.8**
1.A – Fuel combustion activities	11,093.83	9,104.46	8,578.57	10,032.58	10,066.05	10,007.62	-50.2
1.A.1 – Energy industries	2,357.42	2,360.49	2,594.18	3,487.97	3,327.61	3,318.00	-59.3
1.A.2 – Manufacturing industries and construction	873.47	551.24	532.81	576.02	646.83	530.06	-58.3
1.A.3 – Transport	4,982.76	3,953.17	3,454.13	3,939.64	3,767.81	3,601.42	-16.2
1.A.4 – Other sectors	2,880.18	2,239.56	1,997.45	2,028.96	2,323.80	2,558.15	-59.9
1.B – Fugitive emissions from fuels	285.89	321.82	399.28	541.39	606.83	644.28	-.,7
1.B.1 – Solid fuels	57.06	62.08	132.32	234.18	275.61	304.96	-17.8
1.B.2 – Oil and natural gas	228.83	259.74	266.96	307.22	331.22	339.32	1.3

The overall trend of GHG emissions in the "Energy" sector and the difference in GHG emissions in 2023 compared to the base year 1990 by main source categories are presented in Table 3.2.

Table 3.2. Overall trend of GHG emissions in the "Energy" sector by categories for the period 1990–2023.

Category	1990 (kt CO_2e)	2023 (kt CO_2-e)	Difference 1990-2023, kt CO_2-e	Difference 1990-2023, %
Energy industries (1.A.1 CRT)	8,145.84	3,318.00	-4.827.84	-59.27
Manufacturing industries and construction (1.A.2 CRT),	1,270.31	530.06	-740.25	-58.27
Transport (1.A.3 CRT)	4,296.43	3,601.42	-695.01	-16.18
Other sectors (1.A.4 CRT)	6,376.36	2,558.15	-3.818.21	-59.88
Coal mining and processing (1.B.1.a)	370.94	304.96	-65.98	-17.79
Oil and gas (1B.2)	335.03	339.32	4.29	1.28
Total for the energy sector	**20,794.91**	**10,651.90**	**-10.143.01**	**-48.78**

As can be seen from the table, GHG emissions in the "Energy" sector show a declining trend across all categories except the "Oil and gas" category.

Trends in GHG emissions by gas types in the Energy sector for the period 1990–2023 are presented in Figure 3.1.

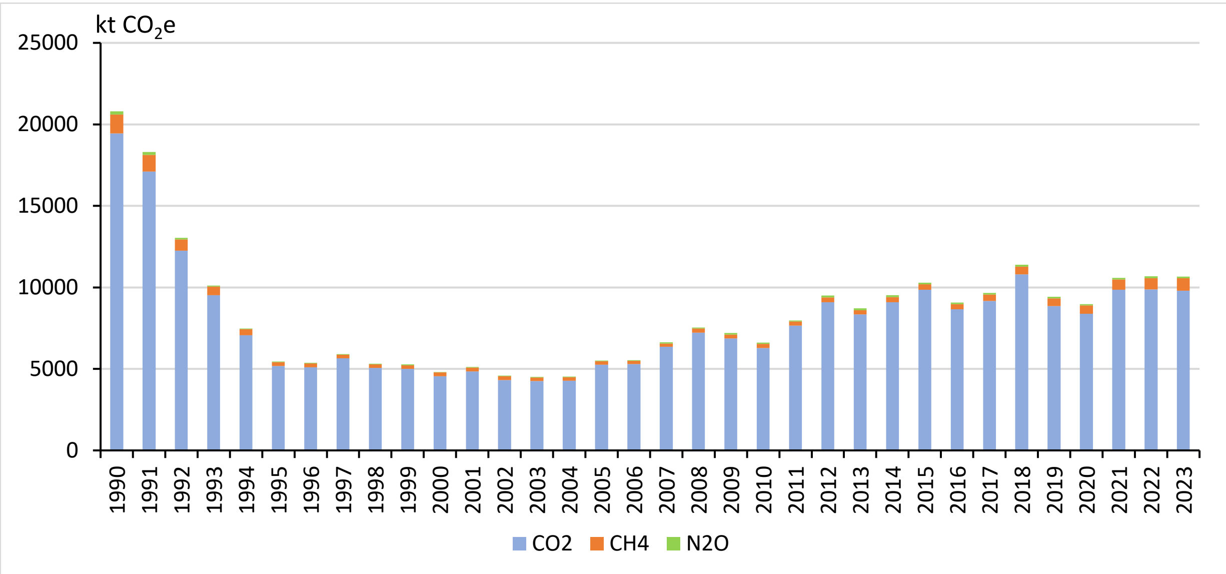


Figure 3.1. Dynamics of GHG emissions by gas types in the Energy sector for the period 1990–2023.

The trend of emissions from the Energy sector shows a sharp decline between 1990 and 1996, followed by a gradual increase in GHG emissions. These changes occurred as a result of a shift in the economic structure, reduced production volumes and energy demand after the collapse of the USSR, followed by economic stabilization, population growth, and gradual industrial expansion. A small decline was also observed in 2020, which was associated with the COVID-19 pandemic.

GHG emissions in the Energy sector by individual gases for the period 1990–2023 are presented in Figure 3.2, which shows that 92–93% of all GHG emissions are carbon dioxide (CO_2).

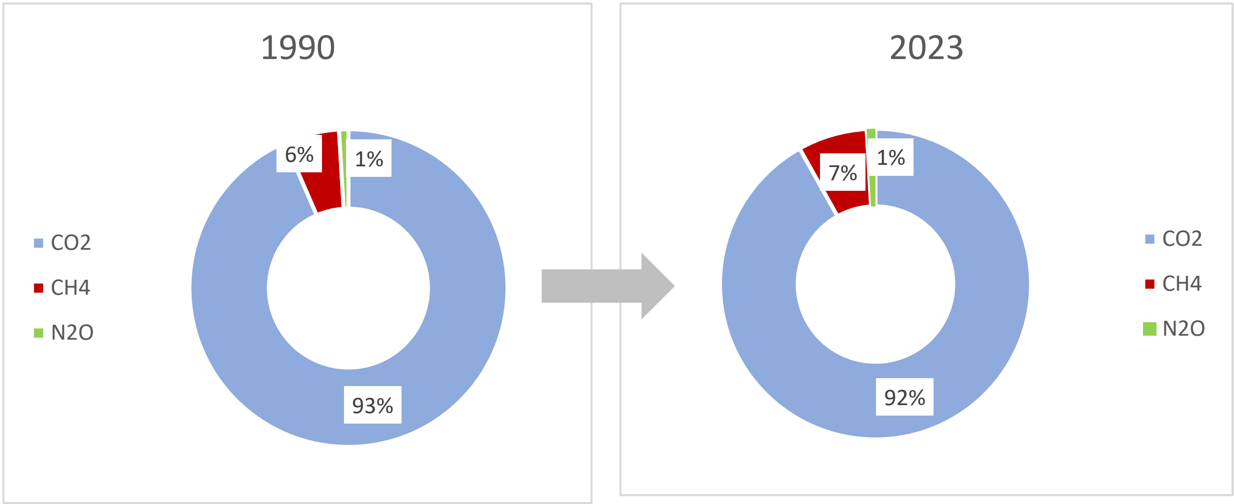


Figure 3.2. GHG emissions in the "Energy" sector by gas types in 1990 and 2023.

The estimated values of GHG emissions by gas types in the Energy sector for the period 1990–2023, in kt CO_2 eq., are presented in Table 3.3.

Table 3.3. Estimated values of GHG emissions in the Energy sector by gas types for the period 1990–2023

Year	CO2	CH4	N2O	Year	CO2	CH4	N2O
1990	19,438.72	1,158.31	197.88	**2007**	6,352.87	203.70	67.92
1991	17,101.35	1,034.45	167.12	**2008**	7,225.83	241.80	70.33
1992	12,259.59	673.63	105.18	**2009**	6,874.16	223.13	98.36
1993	9,530.03	512.52	64.38	**2010**	6,276.74	257.02	86.01
1994	7,072.56	369.25	33.72	**2011**	7,650.59	258.12	53.65
1995	5,172.25	234.58	50.57	**2012**	9,090.01	292.22	110.38
1996	5,068.02	228.21	41.25	**2013**	8,344.30	246.21	118.75
1997	5,571.04	223.85	38.82	**2014**	9,086.28	320.62	118.53
1998	5,017.22	226.30	33.68	**2015**	9,845.18	327.47	110.70
1999	4,997.31	214.15	59.90	**2016**	8,639.47	326.56	98.56
2000	4,550.13	224.58	25.47	**2017**	9,158.33	396.55	107.64
2001	4,834.68	230.23	49.35	**2018**	10,803.23	457.22	119.27
2002	4,498.92	239,35	28.35	**2019**	8,858.36	464.71	103.21
2003	4,670.33	217.68	25.60	**2020**	8,372.05	513.70	92.10
2004	4,900.46	224.56	29.19	**2021**	9,844.78	629.60	99.61
2005	5,262.32	202.79	40.31	**2022**	9,869.17	701.99	101.72
2006	5,304.00	196.55	40.29	**2023**	9,787.92	767.18	96.79

During the NIR 1990–2023, the sector also included an assessment of precursor gas emissions: nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), and sulfur dioxide (SO_2). The dynamics of precursor gas emissions are presented in Figure 3.3.

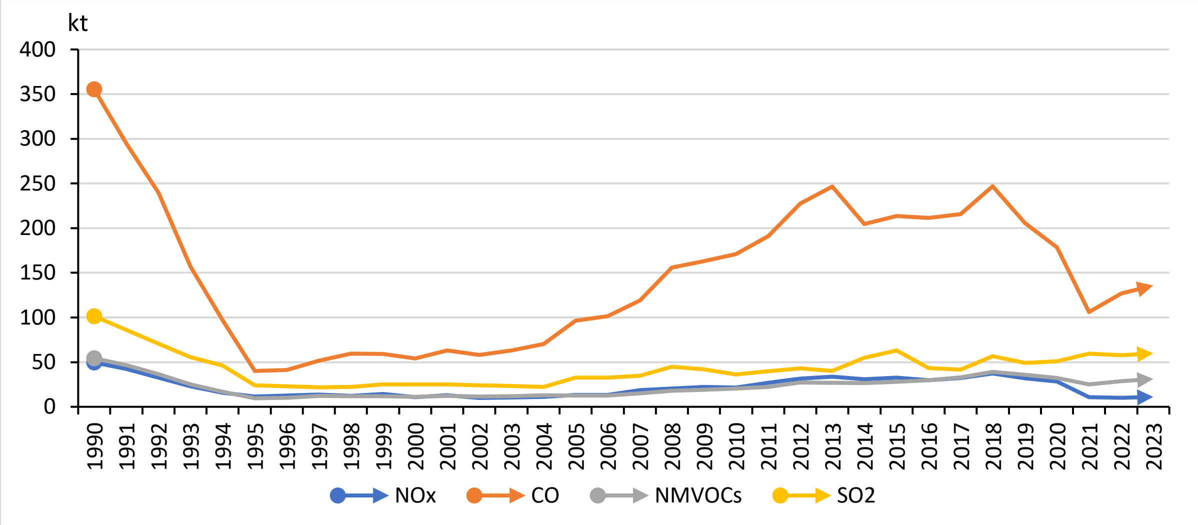


Figure 3.3. Dynamics of precursor gas emissions by gas types in the Energy sector for the period 1990–2023.

3.2. Category "Fuel combustion" (CRT 1.A)

The fuel combustion category is the main source of GHG emissions in the Energy sector. The overall dynamics of GHG emissions from fuel combustion compared to total sectoral emissions are presented in Figure 3.4. The trend of GHG emissions from fuel combustion is similar to the changes in total GHG emissions from the sector, which were described in the sector overview above.

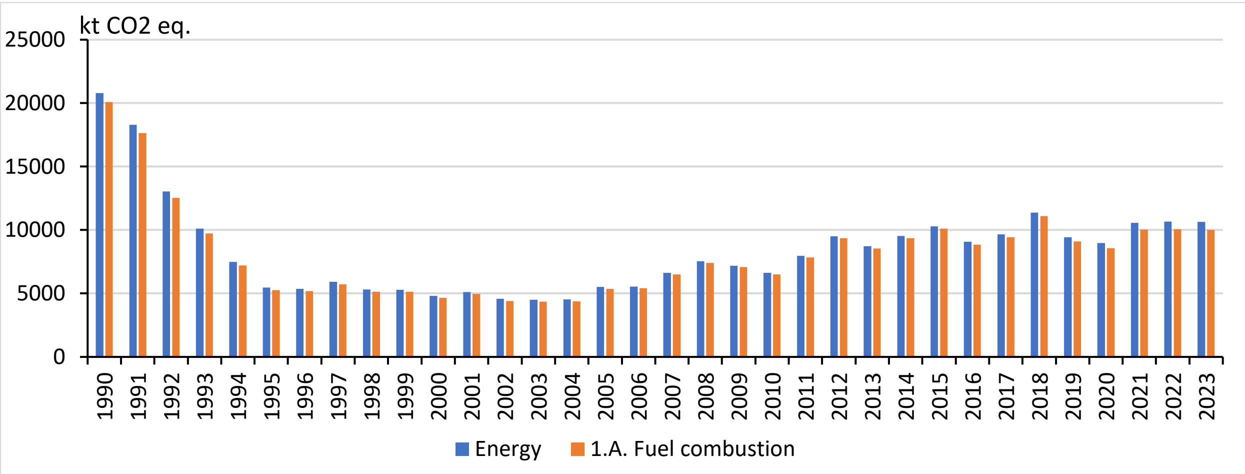


Figure 3.4. Share of GHG emissions from Fuel combustion in total sectoral emissions in the Energy sector.

Emissions in this category in 2023 amounted to 10,007.62 kt CO_2 eq., or 94% of total GHG emissions in the sector, which is 16.6% higher than in 2020, but 50.2% lower than in 1990.

In category 1.A "Fuel combustion activities," emissions were assessed by the following subcategories:

1.A.1.a Electricity and heat production;

1.A.1.b Oil refining;

1.A.2 Manufacturing industries and construction;

1.A.3 Transport (by type of transport);

1.A.4.a Commercial/Institutional sector;

1.A.4.b Residential sector;
1.A.4.c Agriculture.

The largest emissions in the “Energy” sector are produced by the category “Transport (1.A.3 CRT),” since according to the results of calculations in 2023, its share accounted for no less than 33.8% of all GHG emissions in the sector. GHG emissions in the category “Transport (1.A.3 CRT)” in 2023 amounted to 3,601.42 kt CO_2 eq., which is 4.3% higher than in 2020 and 16.2% lower than the 1990 level.

The second largest contributor to total emissions from the “Energy” sector is the category “Energy industries (1.A.1 CRT).” In 2023, the contribution of this category was 31.1%. Compared to 2020, emissions from the category “Energy industries (1.A.1 CRT)” in 2023 increased by 27.90% and amounted to 3,317.997 kt CO_2 eq. Compared to the base year 1990, emissions from this category also decreased by 59.3%.

Next in terms of emissions in the “Energy” sector, with a share of 24%, are emissions from the category “Other sectors (1.A.4 CRT).” GHG emissions in the category “Other sectors (1.A.4 CRT)” in 2023 amounted to 2,558.547 kt CO_2 eq., which is 28.1% higher than in 2020 and 59.87% lower than the 1990 level.

Emissions from the category “Manufacturing industries and construction” in 2023 amounted to 531.145 kt CO_2 eq., or 5% of total sector emissions, which is 0.7% lower than in 2020 and 58.2% lower than the 1990 level.

The distribution of GHG emissions in the “Energy” sector by categories in 1990 and 2023 is presented in Figure 3.5.

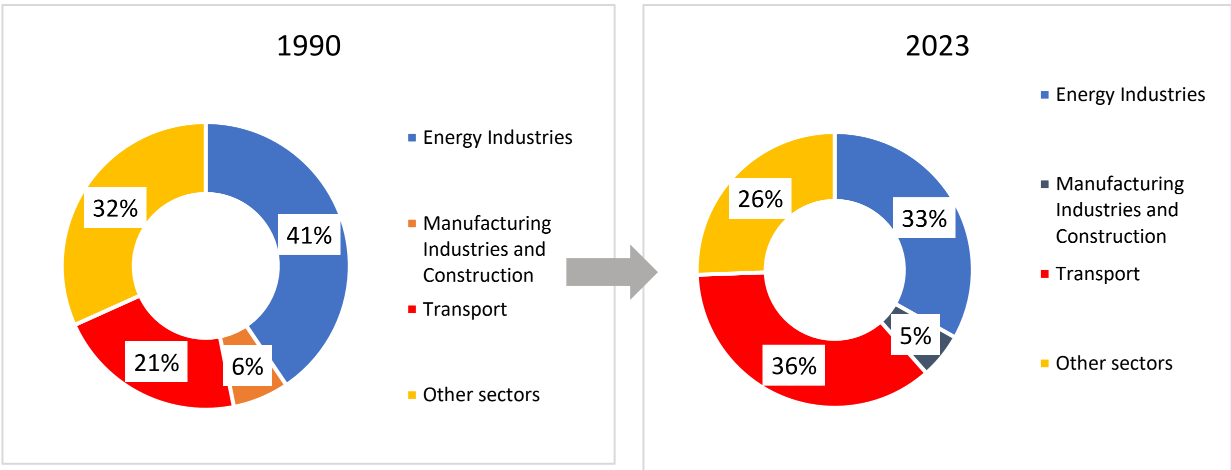


Figure 3.5. Shares of emissions of subcategories of the category “Fuel combustion activities” in 1990 and 2023.

The dynamics of emissions in the category “Fuel combustion activities” by source subcategories for the period 1990–2023 are presented in Figure 3.6.

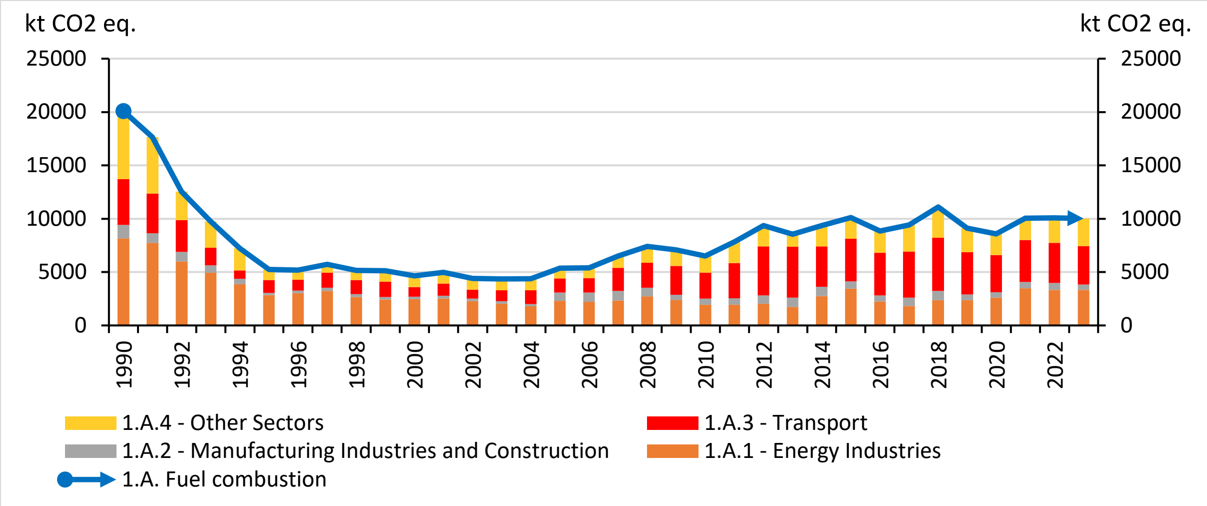


Figure 3.6. Dynamics of GHG emissions by subcategories of the category "Fuel combustion activities" for the period 1990–2023.

3.2.1 Reference approach

CO_2 emissions from fuel combustion were also assessed by the reference approach. Then a comparison was made between the reference and the sectoral approach for the assessment of CO_2 emissions from fuel combustion.

3.2.2 Comparison of the sectoral approach with the reference approach

The reference approach represents the calculation of emissions based on the total consumption of primary and secondary fuels in the country. Calculations were carried out according to the 2006 IPCC Guidelines, Tier 1, in accordance with Equation 6.1, using the values of the lower calorific value of fuels and their carbon content, similar to those used in calculations by the sectoral approach. For the calculations, fuel balance data provided by the National Statistical Committee of the Kyrgyz Republic were used. [42]Actual consumption was calculated as the sum of data on the production of primary fuels and fuel imports minus fuel exports, bunker fuels (estimated data), and stock changes.

The sectoral approach implies the calculation of emissions using information on the final consumption of fuel types in the sectors of the economy, carried out on the basis of energy balance data.

A comparative assessment of CO_2 eq. emissions by the reference and sectoral approaches was carried out in the sector for the category "Fuel combustion activities" (1.A CRT). For the purpose of controlling calculated values of GHG emissions in the "Energy activities" sector, in accordance with the 2006 IPCC Guidelines, a comparative assessment of CO_2 eq. emissions by the reference and sectoral approaches were carried out. The reference approach provides an assessment of CO_2 eq. emissions based on fuel resources in the country, while the sectoral approach is based on fuel consumption (combustion).

The dynamics of CO_2 eq. emissions according to the two approaches, and the percentage difference between them for the period 1990–2022, are presented in Figure 3.7.

[42] NSC. https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/

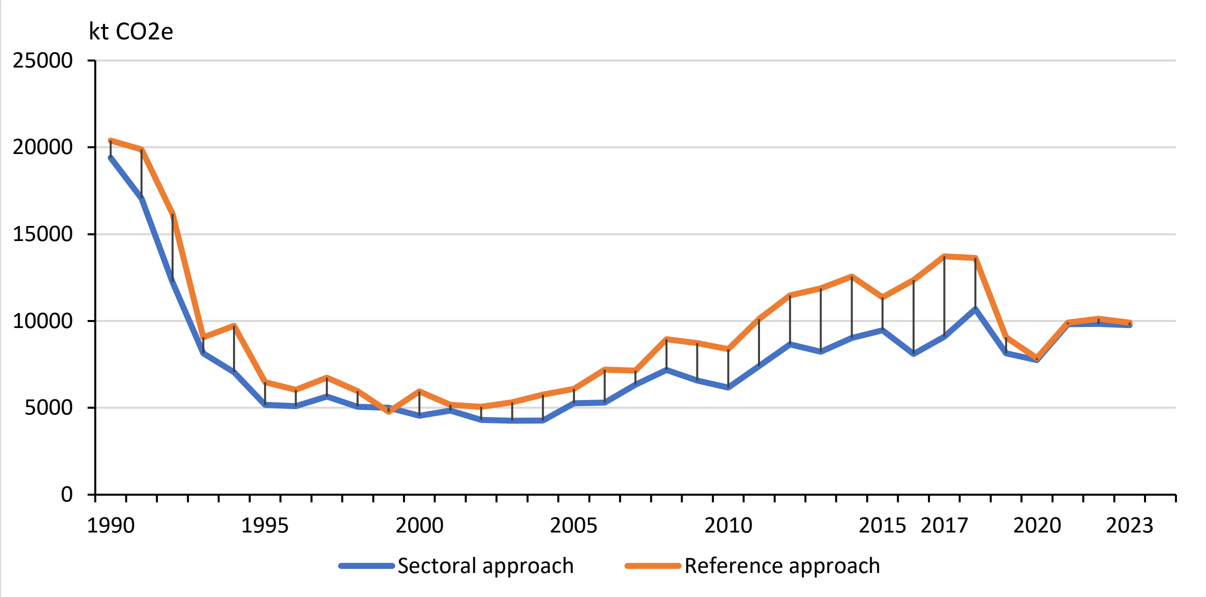


Figure 3.7. Dynamics of CO_2 eq. emissions by reference and sectoral approaches in the Energy sector, 1990–2022.

In general, during the period 1990–2019, GHG emissions in CO_2 eq. by the reference approach exceeded emissions by the sectoral approach, that is, fuel resources according to the national statistical energy balance (EB)[43] were greater than fuel consumption. In recent years, the gap between the two approaches has significantly narrowed. From 2020 to 2023, a notable convergence of the indicators was observed, with CO_2 eq. emissions by the sectoral approach being lower than by the reference approach. In 2023, the difference between the two approaches was 1.4% in favor of the reference approach. A comparative assessment of GHG emissions in CO_2 eq. in the category "Fuel combustion activities" by the reference and sectoral approaches by fuel type for 2023 is presented in Table 3.4.

Table 3.4. Comparative assessment of CO_2 eq. emissions in the sector "Fuel combustion activities" by the reference and sectoral approaches by fuel type for 2023.

Fuel type, TJ	Approach		
	Reference	Sectoral	Difference %
Solid	40,370.50	39,776.300	1.47
Liquid	75,833,17	70,091.430	7.63
Gaseous	14,730.16	13,244.010	10.09

3.2.3. International bunker

International aviation

According to the methodological guidelines of the Intergovernmental Panel on Climate Change (IPCC), greenhouse gas emissions resulting from the combustion of fuel in international air transport are classified under the category "International aviation" and are accounted for separately from emissions on the territory of the country under the item "International bunker." [44] Emissions from

[43] NSC. https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/

[44] IPCC 2006. Guidelines for National Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

flights with the point of departure in one country and the point of arrival in another are not included in national totals; however, they are subject to mandatory reporting within the framework of the inventory of emissions. Military aviation flights are not included in the category “Transport” and were not accounted for.

Within the framework of the national emissions accounting system of the Kyrgyz Republic, it was possible to carry out the relevant calculations for international aviation. This was made possible through cooperation with the State Agency of Civil Aviation (SACA), which provided data on aviation fuel (jet kerosene) consumption since 2011, disaggregated into international and domestic aviation. It should be noted that the collection of information in this area was accompanied by significant difficulties. The National Statistical Committee (NSC) published data on the use of aviation fuel irregularly, even aggregated, and never separately for domestic and international flights.

Nevertheless, as a result of additional requests and archival research, it was possible to construct a continuous time series of aviation fuel consumption data from 1990 to 2010, which made it possible to perform calculations of emissions in the category “International aviation” by the Tier 1 IPCC 2006 methodology. Transition to a higher tier is not feasible due to the absence of a country-specific emission factor.

The assessment of activity data for international aviation is based on volumes of jet kerosene consumption in international flights performed by aircraft, reflected in the archives of national experts from the Technical Expert Group of the UNFCCC, and since 2011 in the reports of the Civil Aviation Agency under the Cabinet of Ministers of the Kyrgyz Republic. The decision was supported in the meetings of the Working Groups held as part of the development of the national inventory under QA/QC procedures.

International navigation

The situation with accounting for emissions from international navigation in the Kyrgyz Republic is fundamentally different. Water transport in the country is not represented as a significant category of transport activity. The Kyrgyz Republic has no access to the sea and no navigable rivers, which effectively excludes the existence of regular or economically significant water transport.

Some activity of water transport historically occurred on Lake Issyk-Kul, but at present such transport has been reduced to zero and does not represent an active transport category. The physical-geographical conditions, including mountainous terrain and the absence of suitable waterways, combined with economic impracticality, make the development of inland and international navigation virtually impossible.

As a result, emissions from the combustion of bunker fuel for international maritime navigation are absent. In the current GHG emissions inventory, the category “International navigation” is designated as “NO,” which fully corresponds to the actual situation.

In conclusion, it can be emphasized that in the framework of reporting on international bunker fuel, the main focus is on aviation activities, while maritime navigation for Kyrgyzstan is not relevant and has no impact on the overall volume of greenhouse gas emissions. The dynamics of GHG emissions from international aviation bunker fuel are presented in Figure 3.8.

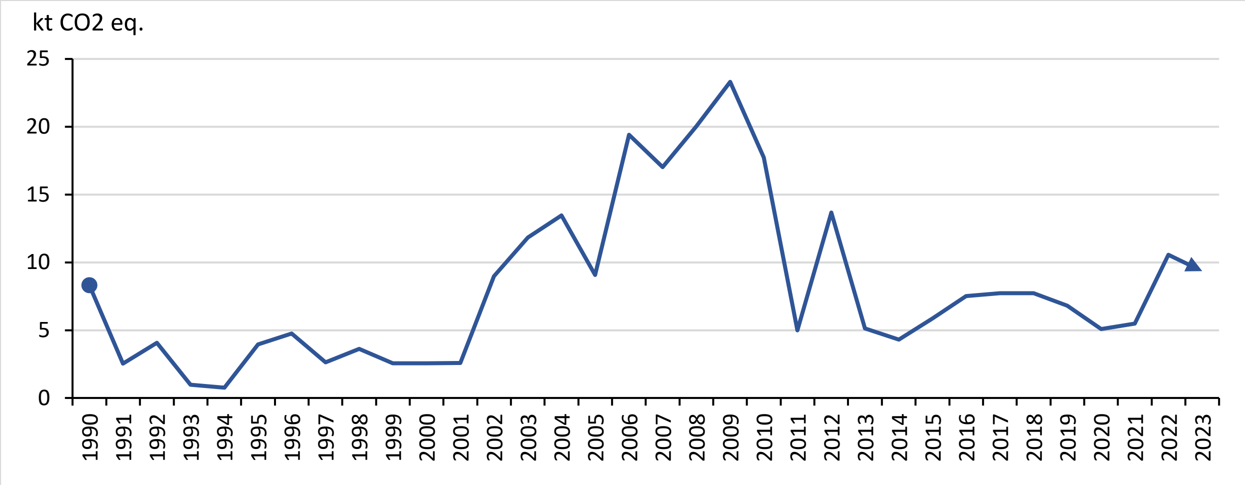


Figure 3.8. Dynamics of GHG emissions from international aviation bunker fuel, 1990-2023.

3.2.4. Raw Materials and Non-Energy Use of Fuels

In general, non-energy use of fuels occurs in the category “Industrial Processes and Product Use” (1.A.2, CRT 2), where fuels are burned to achieve the high temperatures required in technological production processes. This includes cement production, fired bricks, lime, and ceramic products.

Analysis of the fuel use structure, based on the Energy Balance of the Kyrgyz Republic, shows a positive and logical picture: gasoline and diesel fuel intended for domestic consumption are almost entirely directed strictly for their purpose—to the “Transport” category (1.A.3, CRT 1), including fuel for the population. These volumes are fully reflected in the corresponding line of the energy balance “Consumed within the republic.” [45]

This means that expensive transport fuels are not diverted for other uses, which contributes to transparency and logical allocation of fuel, as well as simplifies the analysis and calculation of greenhouse gas emissions.

3.2.5. Category “Energy Industries” (1.A.1 CRT)

3.2.5.1. Category Description

This section presents data on fuel consumption and greenhouse gas emissions by categories:

- Public electricity and heat production (1.A.1.a)
- Petroleum refining (1.A.1.b)

An overview of the methods used and the emission factors (EF), as well as an indication of whether or not a category is key, are presented in Table 3.5.

Table 3.5. Methods, EFs, and indicators of key categories for 2023 in energy industries.

Fuel type	CO2			CH4			NO2		
	Method	EF	Key category	Method	EF	Key category	Method	EF	Key category
Solid	T 1	D	L, T	T 1	D	-	T 1	D	-

[45] NSC website: https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/

Fuel type	CO_2			CH_4			NO_2		
	Method	EF	Key category	Method	EF	Key category	Method	EF	Key category
Liquid	T 1	D	T	T 1	D	-	T 1	D	-
Gaseous	T 1	D	T	T 1	D	-	T 1	D	-
Biomass	T 1	D	-	T 1	D	-	T 1	D	-

Note: T1 – IPCC 2006 Guidelines, Tier 1; D – IPCC Guidelines default emission factors.

Electric and heat generation is the most important category in this subsector, with a share of GHG emissions of 99% in the base year 1990 and almost 93% in 2023. The other category consists mainly of fuel consumption at several oil refineries. Emissions are shown in Figure 3.9 and in Table 3.6.

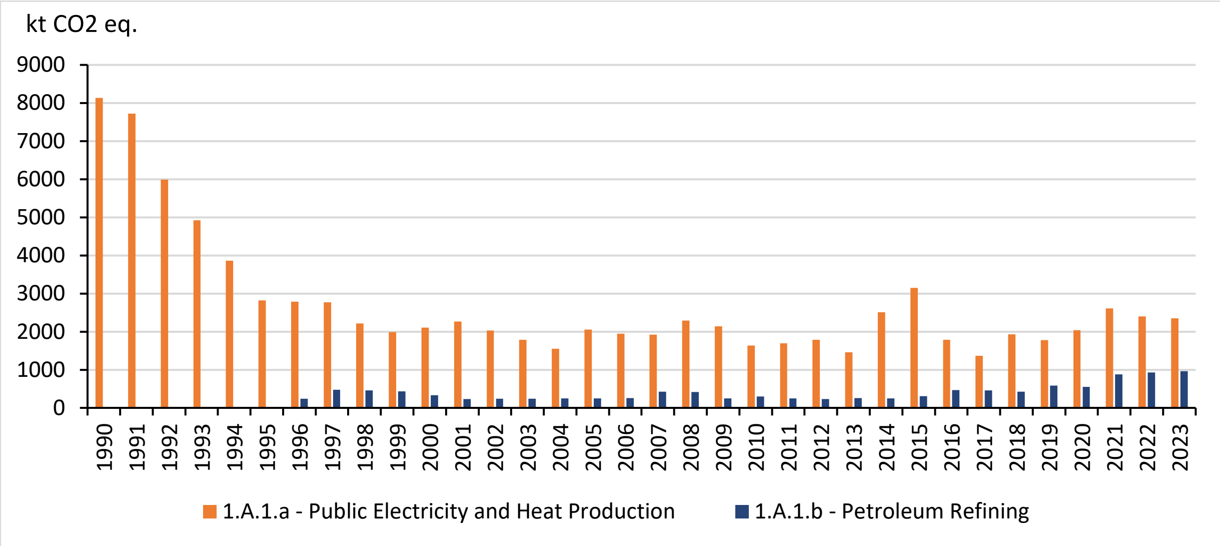


Figure 3.9. Greenhouse gas emissions from energy industries

The existing oil refineries are unable to supply the domestic market with the necessary products. Kyrgyzstan's demand for petroleum products is met mainly through imports. The subcategory "Solid fuel production and other energy industries" (1.A.1.c) was not assessed, since this type of production is absent in the republic. Emissions in the category "Energy Industries" are presented in Table 3.6.

Table 3.6. Greenhouse gas emissions from energy industries in kt CO_2 eq.

Categories	1990	1995	2000	2005	2010	2015	2020	2023
1.A.1 -Energy Industries	**8,145.73**	**2,829,84**	**2,444.97**	**5,362.76**	**1,936.01**	**3,455.58**	**2,594.18**	**3,318.00**
1.A.1.a - Public electricity and heat production	8,136.43	2,820,82	2,10.62	2,304.00	1,633.94	3,152.58	2,042.00	2,353.32
1.A.1.b - Petroleum refining	9.30	9,02	335.35	249.49	303.00	303.00	552.18	964.68

GHG emissions in this subcategory in 2023 decreased by 59.3% compared to 1990.

3.2.5.2. Methodological Issues

Methods used

For estimating GHG emissions in category 1.A.1 "Energy Industries," Tier 1 methodology of the IPCC 2006 Guidelines was applied, using default emission factors (see Table 3.8 – Emission factors for GHGs in the "Energy Activities" sector). Emissions of greenhouse gases from each type of fuel used for energy production were calculated according to Equation 2.1 of the IPCC 2006 Guidelines, Vol. 2, Ch. 2, p. 2.11:

GREENHOUSE GAS EMISSIONS FROM STATIONARY FUEL COMBUSTION
GHG Emissions, fuel = Fuel Consumption × Emission Factor (GHG, fuel)

Where,
GHG Emissions, fuel = emissions of the given GHG by fuel type (kg GHG)
Fuel Consumption, fuel = amount of fuel combusted (TJ)
Emission Factor, GHG, fuel = emission factor of the given GHG by fuel type (kg gas/TJ).
For CO_2, this includes the carbon oxidation factor, assumed equal to 1.

Activity Data

The main source of data for all energy industries of the Kyrgyz Republic is the information of the National Statistical Committee (NSC) available on the NSC website[46] and obtained through official requests, as well as archival research.

Selection of Emission Factors

The emission factors (EFs) for all types of fuel were taken from the 2006 IPCC Guidelines, Volume 2 "Energy," Table 2.2, and NCV ("Net Calorific Value") for each fuel.

3.2.5.2.1. Public electricity and heat production (1.A.1.a)

This subcategory includes the Bishkek Combined Heat and Power Plant (CHPP), the largest source of GHG emissions in Kyrgyzstan, which forms the basis of the centralized heating system in Bishkek. Coal for the Bishkek CHP is supplied from domestic coal mines and delivered by truck, while imported coal from Kazakhstan is transported by rail. The Bishkek CHPP is of a combined type (capacity 812 MW), therefore it generates electricity year-round. There is also a combined-type HPP in Kara-Balta (capacity 50 MW), which operates only during the heating season. Heat and hot water supply across the regions of the republic is provided by a network of municipal, private, and state-owned boilers of various capacities, operating on electricity, fuel oil, coal, and gas.

In 2023, emissions from "1.A.1.a Public Electricity and Heat Production" from solid fuel use amounted to 20,353.56 kt CO_2 eq. (78.2%), from liquid fuel use 1,050.04 kt CO_2 eq.(4%), and from gaseous fuel use 4,618.56 kt CO_2 eq. (17.7%).

The dynamics of emissions in the category "1.A.1.a Public Electricity and Heat Production" by fuel type for the period 1990–2023 are shown in Figure 3.10.

[46] NSC. https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/

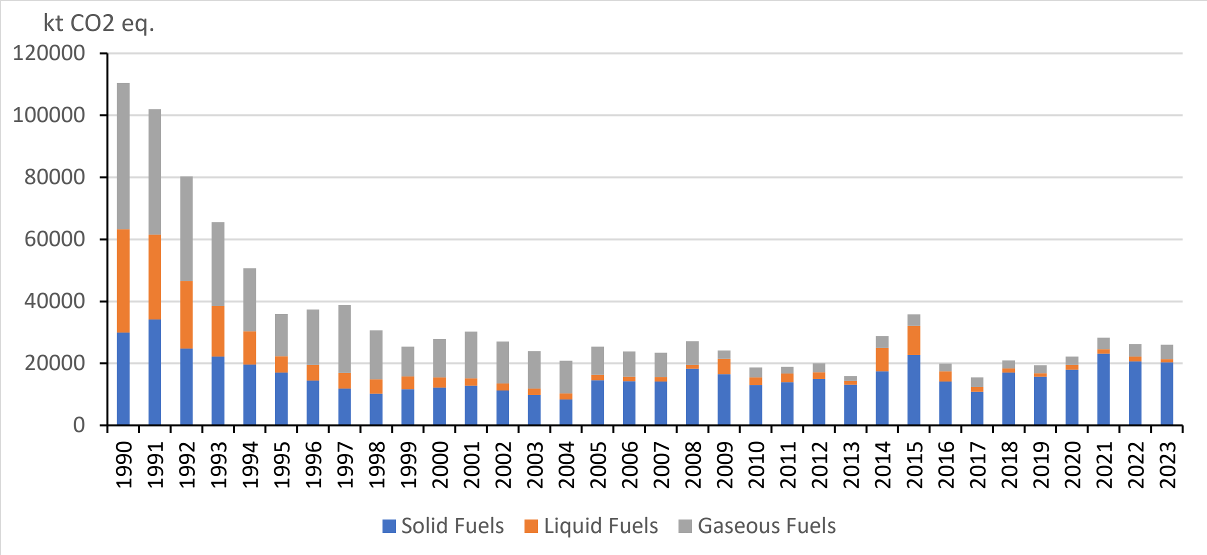


Figure 3.10. Fuel Used for Public Electricity and Heat Production Category 1.A.1.a

The dynamics of fuel used in category “1. A.1.a Public Electricity and Heat Production” reflect the general trend in the country’s energy sector.

The dynamics of GHG emissions from category “Public Electricity and Heat Production” by subcategories for the period 1990–2023 are presented in Figure 3.11.

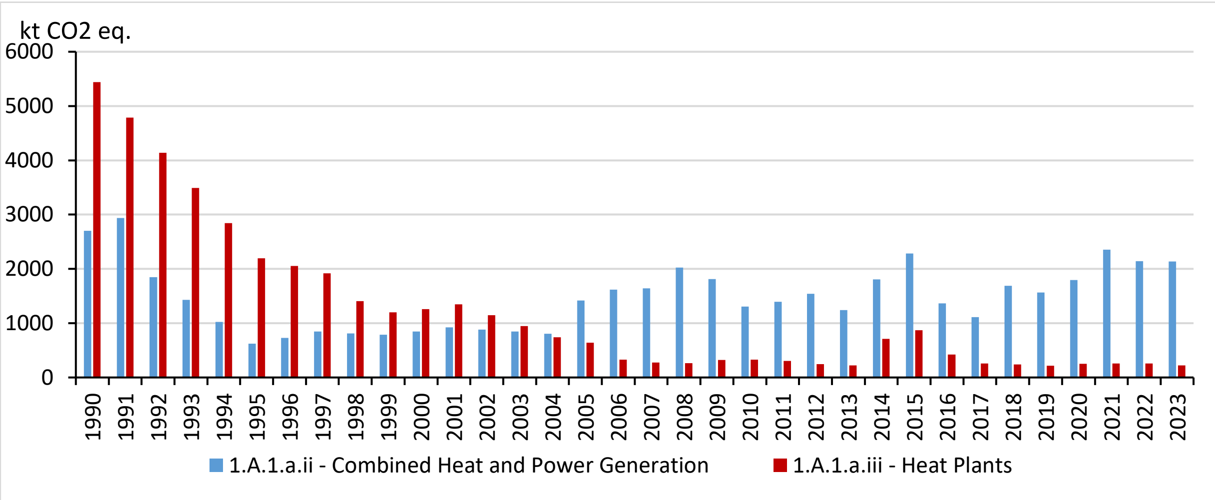


Figure 3.11. Greenhouse Gas Emissions from Public Electricity and Heat Production (1.A.1.a) by Subcategories.

The assessment of GHG emissions from electricity and heat production by fuel type, in kt CO_2e, for the period 1990–2023 is presented in Table 3.7.

Table 3.7. GHG Emissions from Category 1.A.1.a Public Electricity and Heat Production

Fuel Type	1990	995	2000	2005	2010	2015	2020	2023
Solid	2,901.82	1,650.53	1,162.51	1,410.05	1,264.58	2,213.57	1,771.03	2,012.375
Liquid	2,583.27	404.34	253.74	137.23	194.21	727.91	118.80	81.519
Gaseous	2,650.80	765.8q	693.26	507.14	1,633.94	210.93	152.09	259.339
Biomass	NE	NE	NE	NE	NE	NE	NE	NE
Total	**8,135.90**	**2,820.68**	**2,109.51**	**2,054.42**	**3,092.73**	**3,152.42**	**2,041.93**	**2,353.232**

Note: NE – not estimated.

3.2.5.2.2. Oil Refining (1.A.1.b)

According to the National Statistical Committee of Kyrgyzstan, oil products are produced in the country at 9 enterprises. The major ones are: the oil refinery in Jalal-Abad with a capacity of 500 thousand tons of crude oil per year (commissioned in 1996, owned by Kyrgyz Petroleum Company, controlled by “Kyrgyzneftegaz”) and the oil refinery in Kara-Balta with a capacity of 800 thousand tons per year (launched in June 2014, managed by the joint Chinese-Kyrgyz enterprise Zhongda China Petrol). As feedstock, the Kara-Balta plant uses heavy distillate, a mixture of petroleum residues and fuel oil from Kazakhstan, as well as small batches of crude oil extracted in the south of Kyrgyzstan.

The Jalal-Abad plant mainly processes local crude oil in the amount of about 75 thousand tons per year. In the town of Kemin in the east of Chui region of Kyrgyzstan there is also the “Kemin Oil Refinery” with a design capacity of 100 thousand tons per year.

Kyrgyzstan’s needs for petroleum products are met mainly through imports. Kyrgyzstan covers only about 10% of its demand for petroleum products on its own[47], while the remaining fuel consumption is compensated by imports (Table 3.8).

Table 3.8. Fuel consumption in the subcategory “Oil Refining 1.A.1.b”

Fuel Type	1990	1995	2000	2005	2010	2015	2020	2023
Liquid, TJ	126.90	122.67	4,559.94	3,392.46	4,107.33	4,120.02	7,508.25	13,117.23

Dynamics of GHG emissions in this subcategory “Petroleum Refining 1.A.1.b” for the period 1990–2023 are presented in Figure 3.12.

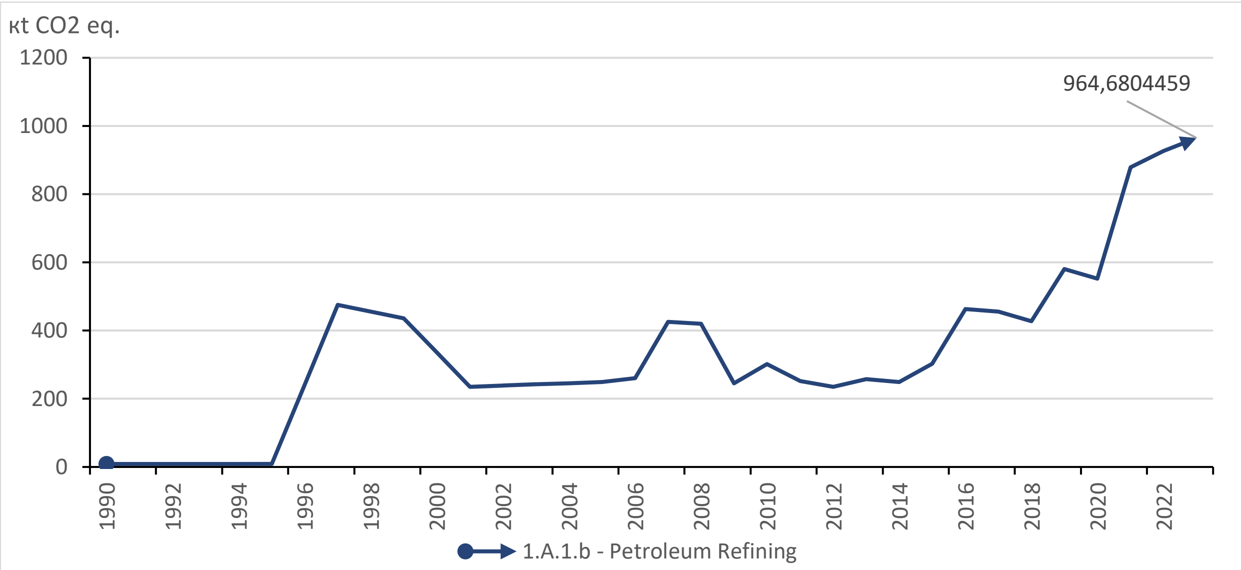


Figure 3.12. Greenhouse gas emissions from category 1.A.1.b

[47] NSC. https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/

3.2.5.3. Uncertainties

The level of uncertainty of activity data is assumed to be ±5% (as for countries with a less developed national statistical system (2006 IPCC Guidelines, Chapter 2, Vol. 2, Table 2.15, p. 2.44).

The default uncertainties of emission factors were calculated based on data for all types of fuel from Tables 1.2 and 1.3, Vol. 2, Introduction, 2006 IPCC Guidelines and amount to about ±5% for CO2, ±75% for CH4, and ±100% for N2O.

The combined uncertainty for fossil fuels under category 1.A.1 “Energy industries” amounted to about ±9.59% for CO2, ±210.85% for CH4, and ±219.18% for N2O.

The same calculation method and similar data sets were used for all years.

3.2.5.4. Time series consistency

According to the 2006 IPCC methodology, good practice for inventory compilers is to check whether changes in calorific values over time are reflected in the information used for the national energy statistics. In compiling the GHG inventory in Kyrgyzstan, it was assumed that there were no changes in calorific values.

3.2.5.5. QA/QC and verification for specific category, if applicable

For category 1.A.1 “Energy industries”, Tier 1 quality control procedures were applied. QA/QC procedures were carried out in accordance with the general QA/QC principles and the QA/QC plan.

Verification included:

- documentation of emission sources,
- data for mechanical errors,
- correctness of formulas and measurement units used for the entire time series,
- consistency of applied emission factors,
- all references to information sources for input data in the software.

3.2.5.6. Recalculations for specific categories

A recalculation of the entire time series of greenhouse gas emissions for the category “Energy industry” in the energy sector was carried out for the period from 1990 to 2020 inclusive, in order to compare the data of the current and previous National Inventory Report. The basis for the recalculation was the requirement to use updated Global Warming Potential (GWP) values from the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), instead of the previously used values from the Second Assessment Report (SAR) of the IPCC.

Table 3.9 presents the estimated GHG emission values after recalculation of the CH4 emissions assessment, which was made using GWP values from SAR, and the current BTR 1 assessment using GWP values from AR5, in CO_2 eq. under the category “Energy industry”.

Table 3.9. Recalculation of GHG emissions for category “1.A.1 Energy industry” for the period 1990–2020.

Year	NC 4	BTR 1	Difference, kt CO_2 eq.	Difference, %	Year	HC 4	BTR 1	Difference, kt CO_2-eq.	Difference, %
1990	8 145,73	8,138.33	7.41	0.09	**2006**	2,206.98	1,947.45	259.53	11.76

Year	NC 4	BTR 1	Difference, kt CO_2 eq.	Difference, %	Year	HC 4	BTR 1	Difference, kt CO_2-eq.	Difference, %
1991	7,730,58	7,723.44	7.14	0.09	**2007**	2,346.20	1,921.48	424.72	18.10
1992	5,997,49	5,989.83	7.66	0.13	**2008**	2,709.87	2,291.30	418.57	15.45
1993	4,931,85	4,924.07	7.77	0.16	**2009**	2,382.11	2,137.38	244.74	10.27
1994	3,876,08	3,868.15	7.93	0.20	**2010**	1,936.01	1,634.74	301.27	15.56
1995	2,829.84	2,821,85	7.99	0.28	**2011**	1,949.66	1,698.22	251.44	12.90
1996	3,028.2q	2,787.04	241.16	7.96	**2012**	2,020.92	1,786.96	233.96	11.58
1997	3,243.75	2,769.41	474.34	14.62	**2013**	1,719.22	1,462.70	256.52	14.92
1998	2,673.66	2,218.84	454.82	17.01	**2014**	2,761.82	2,514.04	247.78	8.97
1999	2,425.25	1,990.12	435.13	17.94	**2015**	3,455.58	3,154.00	301.58	8.73
2000	2,444.67	2,110.34	334.62	13.69	**2016**	2,249.44	1,787.10	462.34	20.55
2001	2,500.57	2,266.45	234.12	9.36	**2017**	1,825.13	1,370.36	454.77	24.92
2002	2,265,16	2,027.28	237.88	10.50	**2018**	2,357.42	1,464.73	892.69	37.87
2003	2,030.05	1,788.44	241.60	11.90	**2019**	2,360.49	1,233.71	1,126.77	47.73
2004	1,794.93	1,549.60	245.33	13.67	**2020**	2,594.18	1,482.94	1,111.25	42.84
2005	2,304.00	2,055.38	248.62	10.79					

Also, during the recalculation the category "Petroleum Refining" (1.A.1.b), which had not been calculated previously, was taken into account.

3.2.5.6. Planned improvements

Improvement of the GHG emissions inventory in the category "Energy industry" is planned through the use of information from the Ministry of Energy of the Kyrgyz Republic, analytical and reference materials on fuel consumption in the country in order to obtain high-quality data for the expenditure part of the national energy balance statistics.

3.2.6. Category "Manufacturing Industries and Construction" (CRT 1.A.2)

3.2.6.1. Category description

This section presents data on fuel consumption and greenhouse gas emissions from the following subcategories:

- Iron and steel (1.A.2.a)
- Chemicals (1.A.2.c)
- Pulp, paper and printing (1.A.2.d)
- Food processing, beverages and tobacco (1.A.2.e)
- Non-metallic mineral products (1.A.2.f)
- Transport equipment (1.A.2.g)
- Machinery (1.A.2.h)
- Mining and quarrying (excluding fuel) industry (1.A.2.i)
- Wood and wood products (1.A.2.j)
- Construction (1.A.2.k)
- Textile and leather (1.A.2.l)
- Non-specified industries (1.A.2.m)

An overview of the methods used and emission factors (EFs), as well as an indication of whether a given category is a key category, is presented in Table 3.10.

Table 3.10. Method, emission factors used, and key category indicators for 2023 in energy industries.

Fuel Type	CO2			CH4			NO2		
	Method	EF	Key category	Method	EF	Key category	Method	EF	Key category
Solid	T 1	D	L, T	T 1	D	-	T 1	D	-
Liquid	T 1	D	L, T	T 1	D	-	T 1	D	-
Gaseous	T 1	D	T	T 1	D	-	T 1	D	-
Biomass	T 1	D	-	T 1	D	-	T 1	D	-

Note: T1 – Tier 1; D – default emission factor according to the IPCC Guidelines; L – key category by level; T – key category by trend.

Dynamics of GHG emissions in category "1.A.2 – Manufacturing Industries and Construction" for the period 1990–2023 are presented in Figure 3.13.

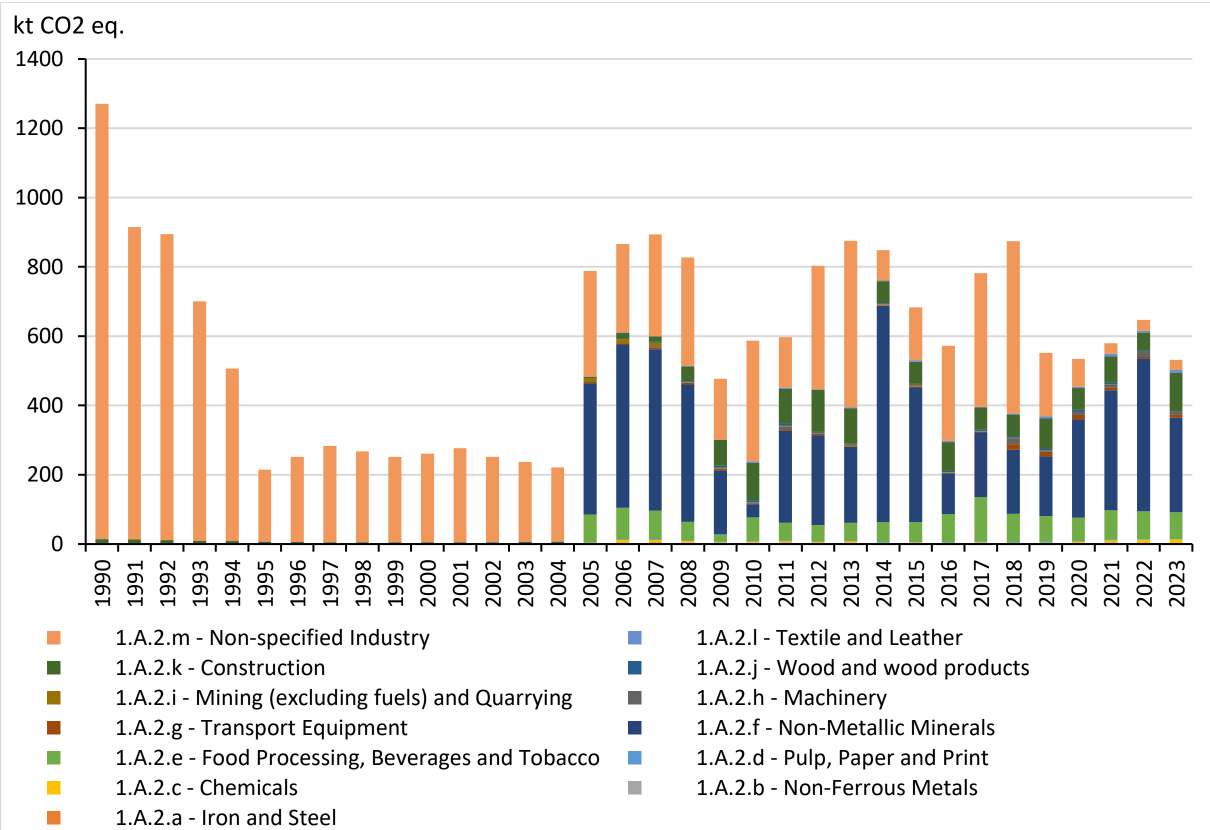


Figure 3.13. Greenhouse gas emissions from category "1.A.2 – Manufacturing Industries and Construction" by subcategories for the period 1990–2023.

From 1990 to 2005, the National Statistical Committee (NSC) of the Kyrgyz Republic did not have disaggregated activity data for category "Manufacturing Industries and Construction" (CRT 1.A.2), and only with the change in the statistical information collection system in 2005 did more detailed data on subcategories become available.

It should also be noted that the disaggregation of emissions for the years prior to 2005 is complicated, since the classification available in the statistical documents is not complete and not comparable with the IPCC category classification, therefore, before 2005 they were assigned to the categories “non-specified industries” (1.A.2.m) and “Construction” (1.A.2.k).

Emissions from category “1.A.2 – Manufacturing Industries and Construction” in 2023 amounted to 531.15 kt CO_2 eq., which is 739.17 kt CO_2 eq. less (58%) than in 1990 and 0.7% less than in 2020 (see Table 3.11).

Table 3.11. GHG emissions from category “1.A.2 – Manufacturing Industries and Construction” by source subcategories for the period 1990–2023.

Categories	1990	1995	2000	2005	2010	2015	2020	2023
Manufacturing Industries and Construction (1.A.2)	**1,270.31**	**215.15**	**260.47**	**788.79**	**586.64**	**683.43**	**683.43**	**531.15**
Iron and Steel (1.A.2.a)	NE	NE	NE	2.32	2.16	0.95	0.95	2.44
Chemicals (1.A.2.c)	NE	NE	NE	1.35	4.63	3.64	3.64	11.16
Pulp, Paper and Printing (1.A.2.d)	NE	NE	NE	0.04	2.34	1.19	1.19	0.67
Food Industry (1.A.2.e)	NE	NE	NE	81.27	67.93	57.24	57.24	77.65
Non-metallic Mineral Products (1.A.2.f)	NE	NE	NE	379.21	37.74	389.20	389.20	272.08
Transport Equipment (1.A.2.g)	NE	NE	NE	3.88	2.58	1.86	1.86	9.92
Machinery (1.A.2.h)	NE	NE	NE	0.02	2.28	0.71	0.71	7.75
Mining and Quarrying (excluding fuel) Industry (1.A.2.i)	NE	NE	NE	11.08	1.20	4.34	4.34	0.38
Wood and Wood Products (1.A.2.j)	NE	NE	NE	0.01	4.79	2.74	2.74	1,57
Construction (1.A.2.k)	14.69	7.291	4,97	3.22	108.68	64.21	64.21	110,69
Textile and Leather (1.A.2.l)	0.00	0.00	0,00	0.40	4.52	4.74	4.74	8,52
Non-specified Industries (1.A.2.m)	1,255.62	207.86	255.50	306.00	347.81	152.61	152.61	28.32

In 2023, the total amount of all types of fuel used in this category amounted to 6,560.35 TJ, which is 1.4% more than in 2020 but 66.6% less than in 1990.

The share of solid fuel used in this category in 2023 was 38.2% or 2,505.97 TJ, which is 23.2% less than in 2020 and 8.1% less than in 1990. The share of liquid fuel used in 2023 was 2,198.93 TJ or 33.5% of the total consumption in this category, which is 58.1% more than in 2020 but 18.8% less than in 1990. The share of gaseous fuel in 2023 was 28.3% of the total fuel used, or 1,855.46 TJ, which is 2.4% more than in 2020 but 86.9% less than in 1990.

The dynamics of fuel consumption by type for the period 1990–2023 are presented in Figure 3.14.

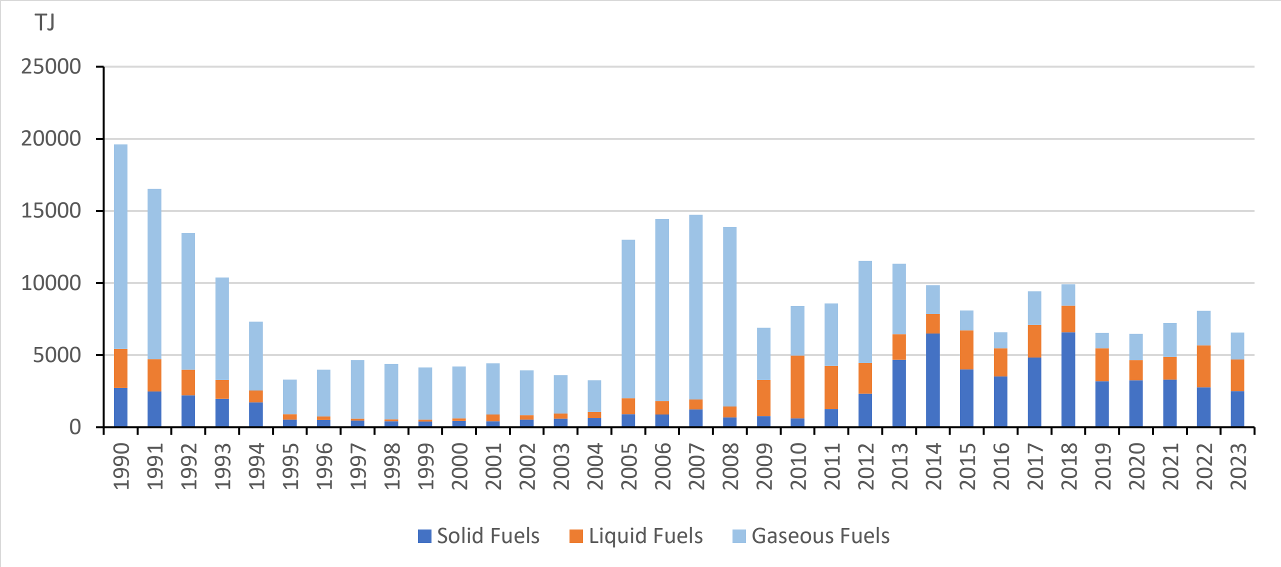


Figure 3.14. Fuel used in category "1.A.2 – Manufacturing Industries and Construction" for the period 1990–2023.

The estimated values of GHG emissions from category 1.A.2 by fuel type for the period 1990–2023 in CO_2e are presented in Table 3.12.

Table 3.12. GHG emissions by fuel type in category "1.A.2 – Manufacturing Industries and Construction" for the period 1990–2023.

Fuel Type	1990	1995	2000	2005	2010	2015	2020	2023
Solid	263.78	50.89	44.06	89.00	63.09	394.87	322.51	251.88
Liquid	210.14	28.86	84.02	84.02	192.78	210.23	110.25	174.97
Gaseous	796.18	135.38	201.70	615.70	192.78	78.18	101.78	104.19
Biomass	NE	NE	NE	NE	NE	NE	NE	NE
Total	**1,270.10**	**215.13**	**329.79**	**788.72**	**448.64**	**683.28**	**534.53**	**531.04**

3.2.6.2. Methodological issues

For the estimation of GHG emissions in category 1.A. "Energy Industries", the Tier 1 methodology of the 2006 IPCC Guidelines was used with default emission factors (Table 3.8 – GHG Emission Factors in the Energy Sector). The estimation of greenhouse gas emissions from each type of fuel used for energy production was calculated according to Equation 2.1 of the 2006 IPCC Guidelines, Vol. 2, Ch. 2, p. 2.11.:

GREENHOUSE GAS EMISSIONS FROM STATIONARY FUEL COMBUSTION

GHG Emissions, fuel = Fuel Consumption × Emission Factor (GHG, fuel)

Where,
GHG Emissions, fuel = emissions of the given GHG by fuel type (kg GHG)
Fuel Consumption, fuel = amount of fuel combusted (TJ)
Emission Factor, GHG, fuel = emission factor of the given GHG by fuel type (kg gas/TJ).
For CO_2, this includes the carbon oxidation factor, assumed equal to 1.

Activity data

The main source of data for all energy industries of the Kyrgyz Republic is the information of the National Statistical Committee, presented on the NSC[48] website and obtained through official request, as well as from archival research. Since 2005, the NSC has moved to new methods of collecting statistical data, and more detailed data on fuel combustion in individual subcategories in the sector “Manufacturing Industries and Construction” 1.A.2 have become available.

Selection of emission factors

The emission factors (EFs) for all types of fuel were taken from the 2006 IPCC Guidelines, Volume 2 “Energy”, Table 2.2, and NCV (“Net Calorific Value”) for each fuel.

3.2.6.3. Uncertainties and time series consistency

Uncertainty estimates for the category “1.A.2 – Manufacturing Industries and Construction” in the base year are based on the 2006 IPCC Guidelines – Vol. 2-2-Ch.2 – Table 2.15 (Industrial combustion – studies of less developed statistical systems).
The uncertainty of the estimation of emissions from this category in terms of activity data (AD) and emission factors (EFs) by fuel types and greenhouse gases for the time series 1990–2023 is presented in Table 3.13.

Table 3.13. Uncertainty of AD and EFs used in the 2025 report for the base year and the latest reporting year, %.

Fuel Type	1990-2023 yy.			
	AD	CO_2 - EF	CH_4 - EF	N_2O - EF
Solid	13.496	12.460	200.000	222.222
Liquid	7.915	6.136	228.788	228.788
Gaseous	6.354	3.922	200.000	200.000
Biomass	13.496	12.460	200.000	222.222

3.2.6.4. QA/QC and verification for specific category, if applicable

For category “Manufacturing Industries and Construction” 1.A.2, Tier 1 quality control procedures were applied. QA/QC procedures were carried out in accordance with the general QA/QC principles and the QA/QC plan.

- Verification included:
- documentation of emission sources,
- data for mechanical errors,
- correctness of formulas and measurement units used for the entire time series,
- consistency of applied emission factors,
- all references to information sources for input data in the software.

When analyzing and assessing emissions from subcategories, trends in the main driving factors of emissions and in activity data were carefully examined, and any anomalies were checked for errors. It should be noted that all sharp changes have officially confirmed data provided by the NSC of Kyrgyzstan.

[48] NSC. https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/

3.2.6.5. Recalculations for specific categories

Recalculations of GHG emission time series for category "1.A.2 Manufacturing Industries and Construction" (Table 3.14) in the Energy sector were carried out for the period from 1990 to 2020 inclusive under NC 4. The basis for the recalculation was the requirement to use in BTR 1 the updated Global Warming Potential (GWP) values from the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), instead of the GWP values from the Second Assessment Report (SAR) of the IPCC previously applied in NC 4.

Table 3.14. Results of recalculation by GWP used in NC 4 and BTR 1

Year	NC 4	BTR 1	Difference, kt CO_2-e	Difference, %	Year	NC 4	BTR 1	Difference, kt CO_2-e	Difference, %
1990	1,270.286	871.64	-398.7	-45.7	**2006**	866.03	556.23	-309.80	-55.7
1991	915.00	829.77	-85.2	-10.3	**2007**	894.00	586.68	-307.32	-52.4
1992	894.65	636.15	-258.5	-40.6	**2008**	826.90	507.67	-319.24	-62.9
1993	700.48	393.43	-307.1	-78.1	**2009**	477.51	264.11	-213.40	-80.8
1994	506.33	210.27	-296.1	-140.8	**2010**	590.88	466.96	-123.93	-26.5
1995	215.15	169.15	-46.0	-27.2	**2011**	600.14	640.72	40.57	6.3
1996	251.28	271.21	19.9	7.4	**2012**	802.91	842.25	39.34	4.7
1997	282.78	331.97	49.2	14.8	**2013**	874.94	1,094.14	219.20	20.0
1998	267.07	346.58	79.5	22.9	**2014**	847.48	1,239.78	392.30	31.6
1999	251.36	202.10	-49.3	-24.4	**2015**	675.41	1,127.46	452.05	40.1
2000	260.46	227.86	-32.6	-14.3	**2016**	572.34	1,160.84	588.50	50.7
2001	276.46	236.65	-39.8	-16.8	**2017**	779.95	1,304.28	524.33	40.2
2002	251.63	269.04	17.4	6.5	**2018**	858.72	1,380.02	521.30	37.8
2003	236.82	370.01	133.2	36.0	**2019**	533.03	1,389.64	856.61	61.6
2004	221.36	435.13	213.8	49.1	**2020**	509.77	1,536.03	1,026.26	66.8
2005	788.77	482.93	-305.8	-63.3					

3.2.6.6. Planned improvements

Improvement of the GHG emissions inventory in the category "Manufacturing Industries and Construction" is planned through the use of information from the Ministry of Energy of the Kyrgyz Republic, analytical and reference materials on fuel consumption in the country in order to obtain high-quality data for the expenditure part of the national energy balance statistics, as well as in case of amendments to the official energy balance by the National Statistical Committee of the Republic.

3.2.7. Category "Transport" (CRT 1 1.A.3)

The "Transport" category includes emissions from fuel combustion in the process of domestic transport, such as civil aviation, road, rail and domestic water transport. Emissions from international marine and aviation bunkers are reported as a Memo item and are not included in the total emissions of the Kyrgyz Republic.

3.2.7.1. Category description

In accordance with the IPCC Guidelines[49] and with national circumstances (the existing fuel accounting system in the energy balance), the "Transport" sector within the framework of the national greenhouse gas inventory in Kyrgyzstan was structured into the following categories:

- 1.A.3.a – Civil aviation
- 1.A.3.b – Road transport
- 1.A.3.c – Railways
- 1.A.3.d – Water transport
- 1.A.3.e – Other transport
  - 1.A.3.e.i – Pipeline transport
  - 1.A.3.e.ii – Off-road transport

Categories 1.A.3.a–d are further subdivided into subcategories.

The **"civil aviation"** category is divided into international and domestic aviation depending on the geography of flights. Civil aviation plays an important role in international transport and tourism development. Despite the growth in passenger traffic, infrastructure requires modernization, including a transition to more environmentally friendly aviation technologies. Within the framework of climate policy, measures are being considered to reduce the carbon footprint through improved fuel efficiency of aircraft and the introduction of alternative aviation fuels.

The **"road transport"** category may be represented by a more complex structure of subcategories covering different types of vehicles. However, due to the lack of activity data, a more detailed breakdown of mobile sources in Kyrgyzstan has not been carried out. Nevertheless, road transport is the most important element of the republic's transport system, the efficient functioning of which creates the necessary conditions for modernization and innovative development of the national economy, for meeting the transport needs of the population, and for integrating the Kyrgyz Republic into the world economic system. The strategic goal of the road transport sector is the full and high-quality satisfaction of freight transport needs in all sectors of the economy, an increase in the mobility of the population, and ensuring the safety of passenger and freight transport. Due to the mountainous terrain and the inaccessibility of regions of the country, road transport is the main mode of transport in the Kyrgyz Republic.

The **"rail transport"** category covers emissions arising from the operation of locomotives and multiple-unit rolling stock, mainly on diesel traction. In Kyrgyzstan, the railway network is limited, and the vast majority of transportation is carried out by diesel locomotives, which makes this segment relevant for the assessment of GHG emissions.

The **"water transport"** category includes emissions from fuel combustion on vessels engaged in domestic water transport and, if applicable, international transport. In the case of Kyrgyzstan, which has no access to the sea and no developed inland waterway network, this category is represented by isolated facilities, such as the ships of the Issyk-Kul Shipping Company. Around 2017, the shipping company ceased operations due to financial insolvency. Despite the low level of activity, the potential development of environmentally friendly water transport (for example, electric boats and solar catamarans) may become part of the climate strategy and expand the carbon-neutral category in the future.

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[49] IPCC 2006 Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

The **“other (off-road) transport”** category covers various types of mobile equipment not used on public roads. This includes: construction machinery, agricultural machines, logging equipment, snowmobiles, loaders, ground support equipment at airports, generator sets on a wheeled base, and other types of mobile equipment. These sources also burn fuel, such as gasoline or diesel, and depending on the type and amount of equipment, can make a significant contribution to national emissions. Due to the lack of official statistics for each of these segments, approaches based on fuel consumption in the corresponding sectors (industrial, construction-assembly, drilling, agricultural, communal-domestic) can be applied.

The Kyrgyz Republic is making significant efforts to modernize the transport sector, which is in line with the national goals under the Nationally Determined Contributions (NDCs). In accordance with the Main Directions[50] for the Development of the Road Sector for 2023–2030, the Concept[51] for the Development of Road Transport of the Kyrgyz Republic for 2020–2024, the Main Directions for the Development of Railway Transport for 2022–2026, and other projects, the government of Kyrgyzstan is implementing measures to improve infrastructure, increase energy efficiency and reduce greenhouse gas (GHG) emissions.

Physico-geographical features (mountainous terrain, absence of navigable rivers and seas) and economic factors (limited development and high cost of air transport) predetermine the dominance of road transport in the system of domestic transport of the Kyrgyz Republic.

In foreign trade transport, the structure remains unchanged: the main part of cargo flows to the north (EAEU countries, Europe) is still carried out mainly by road transport, with a small share of railway transport; in the southeast direction (towards China), road transport routes are mainly used. Air transport maintains a limited role, mainly in passenger transport. The volume of transport carried out by water transport on Lake Issyk-Kul has been reduced to zero and does not represent an active transport category; therefore, for this category in the CRT the notation key NE is used.

The length of the national railway network is 423.9 km. Most of it passes through the Chui region and connects with Kazakhstan. Separate short branches run through the Osh, Jalal-Abad, and Batken regions.

Pipeline transport consists of the main gas pipelines Bukhara – Tashkent – Bishkek – Almaty and Mailuu-Suu – Jalal-Abad – Kara-Suu – Osh and the local gas distribution network.

The dynamics of freight turnover and passenger turnover are shown in Figure 3.15. Personal vehicles are not included, as no statistics are available for them.

[50] Main directions of road sector development for 2023–2030 https://cbd.minjust.gov.kg/159966/edition/1232114/ru

[51] Concept for the Development of Road Transport of the Kyrgyz Republic for 2020–2024

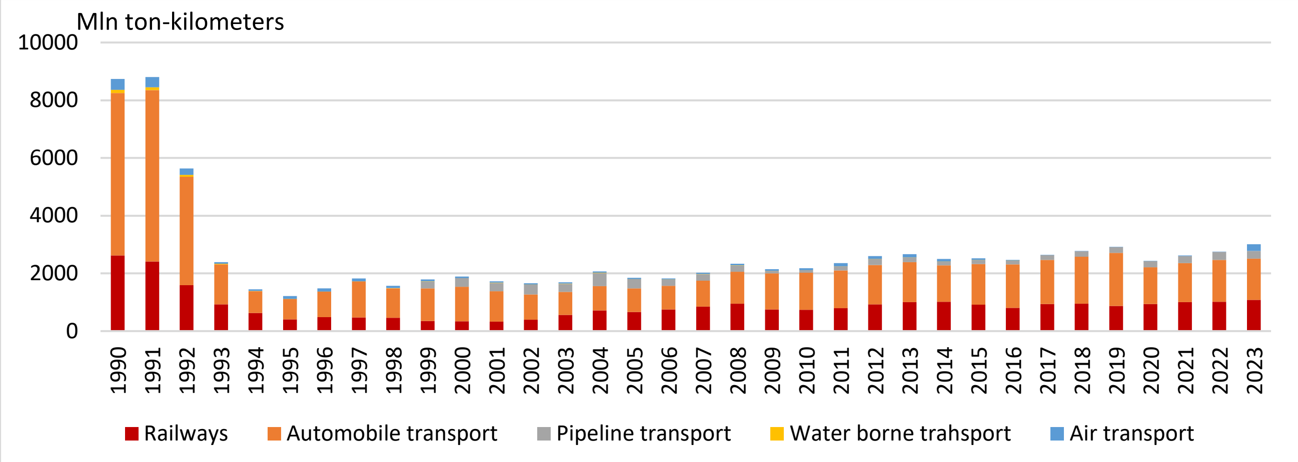
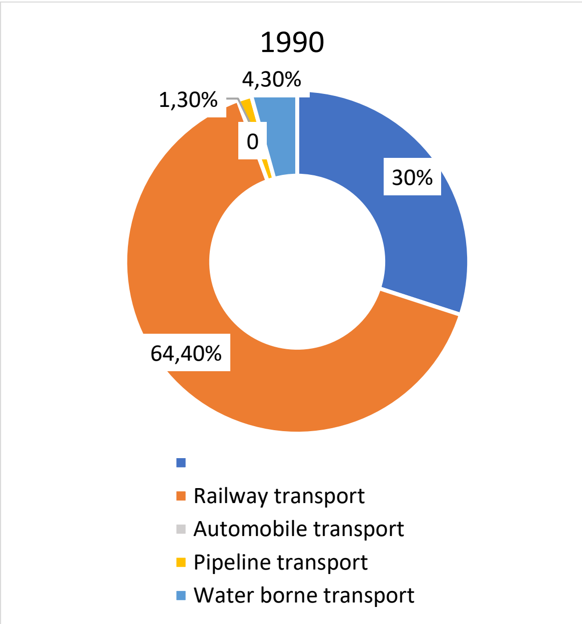


Figure 3.15. Dynamics of freight turnover by mode of transport in the Kyrgyz Republic for 1990–2023 (million ton-kilometers).

The mountainous terrain of the country and the relatively well-developed road infrastructure determine the predominant use of road transport for freight transportation. Figure 3.16 shows the distribution of freight transportation in Kyrgyzstan by mode of transport in 1990 and 2023 (as a percentage of the total volume of freight transportation):



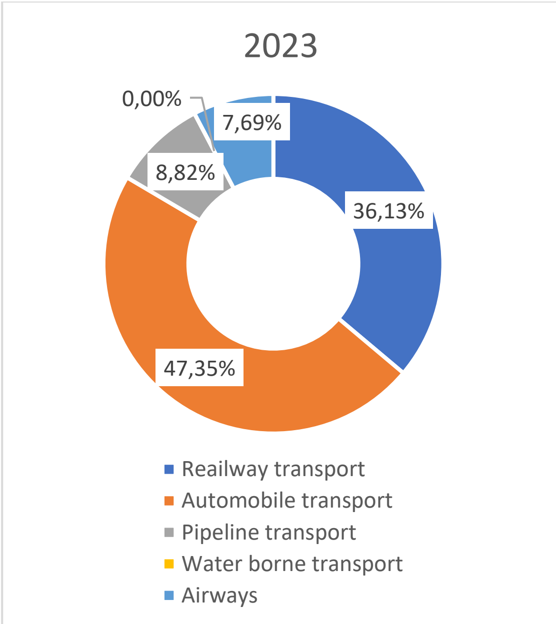


Figure 3.16. Structure of freight transportation in 1990 and 2023.

The dynamics of passengers' transportation by different modes of transport for the period 1990–2023 are presented in Figure 3.17.

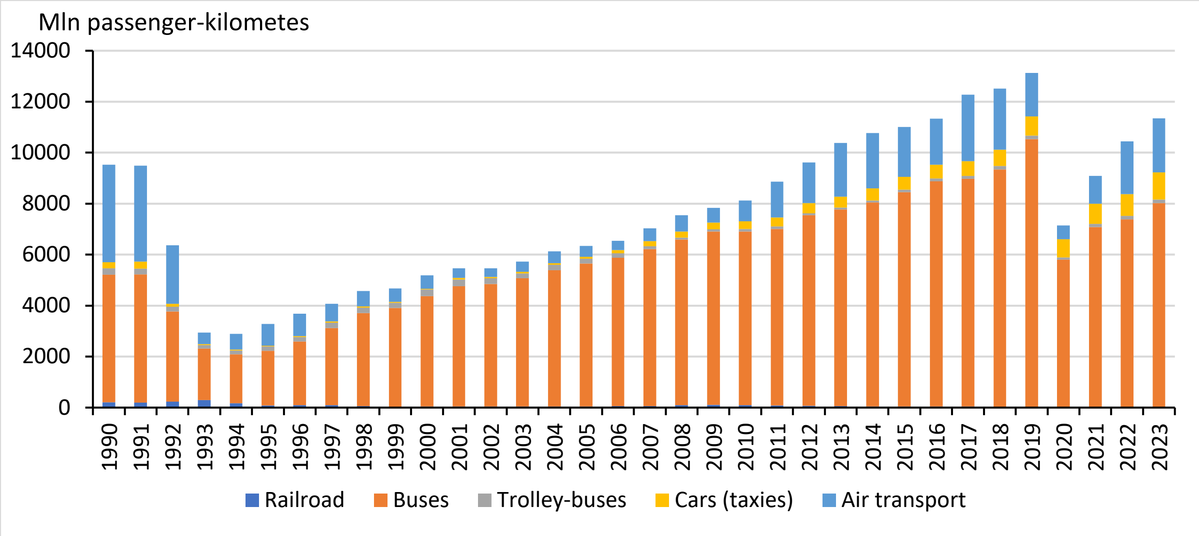
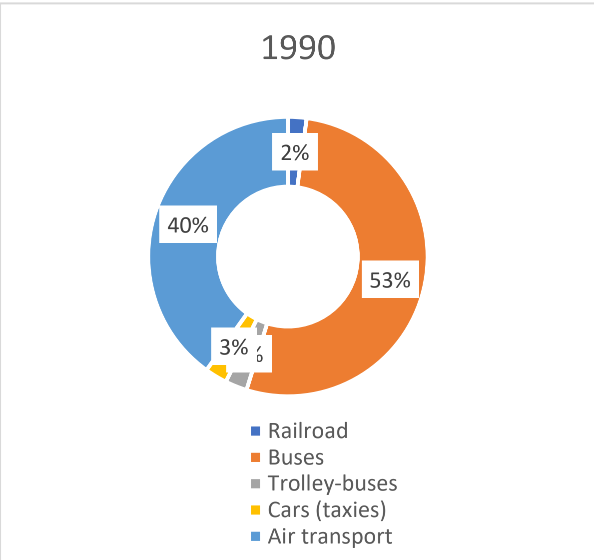


Figure 3.17. Dynamics of passenger turnover in the period 1990–2023 by mode of transport (million passenger-kilometers).[52]

The structure of passenger transportation by mode of transport in 1990 and 2023 is presented in Figure 3.19.



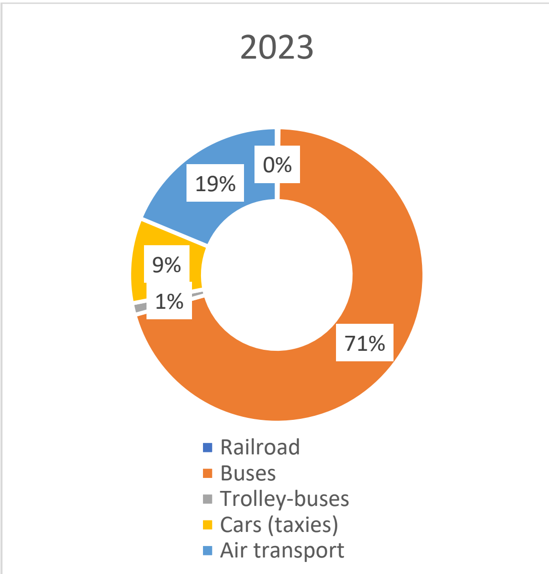


Figure 3.18. Structure of passenger transportation by mode of transport in 1990 and 2024:

The dynamics of passenger transportation in the period 1990–2024 are presented in Figure 3.20.

[52] NSC. http://www.stat.kg/ru/statistics/transport-i-svyaz/

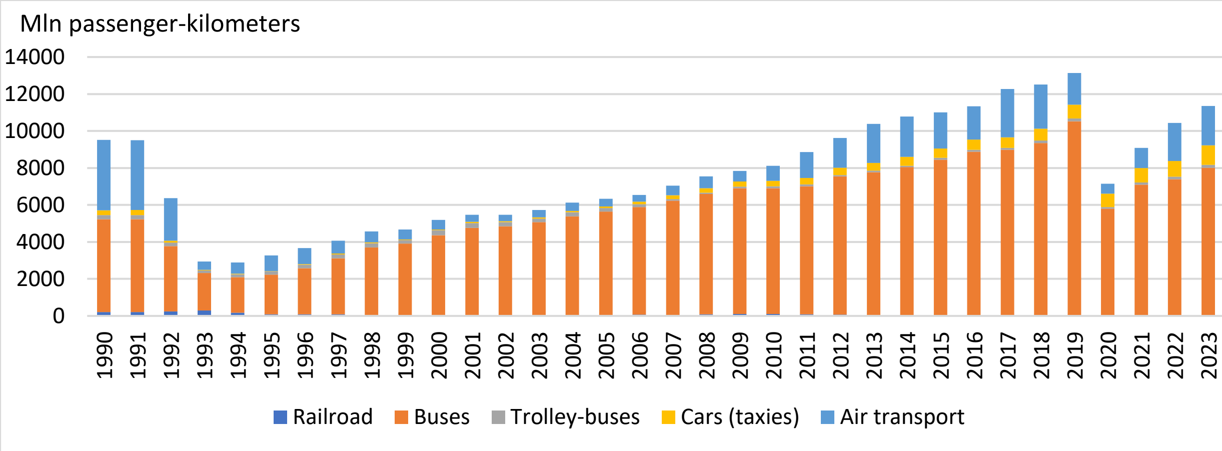


Figure 3.19. Dynamics of passenger transportation in the period 1990–2024.

Fuel and vehicle fleet situation

At present, there are no mandatory requirements in Kyrgyzstan obliging the use of EURO standards (for example, Euro-4, Euro-5) when importing vehicles. However, there have been initiatives and draft regulations:

- Draft resolutions on banning the import of old cars (older than a certain year of manufacture and below a certain EURO level) were raised for discussion but were not implemented in practice for a number of socio-economic reasons (affordability of cars, protests from private importers, etc.).
- The Law "On the Protection of Atmospheric Air" and some subordinate acts indicate the principles of regulating pollutant emissions, but there is no direct reference to EURO standards or mandatory catalytic converters.
- Some large fuel suppliers in Kyrgyzstan (especially those working with international partners or importing from Kazakhstan/Russia) voluntarily ensure compliance of fuel with Euro-4 and even Euro-5 levels. This partially:
- reduces harmful emissions,
- allows the operation of modern cars with catalytic converters.

However, there is no mandatory certification and monitoring, meaning that the quality of fuel and its compliance with the Euro standard is not guaranteed at the state level.

The bulk of the vehicle fleet in the Kyrgyz Republic consists of used cars imported from Japan, Korea, Russia, and Europe. Many of them have disabled or removed catalytic converters due to repair or economic reasons. Catalytic converters are removed at the initiative of owners or service stations, and this is not controlled, including due to the absence of mandatory emission inspections during vehicle technical checks.

Improvements in the situation with fuel and the vehicle fleet are presented in Table 3.15.

Table 3.15. Fuel and vehicle fleet situation.

Improvements	Implemented	Comment
Introduction of EURO standards	No	No obligation regarding EURO standards
Use of catalytic converters	Partially	Present in some imported vehicles, but no control
Fuel quality	Partially	Voluntarily maintained by some suppliers

Improvements	Implemented	Comment
Monitoring and control	No	No mandatory technical inspection and no control of catalytic converters

General characteristics of emission sources:

1) Combustion of motor fuels (gasoline, diesel) in internal combustion engines (ICE):

- Engine types:
  - Gasoline carburetor and injection engines (passenger cars, light commercial vehicles)
  - Diesel engines (trucks, buses)
  - Gas-powered units (buses and passenger cars running on compressed natural gas — CNG, or on liquefied propane-butane mixture)
- Combustion conditions:
  - Nominal mode (idle / cruising speed)
  - Cold start (increased emissions during start-up)
  - Load cycles (urban / highway mode)
- Parameters:
  - Engine displacement (cm^3)
  - Engine efficiency (percentage of fuel energy utilized)
  - Share of mileage in urban and rural modes

2) Mileage on public roads

- Metric:
  - Total annual mileage for each vehicle subcategory
  - Average annual mileage per vehicle
- Classification by road conditions:
  - Urban cycle
  - Intercity and highway routes
- Consideration of traffic intensity:
  - GPS tracker data and traffic counters
  - Adjustments for traffic jams and idling

The characteristics of sources practically determine which tier of methodology should be used for emission estimates for each transport category.

Emission factors (EFs) strongly depend on engine type and operating mode (urban/highway, idle, cold start).

Tier 1 methodology uses averaged EFs, but to improve accuracy (Tiers 2–3), data on each of these characteristics are required. At present, there are no officially approved EF coefficients specific to the country or region. Until local emission factors are developed, the default ones from the 2006 IPCC Guidelines are used.

When further developing the MRV system, it is advisable to collect more detailed statistics on these types of activities in order to move towards more accurate calculations.

3.2.7.2. Dynamics of GHG emissions from the "Transport" category

In 2023, the category "1.A.3 Transport" accounted for 3,601.42 kt CO_2 eq. (33.8% of emissions in the energy sector) or 18.6% of total national emissions. Emissions decreased by 695.13 kt CO_2 eq. (19.3%) compared to 4,296.43 kt CO_2 eq.in 1990 and increased by 4.3% compared to 2020.

In the structure of transport emissions in 2023, emissions from category 1.A.3.b "Road transport" predominated. In 2023, road transport accounted for 3,165.00 kt CO_2 eq. (87.9%) of the total emissions in the transport sector. This is 276 kt CO_2 eq. (8.73%) more than in 1990, when this figure was 2,88.47 kt CO_2 eq.

The key subcategories identified in the Level assessment excluding LULUCF for 2023 for category "1.A.3 – Transport" were as follows:

- 1.A.3.b – Road transport – Liquid fuel by CO_2 emissions – 16.0% of all national GHG emissions
- 1.A.3.e – Other transport – Liquid fuel by CO_2 emissions – 1.8% of all national GHG emissions.

3.2.7.3.1 GHG emission assessment

Greenhouse gas emissions from mobile combustion were assessed by the main transport activities: road, off-road, rail, air traffic, and water navigation. The description of sources (Table 3.13 of the 2006 IPCC Guidelines)[53] reflects the diversity of mobile sources and a range of characteristics affecting emission factors.

To estimate greenhouse gas emissions from transport according to the 2006 IPCC methodology, the amount of fuel consumed was used. This approach is well-suited for calculating CO_2 emissions but has certain limitations in estimating nitrous oxide and methane emissions.

The estimation of CO_2 emissions from the use of urea-based additives in catalytic converters (not related to the combustion process) was not carried out due to the lack of reliable information on the availability and application of such technologies in the transport sector of the Kyrgyz Republic.

The estimates of GHG emissions in the transport sector were based on the Tier 1 method with default emission factor parameters for the combustion of various types of fuel, as defined in the 2006 IPCC Guidelines, and on the collected sectoral activity data.

Thus, to determine the volume of greenhouse gas emissions from transport vehicles, a methodology based on the characteristics of fuel combustion was used. Greenhouse gas emissions from all combustion sources can be calculated based on data on the amounts and types of fuel burned (based on consumption/sales of different types of fuel) and the corresponding emission factors.

The total volume of greenhouse gas emissions from the sector as a whole is determined by summing the amounts of greenhouse gas emissions by source categories, types of gases, and types of fuel.

The collected primary data on fuel used were compiled into long series of normalized data by activity categories for the period 1990–2023 in Excel format and entered into the software to obtain GHG emission calculations.

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[53] IPCC. 2006. Guidelines for National GHG Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

In accordance with the 2006 IPCC Guidelines, gaps in primary data were filled by calculation, using linear interpolation and extrapolation in cases where trends in consumption dynamics were sufficiently clear.

For data processing, the IPCC 2006 Inventory Software was used. The trend of GHG emissions by category is presented in Figure 3.21.

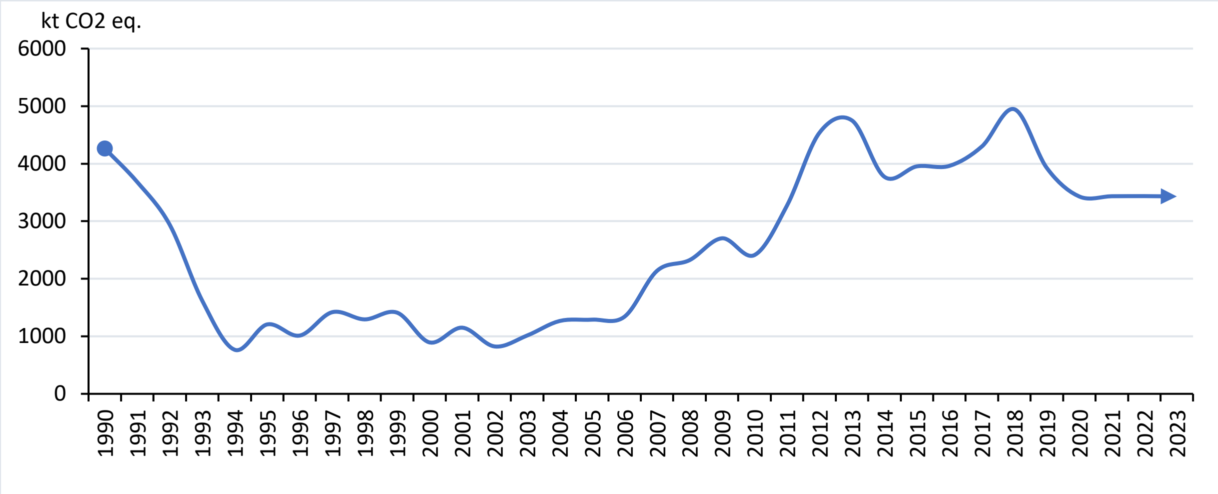


Figure 3.20. The trend of GHG emissions from all mobile sources in the "Transport" sector for 1990–2023.

GHG emissions in the "Transport" category, after decreasing by about four times during the period 1990–1995, subsequently fluctuated at around 1,000 kt CO_2 eq. until 2007. Then, from 2006 to 2010, growth was observed up to levels above 2,000 kt CO_2 eq. Further growth was recorded, reaching 4,982.8 kt CO_2 eq. in 2018, approximately proportional to the increase in fuel consumption volumes. These results to some extent reflect trends in changes in macroeconomic indicators, as well as the structure of the republic's economy. In the meantime, a sharp spike upward was also seen in 2013 to 4,789.9 kt CO_2 eq., followed by a sharp decline in 2014 to 3,800.9 kt CO_2 eq. (see Fig. 3.22).

Some economists argue that in the early 2010s, the Kyrgyz Republic began the process of integration into the Customs Union (as part of the Eurasian Economic Union), which was expected to cause a sharp rise in transport prices. The population actively purchased motor vehicles, resulting in a sharp increase in the spatial mobility of the population and organizations.

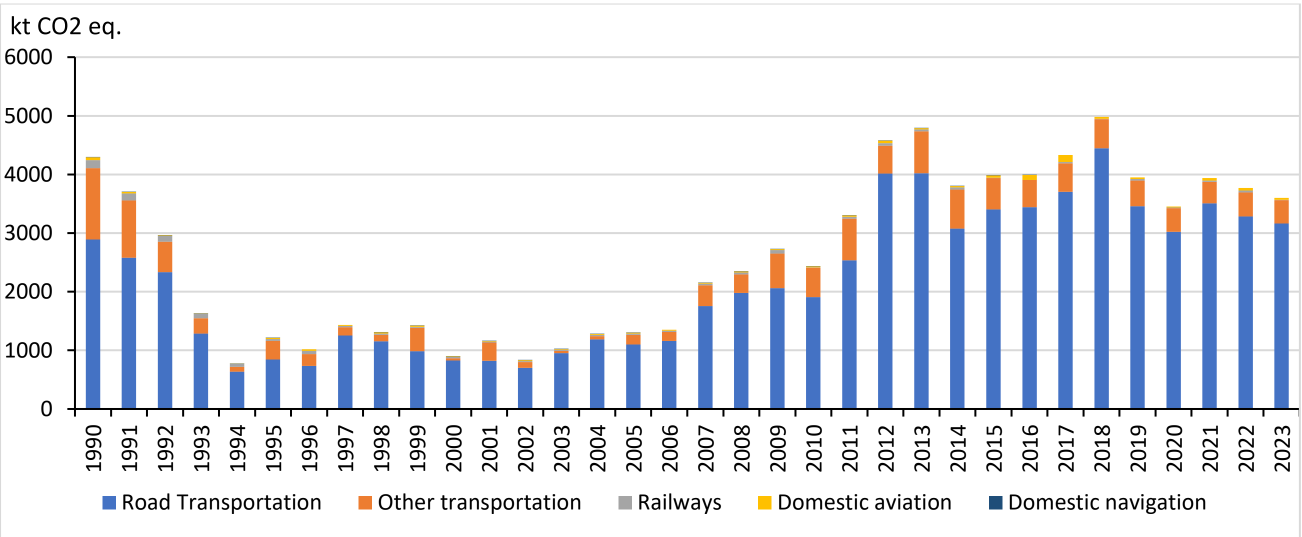
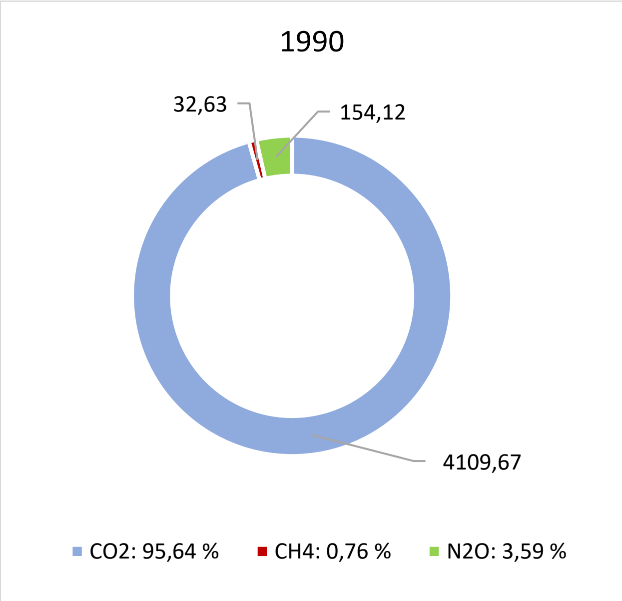


Figure 3.21. Contribution of the main subcategories of the Transport sector to GHG emissions

After reaching the peak of greenhouse gas emissions from transport in 2018 — 4,982.8 kt CO_2 eq., a steady downward trend began in 2019: 3,950.9 kt CO_2 eq. in 2019 and 3,454.1 kt CO_2 eq. in 2020, explained in part by the restrictions of the pandemic period. However, contrary to expectations of recovery, the decline continued in subsequent years, amounting to 3,601.5 kt CO_2 eq.in 2023. At the current stage, there are no definitive explanations for this trend. Possible factors may include the impact of digitalization, a reduction in excessive transport activity of the population, partial transition to electric transport (although its share is still insignificant), as well as probable unaccounted fuel consumption related, for example, to its shadow circulation (smuggling). However, additional research is needed for reliable conclusions. At this stage, only assumptions are being put forward that require confirmation.

GHG emissions by type of gases in 1990 and 2023 in CO_2 eq. are presented in Figure 3.23.



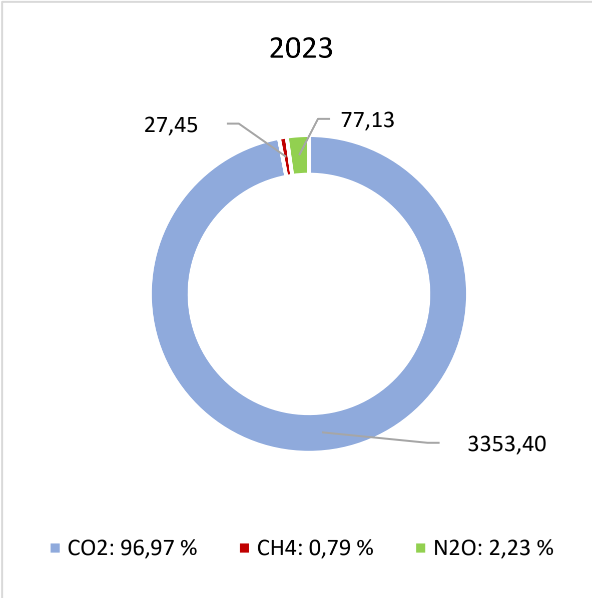


Figure 3.22. Distribution of greenhouse gas emissions for 1990 and 2023.

In the “Transport” sector, emissions are mainly carbon dioxide (CO_2), accounting for 95.64% in 1990 and 96.97% in 2023, and remaining high throughout the entire period under review (as shown in Figure 3.22). The contribution of other GHGs is insignificant. Methane (CH_4) emissions account for about 0.54%–0.76%, and nitrous oxide (N_2O) about 2.6%–4.2%. This distribution has hardly changed over time, since the structure of fuel use has remained practically unchanged.

As seen from Figure 3.23, the main trend in changes in greenhouse gas emissions in the transport sector is determined by the category “Road transport.” Its contribution to total emissions was 67.22% in 1990 and increased to 87.90% in 2023.

The contribution of other categories to total emissions is insignificant. Only the “Off-road transport” category can partially compete with road transport in terms of emission levels. It should be noted that some of its representatives, such as a truck-mounted concrete mixer or a road roller, in fact operate on urban roads and are visually perceived as part of road transport. Nevertheless, the “Off-road transport” category has consistently occupied second place in emissions, second only to road transport. However, its share of emissions has shown a declining trend: from 28.35% in 1990 to 20.70% in 2010 and 10.97% in 2023.

The share of emissions from the “Domestic aviation” category decreased to 0.65% in 2010 compared to 1.1% in 1990 and reached 1.01% in 2023. The share of emissions from the “Railways” category was 3.22% in 1990, 0.14% in 2010, and 0.14% in 2023. The share of emissions from the “Water transport” category was small in 1990 — 0.1%, and by 2010 decreased even further to 0.01%. Starting from 2017, emissions from water transport have consistently been equal to zero, or, as is now stated, no emissions occur, using the notation key “NO.” (See Fig. 3.24).

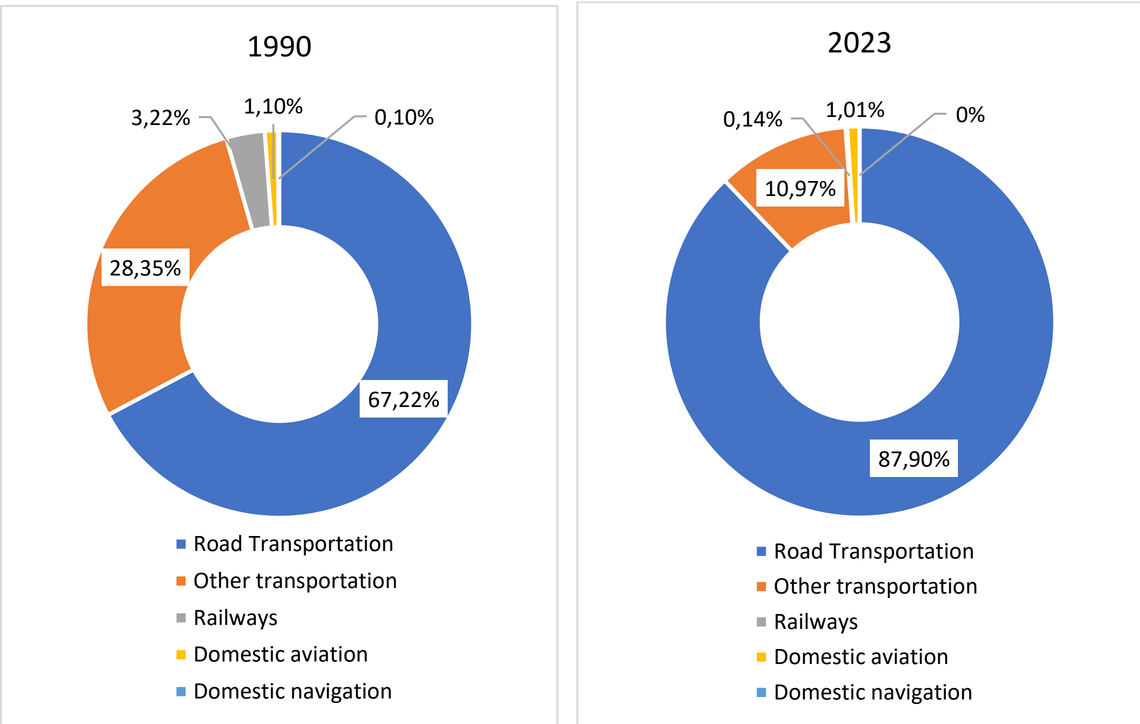


Figure 3.23. Distribution of GHG emissions of the main subcategories of the “Transport” category in 1990 and 2023.

3.2.7.3.2 Overall assessment of completeness

In accordance with IPCC requirements, the national greenhouse gas inventory must include an assessment of the completeness of source data, coverage of all relevant GHG sources and sinks, as well as the entire territory of the country.

The emissions inventory in category “1.A.3 – Transport” covers the entire territory of the Kyrgyz Republic and includes the main emission sources characteristic of the transport sector of the country.

The calculations include three main greenhouse gases: CO_2, CH_4, N_2O.

For subcategory 1.A.3.b.i (road transport, Cars), which includes passenger cars, trucks, buses, and motorcycles, emissions by individual subcategories (e.g., light/heavy trucks, buses, motorcycles) are not presented due to the absence of detailed activity data. All emissions are aggregated within the general category Cars. In this regard, the corresponding rows are marked with the notation key IE (Included Elsewhere).

Emissions of gases with indirect greenhouse effect — NO_x, CO, non-methane volatile organic compounds (NMVOC), and SO_2 — are not included in the calculations for the subcategories of “Road transport,” including the subcategory “Cars,” due to the absence of relevant activity data. These rows are marked with the notation key NE (Not Estimated).

At the same time, emissions of precursors NO_x, CO, SO_2, and NMVOC from all types of vehicles related to subcategory 1.A.3.b.i, if data become available in the future, will be accounted for within the category "Cars" as a whole, which is reflected with the notation key IE (Included Elsewhere).

3.2.7.2. Methodological issues

Emissions can be estimated on the basis of fuel combustion data.

The Tier 1 approach calculates CO_2 emissions by multiplying the mass of fuel sold by the default CO_2 emission factor. This tier is the most appropriate, since the available and accessible data for the sector ensure the reliability and transparency of the GHG inventory calculations in the transport sector. Higher Tiers 2 and 3 require data that are not yet available in the Kyrgyz Republic. Tier 1 is applied to all gases in all categories due to the lack of more detailed data.

For the calculation of emissions, the following equation was used:

$$\text{Emissions} = \sum_a (Fuel_a \cdot EF_a)$$

Where,
Emissions – CO_2 emissions (kg);
$Fuel_a$ = fuel sold (TJ);
EF_a = emission factor (kg/TJ), equal to the carbon content of the fuel multiplied by 44/12.

a – type of fuel (gasoline, diesel, jet kerosene).

Mobile sources produce direct greenhouse gas emissions, namely carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) from the combustion of various types of fuel, as well as several other types of pollutants, such as carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), sulfur dioxide (SO_2), particulate matter (PM), and nitrogen oxides (NO_x), which contribute to local or regional pollution.

According to methodological guidelines, calculations of pollutant emissions — such as carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), and sulfur dioxide (SO_2) — should be performed for the transport sector as an additional component to the assessment of greenhouse gas emissions.

The emission calculation formula for Tier 1 pollutants such as CO, NMVOC, etc. requires that fuel consumption/sales statistics be disaggregated by vehicle subcategories. However, national statistical data do not provide detailed information on fuel consumption volumes by vehicle subcategories (light or heavy-duty commercial transport, passenger vehicles with or without catalytic converters, buses, motorcycles, etc.). Tiers 2 and 3 require more detailed information, for example, fuel types (Euro 3 or Euro 5), mileage, fuel consumption (kg/km), operating modes, and road types (rural, urban, highway).

However, within the framework of this analysis, such calculations were not performed due to the absence of detailed activity data by transport subcategories (for example, separately for trucks, light commercial vehicles, heavy trucks, buses, motorcycles, etc.). Such detail is necessary for the correct application of the relevant emission factors.

For the assessment of pollutant gases, further research work is required at a more detailed level of information on fuel consumption by transport subcategories.

In the future, with more comprehensive statistics, it may be possible to expand the analysis to include the above-mentioned pollutants.

Activity data

The volumes of economic activity in the transport sector and the indicators of energy consumption by the main transport categories are taken from the data of the National Statistical Committee of the Kyrgyz Republic (statistical compendium “Energy Balance”). For the main categories of “Transport,” emissions of the main greenhouse gases CO_2, CH_4, and N_2O are taken into account.

Greenhouse gas emissions in the transport sector are estimated on the basis of emissions from fuel combustion in any device or mechanism engaged in the transportation of material goods, cargo, and passengers, including air transport, road transport, rail transport, water transport, and off-road transport.

Civil aviation

The assessment of activity data for **domestic aviation** is based on the consumption volumes of jet kerosene on domestic flights, reflected in the archives of national experts from the TNC Technical Expert Group. To fill gaps in the time series of aviation activity data, the original TNC data were used in full from 1990 to 2010, since TNC determined separate accounting of aviation fuel consumption in the Kyrgyz Republic. Thereafter, from 2011 to 2023, the full set of activity data of the State Civil Aviation Agency under the Cabinet of Ministers of the Kyrgyz Republic was used.

Road transport

Emission estimates from **road transport** can be based on two independent data sets: fuel sold and its carbon content (see Section 3.2.1.3 of the 2006 IPCC Guidelines) [54]and vehicle mileage. If both data sets are available, it is important to check their comparability; otherwise, estimates of different gases may be contradictory. However, such verification is currently impossible because no data on vehicle mileage are available. In general, the first approach (fuel sold) is suitable for CO_2, while the second (distance traveled by different types of vehicles and roads) is more suitable for CH_4 and N_2O.

For the subcategories Water transport, Rail transport, and Off-road transport, the assessment of activity data was carried out by analogy with road transport.

Data sources

The key source of activity data (AD) for estimating greenhouse gas emissions in the “Transport” category of the Kyrgyz Republic is the energy balance (EB), compiled by the National Statistical Committee (NSC). However, it should be noted that in the published versions of the EB, the level of detail is limited and does not fully reflect the structure of fuel consumption by transport categories.

To obtain more accurate data, additional requests were submitted to the NSC, in response to which internal tables used by the Committee in compiling the EB were provided. These tables contain detailed information on fuel consumption across four categories of transport: road, off-road, rail, and water. This approach helps to avoid duplication and data losses, and also ensures consistency with official national statistics.

[54] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

In addition, the following were used:

- information from the Vehicle Registration Agency under the Cabinet of Ministers of the Kyrgyz Republic;
- data from the State Civil Aviation Agency (SCAA) (on aviation fuel consumption);
- local information from city municipalities (on passenger routes);
- expert assessments and interpolation — in cases where direct data were absent, especially for the retrospective period (1990–2004). The calculation method was applied in cases where consumption dynamics trends were sufficiently clear.

It should be emphasized that despite the systematic approach, a certain degree of uncertainty remains, related in particular to possible fuel imports into the country bypassing official accounting, especially from neighboring Kazakhstan. In the absence of full transparency of the fuel market, part of the consumed gasoline and diesel may not be captured in the official statistics, which should be taken into account when interpreting the results of emission estimates.

Assumptions made during data collection and processing

Activity data can be provided either as fuel combustion data or as mileage data. Emissions from road transport should be assigned to the country in which the fuel was sold; therefore, fuel combustion data must reflect the fuel sold on the territory of the country.

Fuel used for road and off-road transport is recorded separately. Fuel consumption by special vehicles (for example, construction-road vehicles such as concrete mixers, agricultural machinery, and off-road transport when moving on urban roads) is accounted for as off-road transport consumption.

Fuel sold for transportation purposes is not used for other purposes (for example, as fuel for stationary boilers) in the Kyrgyz Republic.

Despite the probability of fuel smuggling, due to the lack of reliable information on volumes such supplies are not included in the estimates.

The use of lubricants as fuel additives in two-stroke engines can be accounted for either as part of the fuel or separately as lubrication. However, the national statistics (NSC) do not provide data on the volume of such additives; therefore, they are not included in the estimates.

Data collection methodologies

In the transport sector of the Kyrgyz Republic, for the calculation of greenhouse gas emissions throughout the entire time series, the Tier 1 methodology of the IPCC (2006) was used. The main source of activity data (AD) was the energy balance (EB), published annually by the National Statistical Committee of the Kyrgyz Republic.

- The methodology did not change: standard IPCC formulas for estimating emissions based on consumed fuel volumes were used.
- The fuel data source for the entire transport sector is the EB, reflecting consumption volumes of gasoline and diesel fuel. However, data on aviation fuel consumption for the past 13 years have been provided by the Civil Aviation Agency.
- Although the structure and detail of EB data may have varied over the years, the basis of calculation — fuel consumption by transport categories — remained stable.

Thus, the Tier 1 methodology using EB data remains unchanged throughout the entire inventory period, ensuring internal consistency of the time series. Although the basis of calculations is stable and comparable over time, the limited detail prevents the transition to higher tiers of methodology

(Tier 2 or Tier 3). Accuracy could be improved with more detailed data on the structure of the vehicle fleet, mileage, fuel types, engine types, etc.

Selection of emission factors

The Tier 1 method is fully based on fuel indicators; therefore, emissions from all combustion sources can be calculated based on the amount of fuel burned and average emission factors. In Kyrgyzstan, there are no national emission factors for GHGs, so the default emission factors from the 2006 IPCC Guidelines were used. The same set of emission factors was applied for the entire time series.

3.2.7.3. Uncertainties (base and latest years)

Uncertainty assessment[55]

For the base year (1990), the main sources of uncertainty were incomplete or aggregated data on fuel consumption in transport, as well as irregular publication of energy balances. For the latest reporting year (2023), the quality of information has improved due to the introduction of more systematic accounting; however, some inaccuracies remain, related to limited disaggregation by types of transport. The level of uncertainty for 1990 is assessed as moderately high, and for 2023 — as medium. Nevertheless, the emission estimates are considered representative and acceptable for the purposes of national reporting and monitoring.

Uncertainty in reporting depends on the accuracy of the collected data. Uncertainties for activity data and emission factors were applied in accordance with the 2006 IPCC Guidelines for the entire time series across all types of transport (see Table 3.12).

Table 3.16. Uncertainty values for the “Transport” sector

Category	Gas	Reporting element	Uncertainty value (%)	IPCC Guidelines
Road transport	CO_2, N_2O and CH_4	Activity data	±5	Default
Road transport	CO_2	Emission factor	±2.09	Default
Road transport	CH_4	Emission factor	±61.52	Default
Road transport	N_2O	Emission factor	±67.83	Default
Domestic aviation	CO_2, N_2O and CH_4	Activity data	±5	Default
Domestic aviation	CO_2	Emission factor	±3.17	Default
Domestic aviation	CH_4	Emission factor	±60	Default
Domestic aviation	N_2O	Emission factor	±70	Default
Rail transport	CO_2, N_2O and CH_4	Activity data	±5	Default
Rail transport	CO_2	Emission factor	±2.02	Default
Rail transport	CH_4	Emission factor	±59.76	Default
Rail transport	N_2O	Emission factor	±50	Default
Water transport	CO_2, N_2O and CH_4	Activity data	±5	Default
Water transport	CO_2	Emission factor	±3.53	Default
Water transport	CH_4	Emission factor	±50	Default
Water transport	N_2O	Emission factor	±40	Default
Off-road transport	CO_2, N_2O and CH_4	Activity data	±5	Default
Off-road transport	CO_2	Emission factor	±2.41	Default
Off-road transport	CH_4	Emission factor	±59.91	Default

[55] IPCC. 2006. Guidelines for National GHG Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

Category	Gas	Reporting element	Uncertainty value (%)	IPCC Guidelines
Off-road transport	N_2O	Emission factor	±50	Default

3.2.7.4. Consistency of time series

To ensure the consistency of time series of greenhouse gas emissions in the “Transport” sector, a single calculation method was used in all reporting years. The main task was to apply uniform data on the volumes of fuel consumed and a stable set of emission factors throughout the entire period.

Since methane (CH_4) and nitrous oxide (N_2O) emissions depend on engine type and technology used, in the absence of detailed national emission factors tied to specific technologies, it was decided to apply the standard set of default emission factors corresponding to each type of fuel in accordance with the 2006 IPCC Guidelines. This approach ensures consistency of calculations and minimizes methodological discrepancies in the time series.

Thus, consistency of methodology and source parameters across all years has made it possible to avoid unsystematic fluctuations in the data and to ensure the integrity of the emission time series.

3.2.7.5. Quality assurance and quality control

The main criterion of reliability and quality of the data is the use of official data from the National Statistical Committee of the Kyrgyz Republic, the application of the IPCC methodology, and constant greenhouse gas emission factors; the sources of data are permanent, which guarantees the homogeneity of the series. Thus, quality assurance (QA) and quality control (QC) in these categories are ensured by using the emission factors recommended by the 2006 IPCC Guidelines.

As part of the GHG inventory in the transport sector, QA and QC measures were implemented in line with the IPCC Guidelines:

1. The results of the calculations and the quality of data entry into the CRT tables were checked and verified by mutual reviews. For the purpose of internal cross-checking and improving the reliability of the calculations, the principle of reciprocal expert review was applied: the transport sector specialist checked the calculations for the energy sector, while the energy expert reviewed the transport section. This approach helps to identify logical inconsistencies, technical inaccuracies, and promotes improved consistency of data between sectors.
2. In addition, national consultations were held with the participation of relevant government bodies and experts. During the discussions, the following were agreed:

    i. the methodology applied for the GHG inventory calculations in the transport sector;
    ii. the list of necessary parameters and data sources for 2021–2023;
    iii. the existing data series since the 1990s (including periods 1990, 1995, and 2000);
    iv. approaches to extrapolation and interpolation to eliminate data gaps.

The measures carried out ensured a sufficient degree of transparency, consistency, and reproducibility of calculations and represent an important element of the QA/QC system in national climate reporting practice.

3.2.7.6. Recalculations for specific categories

In accordance with the terms of reference, for the purpose of preparing the section on the “Transport” sector for the National Emissions Inventory Report and the Common Reporting Tables

(CRT), a recalculation of the entire time series of greenhouse gas emissions for 1990–2020 was carried out (see Table 3.2.5.6). The basis for the recalculation was the requirement to use updated Global Warming Potential (GWP) values from the IPCC Fifth Assessment Report (AR5), replacing the factors previously applied from the IPCC Second Assessment Report (SAR).

During the verification of activity data received from the main sources — the National Statistical Committee (NSC) and the Civil Aviation Agency under the Cabinet of Ministers — no discrepancies or revisions of historical data were identified. Thus, there were no grounds for additional recalculations related to updates of the primary input data. The recalculation was performed solely due to the update of the global GWP factors, which ensured comparability with current international reporting standards.

According to the recommendations of the IPCC Fifth Assessment Report, 2014 (AR5), the present NIR used the latest GWP values relative to CO_2, under which the following values were applied for the entire time series 1990–2023: methane (CH_4) = 28, nitrous oxide (N_2O) = 265.

Table 3.17 shows the differences in estimates of GHG emissions in kt CO_2 eq. from the "Transport" sector, obtained in NC4 with GWP values from AR2 and the current inventory estimates using GWP values from AR5 for BTR1.

Table 3.17. Recalculation of GHG emissions in the "Transport" sector for the period 1990–2023, kt CO_2 eq.

Year	HC 4	BTR 1	Change in kt CO_2eq.	Change in %	Year	HC 4	BTR 1	Change in kt CO_2eq.	Change in %
1990	4,314.44	4,296.43	-18.01	-0.42	**2006**	1,355.29	1,353.34	-1.95	-0.14
1991	3,723.81	3,709.32	-14.49	-0.39	**2007**	2,161.54	2,156.62	-4.92	-0.23
1992	2,970.90	2,963.78	-7.12	-0.24	**2008**	2,348.08	2,343.63	-4.45	-0.19
1993	1,635.78	1,647.53	11.75	0.72	**2009**	2,734.61	2,725.88	-8.73	-0.32
1994	774.15	773.41	-0.74	-0.10	**2010**	2,438.42	2,431.29	-7.13	-0.29
1995	1,220.91	1,216.59	-4.32	-0.35	**2011**	3,298.79	3,298.89	0.10	0.00
1996	1,023.09	1,020.29	-2.80	-0.27	**2012**	4,583.54	4,577.11	-6.43	-0.14
1997	1,434.07	1,432.25	-1.82	-0.13	**2013**	4,798.36	4,789.98	-8.38	-0.17
1998	1,307.47	1,306.39	-1.08	-0.08	**2014**	3,810.51	3,800.92	-9.59	-0.25
1999	1,427.23	1,421.26	-5.97	-0.42	**2015**	3,992.60	3,985.08	-7.52	-0.19
2000	901.44	900.60	-0.84	-0.09	**2016**	4,000.78	3,994.94	-5.84	-0.15
2001	1,163.41	1,159.01	-4.40	-0.38	**2017**	4,338.98	4,331.32	-7.66	-0.18
2002	832.55	831.28	-1.27	-0.15	**2018**	4,990.40	4,982.76	-7.64	-0.15
2003	1,023.56	1,023.15	-0.41	-0.04	**2019**	3,958.38	3,953.17	-5.21	-0.13
2004	1,279.00	1,278.97	-0.03	0.00	**2020**	3,460.72	3,454.13	-6.59	-0.19
2005	1,303.37	1,300.42	-2.95	-0.23					

3.2.7.7. Planned improvements

No improvements have yet been planned for the "Transport" category.

3.3. Category “Other Sectors” (CRT 1.A.4э)

This chapter presents data on fuel consumption and greenhouse gas emissions in the subcategories:

- “Commercial/Institutional” (1.A.4.a)
- “Residential” (1.A.4.b)
- “Agriculture/Forestry/Fishing” (1.A.4.c)

Information on the methodology used in the NIR for this category is presented in Table 3.18.

Table 3.18. Method, EFs used, and key category indicators for 2023 in the category “Other Sectors.”

Fuel Type	CO_2			CH_4			NO_2		
	Method	EF	Key category	Method	EF	Key category	Method	EF	Key category
Solid	T 1	D	L, T	T 1	D	-	T 1	D	-
Liquid	T 1	D	L, T	T 1	D	-	T 1	D	-
Gaseous	T 1	D	T	T 1	D	-	T 1	D	-
Biomass	T 1	D	-	T 1	D	-	T 1	D	-

In this sector, CO_2 emissions from the use of solid, gaseous, and liquid fuels are a key category by level. CO_2 emissions from the combustion of solid, gaseous, and liquid fuels are a key category by trend, while CH_4 emissions from solid fuel combustion are also a key category by trend.

In 2023, GHG emissions in category “1.A.4 – Other Sectors” amounted to 2,558.15 kt CO_2 eq., or 24% of total emissions in the “Energy” sector, which is 59.9% lower than in 1990 and 28.1% higher than in 2020, the last year of the previous NIR.

The estimated GHG emissions and trend dynamics for the period 1990–2023 for this category are presented in Table 3.19 and in Figure 3.25.

Table 3.19. GHG emissions in category “Other Sectors” for 1990–2023.

Categories	1990	1995	2000	2005	2010	2015	2020	2023
Other Sectors (1.A.4)	**6,376.36**	**997.64**	**1,040.89**	**969.55**	**1,543.97**	**1,985.89**	**1,997.52**	**2,558.15**
Commercial / Institutional (1.A.4.a)	NE	NE	NE	101.96	179.98	352.12	321.77	286.37
Residential (1.A.4.b)	6,311.85	959.76	987.13	832.84	1,335,05	1,609.87	1,666.57	2,267.16
Agriculture / Forestry / Fishing (1.A.4.c)	64.51	37.88	53.77	34.74	28,93	23.90	9.19	5,02

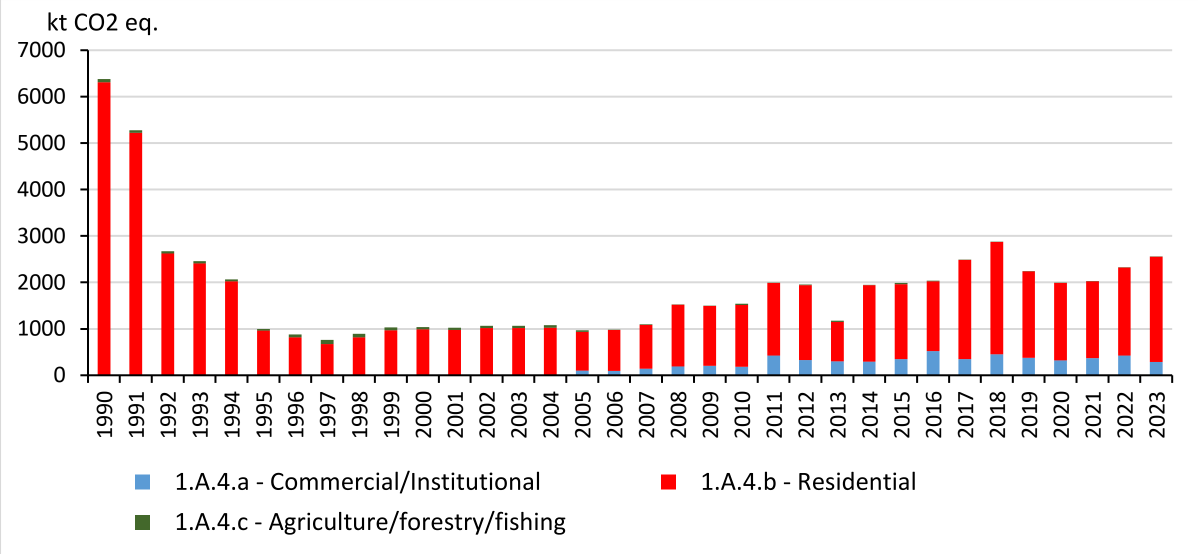


Figure 3.24. Dynamics of GHG emissions in category "1.A.4 Other Sectors" by subcategories for the period 1990–2023.

3.3.1 Category "1.A.4.a Commercial / Institutional Sector" and category "1.A.4.b Residential Sector"

3.3.1.1 Category description

GHG emissions from these two subcategories include emissions from energy installations of private companies, industrial production organizations, and service providers, usually providing corporate heat and electricity supply, operating autonomously within their own networks, as well as private households supplying themselves with energy from individual energy units.

Disaggregated statistical activity data for these subcategories became available starting in 2005, after the NSC changed its methodology for collecting primary statistical information.

In 2023, emissions from subcategory 1.A.4.a – Commercial / Institutional sector amounted to 286.371 kt CO_2 eq., or 11.2% of emissions of the entire category "Other Sectors," which is almost 181% higher than in 2005 and 11% lower than in 2020. Emissions from subcategory 1.A.4.b – Residential sector in 2023 amounted to 2,267.157 kt CO_2 eq. or 88.6% of the entire category "Other Sectors," which is 64.1% lower than in 1990 and 36% higher than in 2020.

3.3.1.2 Methodological issues

For the estimation of GHG emissions in these subcategories, the Tier 1 methodology of the 2006 IPCC Guidelines was used with default emission factors (Table 3.8 – GHG Emission Factors in the "Energy Activities" sector). The estimation of greenhouse gas emissions from each type of fuel used for energy production was calculated according to Equation 2.1 of the 2006 IPCC Guidelines, Vol. 2, Ch. 2, p. 2.11:

GREENHOUSE GAS EMISSIONS FROM STATIONARY FUEL COMBUSTION
GHG Emissions, fuel = Fuel Consumption × Emission Factor (GHG, fuel)

Activity data

The source of official activity data is the NSC of the Kyrgyz Republic.[56] When using the data, the inventory team ensured that natural gas consumption, expressed in volumetric units, was normalized and correctly converted into mass units.

Emission factors

The emission factors were taken from the 2006 IPCC Guidelines, Volume 2, Table 2.4 and Table 2.5, based on the net calorific value (NCV) of the fuel.

3.3.1.3 Uncertainty and consistency of time series

Uncertainty estimates for the "Commercial/Institutional sector" and the "Residential sector" are based on the recommendations of the 2006 IPCC Guidelines methodology. Uncertainty in activity data represents a combination of systematic and random errors. The inventory compilers selected the uncertainties associated with stationary fuel combustion, as recommended in the 2006 IPCC Guidelines. The selected uncertainties represent an average value for extrapolation for less developed statistical systems. Uncertainties are presented as percentages in Table 3.20 below.

Table 3.20. Uncertainties of activity data (AD) and emission factors (EF) used by fuel type

Fuel Type	1990-2023 yy.			
	AD	CO_2 EF	CH_4 EF	N_2O EF
Solid	5.0	12.460	200.0	218.778
Liquid	5.0	6.136	200.0	228.788
Gaseous	5.0	3.922	200.0	200.0
Biomass	5.0	17.751	200.0	250.0

3.3.1.4. Quality assurance and quality control

The data for these categories were verified using the general quality control procedures described in the relevant sections of the 2006 IPCC Guidelines, while QA was applied through comparison with energy balance data under the reference approach.

3.3.1.5. Recalculations for specific categories

Recalculations of time series of GHG emissions were carried out for the period from 1990 to 2020 inclusive. The basis for the recalculation was the requirement in BUR1 to use updated Global Warming Potential (GWP) values from the IPCC Fifth Assessment Report (AR5), instead of the GWP values from the IPCC Second Assessment Report (SAR) previously applied in NC4.

The results of recalculating GHG emissions in CO_2 eq. for category "1.A.4 Other Sectors" from the previous NIR for the preparation of NC4 (using SAR GWPs) and the results of the current NIR for the preparation of BTR1 (using AR5 GWPs) are presented in Table 3.21.

Table 3.21. Recalculation of GHG emissions in the sector "1.A.4 Other Sectors" for the period 1990–2020.

Year	HC 4	BTR 1	Difference, kt CO_2-e	Difference, %	Year	HC 4	BTR 1	Difference, kt CO_2-e	Difference, %
1990	6,266.82	6,376.36	109.54	1.72	**2006**	968.57	980.75	12.18	1.24

[56] NSC. https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/

Year	HC 4	BTR 1	Difference, kt CO_2-e	Difference, %	Year	HC 4	BTR 1	Difference, kt CO_2-e	Difference, %
1991	5,190.33	5,279.44	89.07	1.69	**2007**	1,085.00	1,098.48	13.47	1.23
1992	4.139.07	2,674.14	-1,464.93	-54.78	**2008**	1,501,65	1,522.49	20.85	1.37
1993	3,087.79	2,458.35	-629.43	-25.60	**2009**	1,473.57	1,493.97	20.40	1.37
1994	2,037.65	2,065.41	27.77	1.34	**2010**	1,516.22	1,543.97	27.74	1.80
1995	990.33	997.64	7.31	0.73	**2011**	1,966.17	1,991.96	25.78	1.29
1996	875.00	880.71	6.61	0.75	**2012**	1,924.12	1,951.56	27.45	1.41
1997	758.18	765.00	5.92	0.78	**2013**	1,703.32	1,175.34	-527.98	-44.92
1998	887.08	896.561	9.48	1.06	**2014**	1,916.75	1,946.10	29.35	1.51
1999	1,016.30	1,029.33	13.04	1.27	**2015**	1,958.01	1,985.89	27.88	1.40
2000	1,026.57	1,040.89	14.32	1.38	**2016**	2,020.11	2,038.75	18.65	0.91
2001	1,010.19	1,025.81	15.62	1.52	**2017**	2,457.61	2,488.02	30.41	1.22
2002	1,238.09	1,063.49	-174.60	-16.42	**2018**	3,392.83	2,880.25	-512.59	-17.80
2003	1,465.64	1,068.87	-396.77	-37.12	**2019**	2,210.57	2,239.75	29.18	1.30
2004	1,695.39	1,076.54	-618.86	-57.49	**2020**	1,890.68	1,997.52	106.85	5.35
2005	957.88	969.55	11.67	1.20					

3.3.1.6 Planned improvements for specific categories

Improvements may be made in case of updates to the statistical data of the NSC of the Kyrgyz Republic for these subcategories.

3.3.2 Category "1.A.4.c. Agriculture / Forestry / Fishing (CRT 1.A.4.c.)

3.3.2.1. Category description

This section should cover all fuel consumption in "Agriculture, Forestry, and Fishing." However, in this category, only fuel consumption for the subcategory "Stationary" (1.A.4.c.i) is presented as a source of GHG emissions in this sector. For mobile fuel consumption in Kyrgyzstan in this sector, there are insufficient data; therefore, these volumes are included under the "Transport" sector.

3.3.2.2. Methodological issues

For the estimation of GHG emissions in this subcategory, the Tier 1 methodology of the 2006 IPCC Guidelines was used with default emission factors (Table 3.8 – GHG emission factors in the "Energy Activities" sector). The estimation of greenhouse gas emissions from each type of fuel used for energy production was calculated according to Equation 2.1 of the 2006 IPCC Guidelines, Vol. 2, Ch. 2, p. 2.11.:

GREENHOUSE GAS EMISSIONS FROM STATIONARY FUEL COMBUSTION
GHG Emissions, fuel = Fuel Consumption × Emission Factor (GHG, fuel)

Activity data

The source of official activity data is the NSC of the Kyrgyz Republic[57]. It should be noted that the applied methodology covers only large state and private agricultural organizations, but not the entire agricultural sector, which poses a problem of data completeness.

Emission factors

The emission factors were taken from the 2006 IPCC Guidelines, Volume 2, Table 3.3.1, based on the net calorific value (NCV) of the fuel.

3.3.2.3. Uncertainty and consistency of time series

Uncertainty estimates for the subcategory "Agriculture, Forestry, and Fisheries" are based on the recommendations of the 2006 IPCC Guidelines methodology. Uncertainty in activity data represents a combination of systematic and random errors. The inventory compilers selected the uncertainties associated with stationary fuel combustion, as recommended in the 2006 IPCC Guidelines.

3.3.2.4. Quality assurance and quality control

Tier 1 quality control procedures were applied to subcategory "1.A.4.c. Agriculture, Forestry, and Fisheries." QA/QC procedures were carried out in accordance with the general QA/QC principles and the QA/QC plan.

Checks performed:

- documentation of emission sources,
- data for mechanical errors,
- correctness of formulas used and measurement units across the entire time series,
- consistency of applied emission factors,
- all references to data sources in the software.

When analyzing and assessing emissions from the subcategories, trends in the main drivers of emissions and activity data were carefully examined, and anomalies were checked for errors. It should be noted that all abrupt changes have officially confirmed data provided by the NSC of Kyrgyzstan.

3.3.2.5. Recalculations for specific categories

Recalculations of GHG emission time series were carried out for the period from 1990 to 2020 inclusive. The basis for the recalculation was the requirement to use updated Global Warming Potential (GWP) values from the IPCC Fifth Assessment Report (AR5), replacing the GWP values from the IPCC Second Assessment Report (SAR) previously applied.

3.3.2.6. Planned improvements for specific categories

Improvements may be made if the NSC of the Kyrgyz Republic updates statistical data for these subcategories.

[57] NSC. https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/

3.3.3 Category "1.A.5 Other" (CRT 1.A.5)

3.2.8.1. Category description

This category does not exist in Kyrgyzstan as an industry type. Therefore, notation key "NO" is used for this category group.

3.4 Category "1.B Fugitive emissions from fuels" (CRT 1.B.)

This chapter presents data on fugitive greenhouse gas emissions from:

- Solid fuels (1.B.1)
- Oil and natural gas (1.B.2)

Coal mining and processing is a key category for CH_4, and emissions were calculated using the Tier 1 methodology with default EF from the 2006 IPCC Guidelines. Methane emissions from abandoned and closed coal mines were not estimated due to lack of information-gathering resources. Fugitive emissions from oil are a key category for CH_4 and were calculated using the Tier 1 approach and default EF, as indicated in Table 3.22 below.

Table 3.22. Method, EF used, and key category indicators for 2023 in category "Fugitive emissions from solid fuels, oil, and natural gas" (1.B.)

Fuel Type	CO_2			CH_4			NO_2		
	Method	EF	Key category	Method	EF	Key category	Method	EF	Key category
Coal mining and handling	T 1	D	-	T 1	D	L, T	NO	NO	NA
Oil and natural gas	T 1	D	-	T 1	D	L, T	T 1	D	-

Emissions in category "1.B Fugitive fuel emissions" in 2023 amounted to 644.28 kt CO_2 eq., which is 8.7% lower than in 1990 and 61.4% higher than in 2020. Emissions in subcategory "1.B.1 Solid fuels" in 2023 amounted to 304.95 kt CO_2 eq., or 47.3% of all emissions in category 1.B, which is 17.8% lower than in 1990 but 130.5% higher than in 2020. Emissions in subcategory "1.B.2 Oil and natural gas" in 2023 amounted to 339.32 kt CO_2 eq., or 52.7% of all emissions in category 1.B, which is 1.3% higher than in 1990 and 27.1% higher than in 2020.

Greenhouse gas emissions in kt CO_2 eq.by each subcategory for the period 1990–2023 are presented in Table 3.23 and in Figure 3.26.

Table 3.23. GHG emissions in category "1.B Fugitive fuel emissions" by subcategories for the period 1990–2023.

Categories	1990	1995	2000	2005	2010	2015	2020	2023
Fugitive fuel emissions (1.B)	**705.97**	**198.49**	**161.27**	**143.87**	**122.88**	**183.94**	**399.28**	**644.28**
Solid fuels (1.B.1)	370.94	34.80	25.40	14.08	15.38	47.89	132.32	304.96

Categories	1990	1995	2000	2005	2010	2015	2020	2023
Oil and natural gas (1.B.2)	335.03	163.69	135.87	129.79	107.50	136.05	266.97	339.32

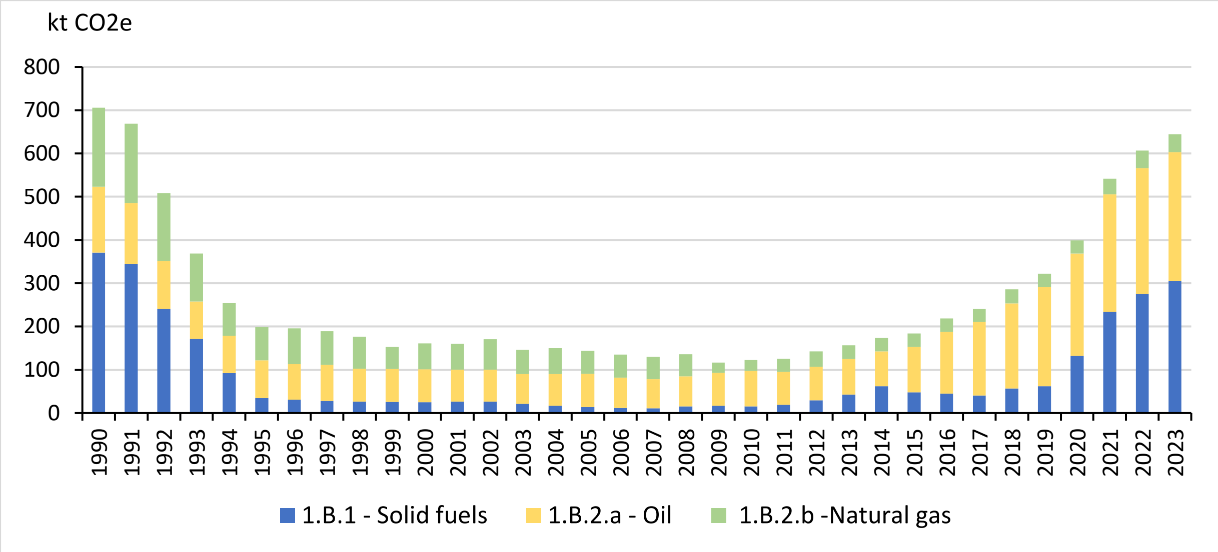


Figure 3.25. Dynamics of emissions from solid fuels, oil, and natural gas for the period 1990–2023.

Fugitive fuel emissions accounted for only 3.0% of emissions in the "Energy" sector in 2023 and increased by 2% compared to emissions in 1990. The increase in emissions is mainly associated with the growth of open-pit oil and coal production. In 1990, emissions from solid fuels made up 52% of fugitive GHG emissions, while the remaining 48% came from oil and natural gas.

3.4.1. Solid fuels (CRT 1.B.1.)

3.4.1.1. Category description

In the current NIR, this category is represented by the subcategory "1.B.1.a. Coal mining and handling," which includes emissions reflecting the extraction method: subcategory "1.B.1.a.i Underground mining," arising in the process of coal mining operations (1.B.1.a.i.1) and emissions of seam gas after coal extraction (1.B.1.a.i.2), as well as emissions from subcategory "1.B.1.a.ii Surface mining," also arising during mining operations and emissions of seam gas after extraction.

The main GHG in this category is methane (CH_4), emitted during and after coal extraction, although carbon dioxide (CO_2) emissions also occur. CH_4 emissions from abandoned coal mines and surface pits were not assessed due to the lack of necessary data. Activities for methane capture, flaring, or utilization at mines are not carried out. There is also no activity related to uncontrolled coal combustion or conversion.

Estimated values of GHG emissions for the category "Solid fuels" and all its subcategories for the period 1990–2023 are presented in Table 3.24.

Table 3.24. GHG emissions from category "1.B.1 Solid fuels" for the period 1990–2023 by subcategories

Categories	1990	1995	2000	2005	2010	2015	2020	2023
1.B.1 Solid fuels	**370.94**	**34.80**	**25.40**	**14.08**	**15.30**	**47.89**	**132.32**	**304.96**

Categories	1990	1995	2000	2005	2010	2015	2020	2023
1.B.1.a.i Underground mining	***35724***	***32.78***	***23.35***	***12.29***	***12.06***	***36.65***	***116.45***	***281.40***
1.B.1.a.i.1 Mining operations	327.75	30.08	21.42	11.28	11.06	33.62	106.83	258.16
1.B.1.a.i.2 Post-mining seam gas emissions	29.50	2.71	1.93	1.02	0.10	3.03	9.62	23.24
1.B.1.a.ii Surface mining	***13.70***	***2.02***	***2.04***	***1.79***	***3.32***	***11.24***	***15.87***	***23.56***
1.B.1.a.ii.1 Mining operations	13.29	1.96	1.98	1.73	3.22	10.91	12.17	18.07
1.B.1.a.ii.2 Post-mining seam gas emissions	0.40	0.06	0.06	0.05	0.10	0.33	3.70	5.49

3.4.1.2. Methodological issues

Coal mining and processing

For the estimation of GHG emissions in these subcategories, the Tier 1 methodology of the 2006 IPCC Guidelines was applied using default emission factors (Table 3.8 – GHG emission factors in the "Energy" sector). The estimation of greenhouse gas emissions from each type of fuel used for energy production was calculated according to Equation 4.1 of the 2006 IPCC Guidelines, Vol. 2, Ch. 4, p. 4.13.:

Emissions CH_4 = Emission factor CH_4 × Underground coal production × Conversion factor

Where,

Underground coal production – (metric $tons^{-1}$)

Emission factor – low CH_4 emission factor = 10 m^3 ton^{-1}

Conversion factor – CH_4 density, converts CH_4 volume into CH_4 mass = 0.67 (kg/m^3)

CO_2 emissions (t)=EF3(m3CO2/t)×extracted coal (t)×1.84(kg/m3)

EF_3 – CO_2 emission factor during coal mining (m^3 CO_2 / t)

Activity data

The source of official activity data is the NSC of the Kyrgyz Republic.[58] It should be noted that disaggregation by type of mining is not provided by the NSC, therefore additional requests were sent to the relevant agencies.

Emission factors

The emission factors used were taken from the 2006 IPCC Guidelines, Vol. 4, Section 4.1.3.2.

Low emission factors:

- CH_4 = 10 m^3 ton^{-1} during mining and CH_4 = 0.9 m^3 ton^{-1} post-mining in underground mines.
- CH_4 = 0.3 m^3 ton^{-1} during mining and CH_4 = 0.1 m^3 ton^{-1} post-mining in surface mines.

[58] NSC. https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/

3.4.1.3. Uncertainty and consistency of time series

Uncertainty values were taken from the 2006 IPCC Guidelines. Percentage values of uncertainties for activity data (AD) and emission factors (EF) by gas type are presented in Table 3.25, in line with the 2006 IPCC Guidelines.

Table 3.25. Uncertainties of activity data and emission factors used in the 2025 submission for the base year and the latest reporting year.

Fuel Type	1990-2023 yy.			
	AD	CO_2 EF	CH_4 EF	N_2O EF
Coal mining and processing	5.0	150.0	200.0	NA

3.4.1.4. Quality assurance and quality control

Tier 1 quality control procedures were applied to category "Solid fuels" (1.B.1). QA/QC procedures were carried out in accordance with the general principles of the 2006 IPCC Guidelines. It should be noted that all sharp changes are supported by officially confirmed data provided by the NSC of Kyrgyzstan.

3.4.1.5. Recalculations for specific categories

Recalculations of time series of GHG emissions were performed for the period from 1990 to 2020 inclusive. The basis for the recalculation was the requirement to use updated Global Warming Potential (GWP) values from the IPCC Fifth Assessment Report (AR5) for the current NIR BTR1, instead of the values from the IPCC Second Assessment Report (SAR) previously applied in NC4. The results of the recalculations and the differences obtained in kt CO_2 eq. and in percentages are presented in Table 3.26.

Table 3.26. Recalculation of GHG emissions in category "1.B Fugitive fuel emissions" for the period 1990–2020.

Year	HC4	BTR 1	Difference, kt CO_2e	Difference, %	Year	HC4	BTR 1	Difference, kt CO_2e	Difference, %
1990	539,85	705,97	166,12	23,53	**2006**	101,84	134,79	32,95	24,44
1991	510,90	668,46	157,57	23,57	**2007**	98,16	130,00	31,84	24,49
1992	388,13	508,34	120,21	23,65	**2008**	102,80	135,99	33,18	24,40
1993	281,31	368,70	87,40	23,70	**2009**	88,51	116,89	28,38	24,28
1994	193,61	254,28	60,68	23,86	**2010**	93,09	122,88	29,79	24,24
1995	150,43	198,49	48,06	24,21	**2011**	95,31	125,60	30,29	24,11
1996	148,28	195,97	47,69	24,34	**2012**	108,17	142,31	34,14	23,99
1997	142,84	188,82	45,98	24,35	**2013**	119,35	156,70	37,35	23,84
1998	133,51	176,59	43,08	24,40	**2014**	132,45	173,52	41,08	23,67
1999	115,65	152,64	37,00	24,24	**2015**	140,00	183,94	43,94	23,89
2000	122,23	161,27	39,04	24,21	**2016**	166,05	218,77	52,72	24,10
2001	121,29	159,96	38,67	24,17	**2017**	182,70	241,10	58,40	24,22
2002	129,2469	170,6323	41,39	24,25	**2018**	177,80	285,89	108,09	37,81
2003	110,8841	146,3855	35,50	24,25	**2019**	201,46	321,82	120,37	37,40
2004	113,7182	150,2294	36,51	24,30	**2020**	215,97	399,28	183,31	45,91

Year	HC4	BTR 1	Difference, kt CO_2e	Difference, %	Year	HC4	BTR 1	Difference, kt CO_2e	Difference, %
2005	108,8071	143,8726	35,07	24,37					

3.2.4.1.6. Planned improvements for specific categories

Improvements may be made if the NSC of the Kyrgyz Republic updates statistical data for these subcategories.

3.5. Category “CO_2 Transport and Storage” (CRT 1.C.)

3.5.1. Category description

This category does not exist in Kyrgyzstan as an industry type. Therefore, notation key “NO” is used for this category group.

4. Industrial Processes and Product Use (CRT 2.)

4.1. Sector overview

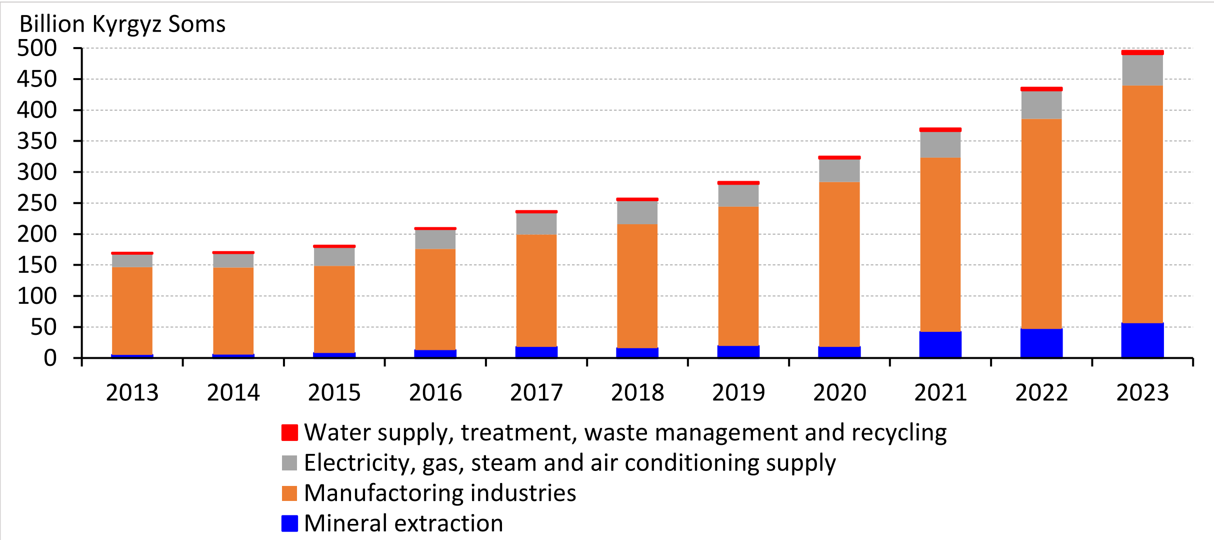
The industry of the Kyrgyz Republic includes the following sectors[59]:

- Mining – 11,38%[60]
- Manufacturing – 77.34%
- Supply of electricity, gas, steam, and air conditioning – 10.30%
- Water supply, treatment, waste management, and recovery of secondary raw materials – 0.98%

The main contribution to industrial production comes from manufacturing, which is broken down into the following types:

- Manufacture of food products (including beverages) and tobacco products
- Textile production; manufacture of clothing and footwear, leather, and other leather goods
- Manufacture of wood and paper products; printing activities
- Manufacture of coke and refined petroleum products
- Manufacture of chemical products
- Manufacture of pharmaceutical products
- Manufacture of rubber and plastic products, and other non-metallic mineral products
- Manufacture of basic metals and fabricated metal products, except machinery and equipment
- Manufacture of computers, electronic and optical equipment
- Manufacture of electrical equipment
- Manufacture of machinery and equipment not elsewhere classified
- Manufacture of transport equipment
- Other manufacturing, repair, and installation of machinery and equipment

Despite overall significant growth, over the past ten years the share of the main industrial sectors in total production has not changed significantly (see Fig. 4.1).



[59] Sectoral breakdown according to the data of the National Statistical Committee of the Kyrgyz Republic.
[60] Shares of industrial production volumes in million soms (NSC, Table 1.04.01.01)

Figure 0.1. Dynamics of industrial production volumes in the Kyrgyz Republic for 2013–2023.

Some relative growth is observed only in the mining sector.

The growth of industrial production leads to a corresponding increase in GHG emissions. Industry in the Kyrgyz Republic related to energy generation and mineral extraction is accounted for in the "Energy" sector. The emission sources relevant to the IPPU sector are industrial processes in which raw materials are transformed through physical changes and/or chemical reactions.

Various greenhouse gases are released in the process. According to the results of several recent inventories, these gases include: carbon dioxide (CO_2), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), and sulfur hexafluoride (SF_6). In addition, emissions of major precursor gases are recorded: carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and non-methane volatile organic compounds (NMVOC). Emissions of sulfur hexafluoride have not been observed throughout the entire inventory period; however, there is a significant volume of this gas in use in the energy sector, which will be described in more detail below.

4.2. Categories of GHG emission sources

4.2.1. Category description

The general list of GHG emission source categories for which emissions were assessed over the reporting period has not changed and is presented in Table 4.1. Categories that do not exist in the Kyrgyz Republic have been excluded. The table also includes information on the main data providers, the methodological tier applied for each category, and the gases considered in the inventory.

Table 0.1. List of GHG emission source categories in the sector, data providers, methodological tier, and emission factors.

CRT Category	Data providers (in descending order of importance)	Methodological tier / emission factor used	Greenhouse gases and precursor gases
2.A Mineral products manufacturing			
2.A.1 Cement production	Industry enterprises, NSC	T2, Д[61]	CO_2
2.A.2 Lime production	NSC	T1, Д	CO_2
2.A.3 Glass production	Industry enterprises	T2, D	CO_2
2.A.4 Other carbonate use			
2.A.4.a Ceramics	NSC, industry enterprises	T1, D	CO_2
2.C Metal industry			
2.C.8 Other metals	NSC, industry enterprises	T1, D	CO_2, NO_x, CO, SO_2
2.D Use of solvents and low-energy products from fuel			
2.D.1 Lubricant use	NSC	T1, D	CO_2
2.D.2 Use of solid paraffins	NSC	T1, D	CO_2
2.D.3 Solvent use	NSC	T1, D	NMVOCs
2.D.4 Other (asphalt production)	NSC, industry enterprises	T1, D	NMVOCs

[61] T – tier, Д -default emission factors according to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

CRT Category	Data providers (in descending order of importance)	Methodological tier / emission factor used	Greenhouse gases and precursor gases
2.F Use of substitutes for ozone-depleting substances			
2.F.1 Cooling and air conditioning	Ozone Center of KR, JSC "Manas International Airport", MES, NSC		HFCs
2.F.1.a Cooling and stationary air conditioning		T1, D	HFCs
2.F.1.b Mobile air conditioning		T1, D	HFCs
2.F.2 Foam-blowing agents		T1, D	HFCs
2.F.3 Fire protection		T1, D	HFCs
2.F.4 Aerosols		T1, D	HFCs
2.F.5 Solvents		T1, D	HFCs
2.F.6 Other applications (specify)		T1, D	HFCs
2.G Production and use of other products			
2.G.1 Electrical equipment			
2.G.1.b Use of electrical equipment	Energy industry enterprises	T1, D	SF_6
2.G.1.c Disposal of electrical equipment		T1, D	SF_6
2.G.3 N_2O from product use	NSC, Ministry of Health	T1, D	N_2O
2.H Other			
2.H.1 Pulp and paper industry	NSC	T1, DEEA[62]	NO_x, CO, NMVOCs, SO_2
2.H.2 Food and beverages production	NSC	T1, DEEA	NMVOCs

4.2.2. Methodological issues

The methodological basis of the present inventory in the IPPU sector included the following documents:

- 2006 and 2019 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006)
- IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000
- EMEP/EEA Air Pollutant Emission Inventory Guidebook, 2019 edition

In addition to methodological literature, materials and results of previous assessments obtained under the Third and Fourth National Communications were used.

Automation of calculations and data management for all GHG emission source categories was carried out using IPCC Inventory Software (version 2.970.9249.15623 dated 28 April 2025).

For the assessment of GHG emissions in CO_2 eq., the global warming potentials (GWPs) according to the IPCC Fifth Assessment Report (AR5) were used, as presented in Table 4.2.

Table 0.2. Global Warming Potential values relative to CO_2

[62] Default Emission Factors in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2019)

Gas name	Chemical formula	GWP (100-year horizon)	
		AR 2	AR 5
Carbon dioxide	CO_2	1	1
Methane	CH_4	21	28
Nitrous oxide	N_2O	310	265
Hydrofluorocarbons (HFC)			
HFC-32	CH_2F_2	650	677
HFC-125	CHF_2CF_3	2,800	3,170
HFC-134a	CH_2FCF_3	1,300	1,300
HFC-152a	CH_3CHF_2	140	138
HFC-143a	CH_3CF_3	3,800	4,800
HFC-227ea	CF_3CHFCF_3	2,900	3,350
HFC-245fa	$CHF_2CH_2CF_3$	-	858
HFC-365mfc	$CH_3CF_2CH_2CF_3$		804
Perfluorocarbons (PFCs)			
Sulfur hexafluoride	SF_6	23,900	23,500
Nitrogen trifluoride	NF_3		16,100

4.2.3. Trends in emissions of the IPPU sector

This assessment of greenhouse gas (GHG) emissions and removals for the First Biennial Transparency Report of the Kyrgyz Republic on climate change covers the period from 2021 to 2023. For the analysis of trends and the possibility of forecasting GHG emissions in the medium term, data series from previous inventories for the period 1990–2020 were used. Thus, the assessment covered a period of 34 years, from 1990 to 2023.

According to the results of the latest inventory, covering the period 1990–2020, the IPPU sector is the third largest in total GHG emissions after the Energy and Agriculture sectors. Since 2020, the sector's contribution to national emissions increased from 1,481.40 kt CO_2 eq. in 2020 (NC4 data) to 2,008.04 kt CO_2 eq.in 2023. At the same time, the share of emissions, excluding LULUCF, changed only slightly — from 9.7% to 10.3% (see Fig. 4.2).

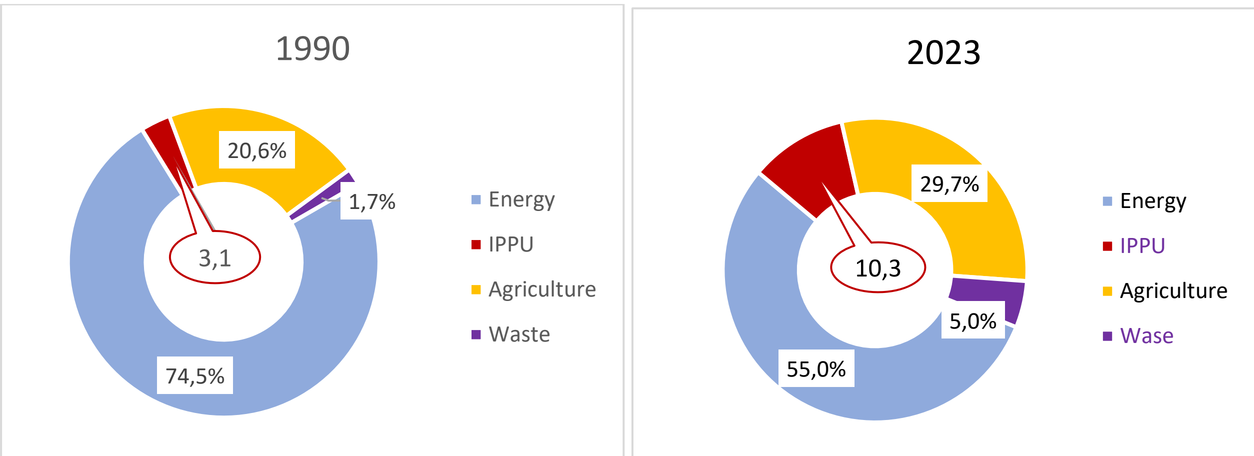


Figure 0.2. The share of the IPPU sector in total emissions of the Kyrgyz Republic in 1990 and 2023.

The projected decline in GHG emissions for 2021–2022 due to the effects of the COVID-19 pandemic was not confirmed. Overall, the sector shows a steady increase (see Fig. 4.3).

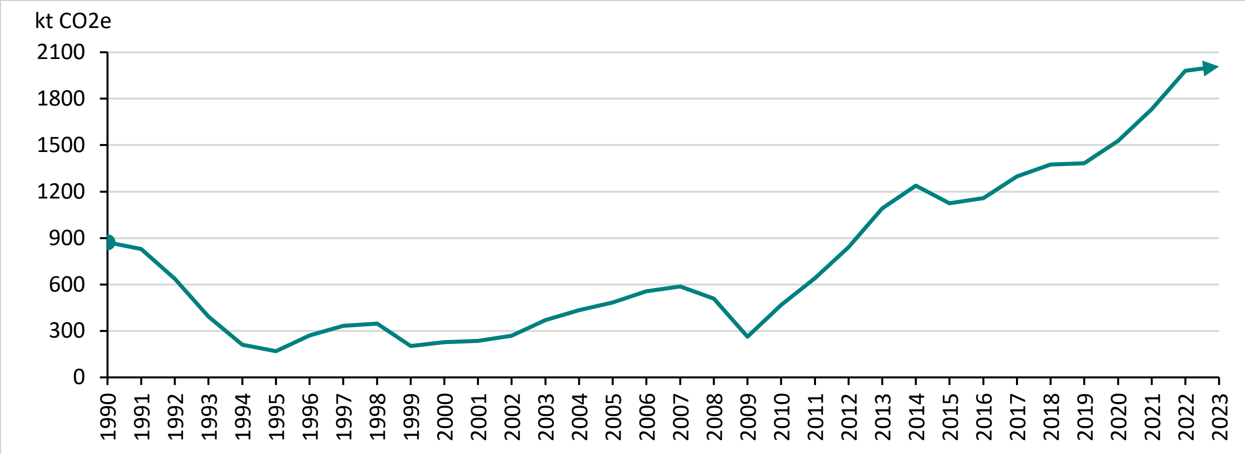


Figure 0.3. Dynamics of GHG emission growth in the IPPU sector.

The overall trend in GHG emissions is not uniform across different source categories. The largest contribution, as in the previous period, comes from two categories: "2.A.1 Cement production" and "2.F Use of substitutes for ozone-depleting substances" (see Fig. 4.4). Considering that the overwhelming share of emissions in the sector is attributed to CO_2 and HFCs — since nitrous oxide emissions are extremely negligible and emissions of other GHGs are absent — this figure also reflects the dynamics of emissions by gas.

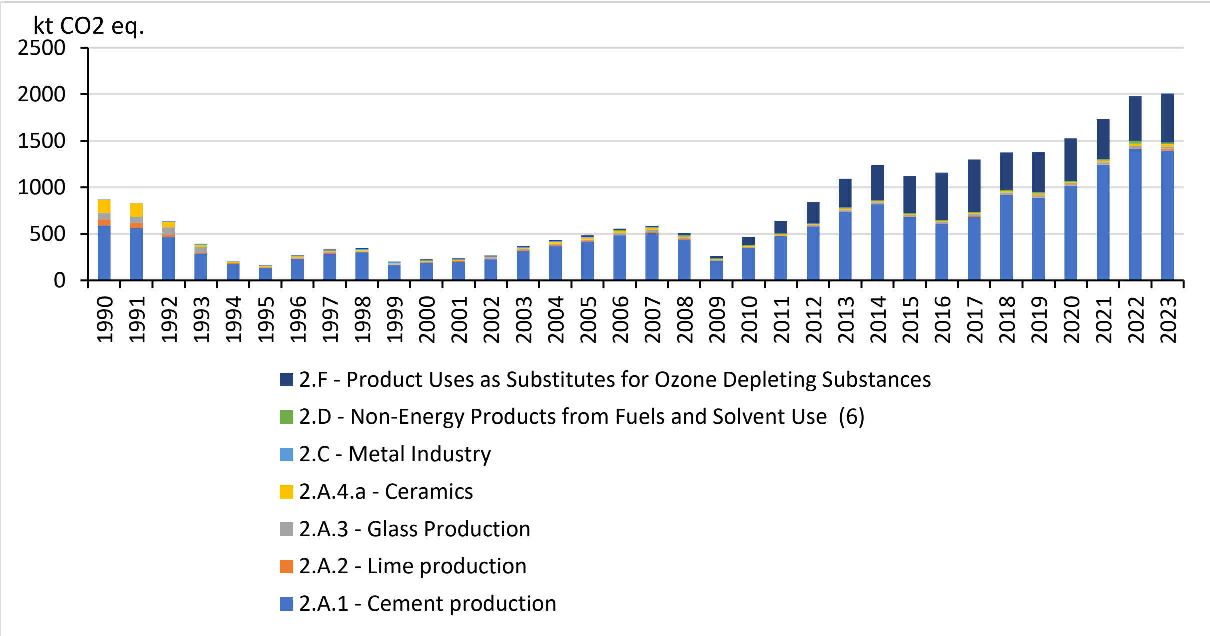


Figure 0.4. Emissions of the IPPU sector during 1990–2023 by sources[63]

Fluctuations in total GHG emissions of the sector mainly depend on corresponding fluctuations in cement production. According to information from enterprises, this is due to changes in demand.

The overall dynamics by main categories for the entire period from 1990 to 2023 are presented in Table 4.3.

[63] Category "2G Other Products and Use" is not included, as the total volume of GHG emissions from it is extremely insignificant.

Table 0.3. GHG emissions of the IPPU sector by categories[64]

Year	GHG emissions by categories in IPCC coding, kt CO_2e					
	2.A	2.C	2.D	2.F	2.G	Всего
1990	871.04	0,60	NE	NA	NE	871.64
1991	829.17	0.60	NE	NA	NE	829.76
1992	628.07	8.08	NE	NA	NE	636.14
1993	382.11	11.32	NE	NA	NE	393.43
1994	202.90	7.37	NE	NA	NE	210.27
1995	158.52	6.99	NE	3.64	NE	169.15
1996	255.79	11.32	NE	4.09	NE	271.21
1997	315.41	11.85	NE	4.72	NE	331.97
1998	328.56	12.50	NE	5.51	NE	346.58
1999	183.12	12.51	NE	6.47	NE	202.10
2000	209.61	10.65	NE	7.60	NE	227.86
2001	216.62	11.14	NE	8.90	NE	236.65
2002	248.19	10.50	NE	10.36	NE	269.04
2003	350.85	7.17	NE	11.99	NE	370.01
2004	412.00	9.47	NE	13.66	NE	435.13
2005	461.27	5.90	NE	15.76	NE	482.93
2006	529.28	3.30	5.75	17.89	0.000	556.23
2007	560.48	6.47	1.83	17.90	0.000	586.68
2008	471.83	5.25	7.32	23.19	0.08	507.67
2009	226.68	2.81	8.33	25.50	0.24	263.56
2010	368.72	2.01	6.69	88.99	0.000	466.41
2011	494.32	2.20	8.41	135.17	0.03	640.13
2012	609.27	1.37	0.41	229.92	0.16	841.13
2013	773.34	1.40	10.34	307.00	0.25	1,092.33
2014	853.59	0.93	3.21	379.52	0.000	1,237.25
2015	714.07	0.55	9.06	400.32	0.15	1,124.14
2016	638.11	0.19	8.27	510.10	0.000	1,156.66
2017	726.84	0.03	9.67	562.61	0.000	1,299.16
2018	957.68	1.30	11.13	403.74	0.000	1,373.85
2019	934.66	0.29	14.49	430.20	2.64	1,382.29
2020	1,055.11	0.27	11.43	460.60	0.000	1,527.41
2021	1,288.91	0.26	13.69	430.21	C	1,733.06
2022	1,472.23	0.11	27.37	481.59	C	1,981.30
2023	1,466.05	0.19	15.69	526.11	C	2,008.04

Notes: NE – not estimated, since import data for this period were not provided by the NSC, referring to the fact that the import/export database was launched in 2006. NA – not applicable, since HFCs began to be introduced into circulation starting from 1995. C – confidential: data on imports of nitrogen oxides (HS code 2811293000) for 2021–2023 were not provided by the NSC, citing confidentiality of information on an individual commodity.

The contribution of different greenhouse gases to total GHG emissions of the sector in 2020 and 2023 is shown in Fig. 4.5. Despite the overall growth in HFC emissions over the past ten years, with their assessment starting in 1995, in the long-term perspective their gradual decline is projected, since the Kyrgyz Republic has ratified the Kigali Amendment to the Montreal Protocol. According to the commitments undertaken, HFCs will be gradually phased out of circulation. At the same time, CO_2

[64] The table includes data only for those categories for which GHG emissions are reported.

emissions are expected to continue increasing. For example, in 2024 a new cement clinker plant with a capacity of 1,300 thousand tons of clinker per year was launched in the Kyrgyz Republic.

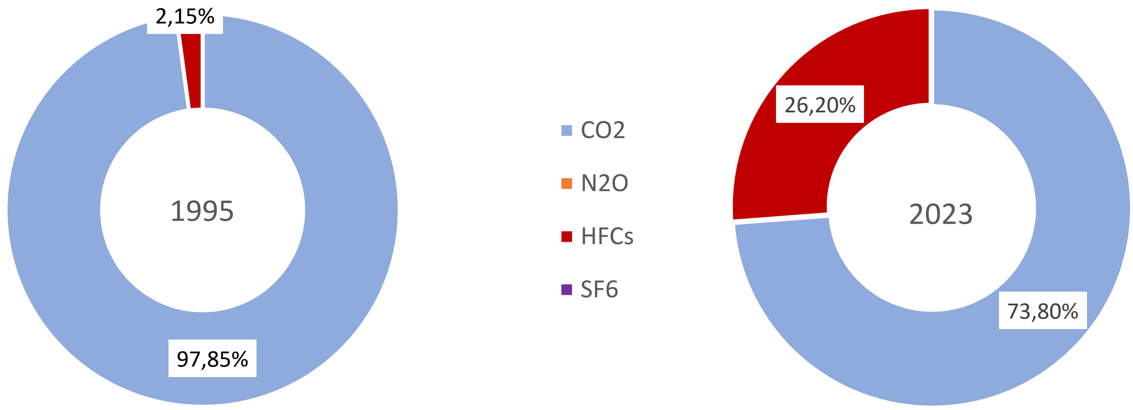


Figure 0.5. GHG emissions by gas types in 2020 and 2023.

The dynamics of total emissions of the IPPU sector by gas types, including precursors, are presented in Table 4.4.

Table 0.4. GHG emissions of the IPPU sector by gas types

Year	GHG, kt CO_2 eq.				Precursor gases, kt			
	CO_2	N_2O	HFC	ВСЕГО	NOx	CO	НМЛОС	SO_2
1990	871.64	NE	NE	**871.64**	0.081	0.409	6.590	0.011
1991	829.76	NE	NE	**829.76**	0.079	0.641	6.576	0.009
1992	636.14	NE	NE	**636.14**	0.048	5.167	3.807	0.897
1993	393.43	NE	NE	**393.43**	0.022	7.217	5.442	1.285
1994	210.27	NE	NE	**210.27**	0.006	4.697	4.976	0.843
1995	165.51	NE	3.64	**169.15**	0.004	4.454	4.682	0.800
1996	267.11	NE	4.09	**271.21**	0.005	7.215	5.082	1.298
1997	327.25	NE	4.72	**331.97**	0.066	7.548	3.080	1.358
1998	341.07	NE	5.51	**346.58**	0.002	7.861	3.063	1.417
1999	195.63	NE	6.47	**202.10**	0.002	7.965	1.959	1.435
2000	220.26	NE	7.60	**227.86**	0.002	6.828	2.159	1.230
2001	227.76	NE	8.90	**236.65**	0.004	7.298	1.910	1.313
2002	258.68	NE	10.36	**269.04**	0.006	6.840	3.265	1.234
2003	358.02	NE	11.99	**370.01**	0.006	4.584	4.303	0.827
2004	421.47	NE	13.66	**435.13**	0.007	6.045	4.503	1.089
2005	467.17	NE	15.76	**482.93**	0.006	3.770	3.984	0.678
2006	538.33	NE	17.90	**556.23**	0.007	2.118	3.862	0.381
2007	568.78	NE	17.89	**586.68**	0.009	4.130	3.769	0.741
2008	484.39	0.08	23.19	**507.67**	0.006	3.600	3.144	0.648
2009	237.83	0.24	25.50	**263.56**	0.014	4.011	2.931	0.714
2010	377.42	NE	88.99	**466.41**	0.015	4.141	3.701	0.737
2011	504.93	0.03	135.17	**640.13**	0.008	1.432	3.641	0.255
2012	611.05	0.16	229.92	**841.13**	0.007	0.958	3.913	0.170

Year	GHG, kt CO_2 eq.				Precursor gases, kt			
	CO_2	N_2O	HFC	ВСЕГО	NOx	CO	НМЛОС	SO_2
2013	785.08	0.25	307.00	**1,092.33**	0.006	0.903	5.542	0.161
2014	857.73	NE	379.52	**1,237.25**	0.007	0.627	4.345	0.111
2015	723.68	0.15	400.32	**1,124.14**	0.004	0.611	3.465	0.106
2016	646.56	NE	510,10	**1,156.66**	0.005	0.639	4.127	0.116
2017	736.55	NE	562.61	**1,299.16**	0.007	0.038	2.862	0.006
2018	970.12	NE	403.74	**1,373.85**	0.009	0.049	3.218	0.006
2019	949.45	2.64	430.20	**1,382.29**	0.007	0.036	1.735	0.004
2020	1,066.81	NE	460.60	**1,527.41**	0.006	0.187	1.221	0.034
2021	1,302.86	NE	430.21	**1,733.06**	0.011	0.213	2.312	0.044
2022	1,499.71	NE	481.59	**1,981.30**	0.007	0.098	3.419	0.020
2023	1,481.93	NE	526.11	**2,008.04**	0.008	0.143	4.569	0.027

Among the precursor gases, the largest volume falls on non-methane volatile organic compounds (NMVOCs) (see Fig. 4.6). In absolute terms, the volume of NMVOCs increased from 1.221 kt in 2020 to 4.569 kt in 2023. The largest contribution to this increase came from the categories “2H2 Production of food products and beverages” and “2D3 Use of solvents.” The total volume of emissions of the other precursor gases did not exceed 0.228 kt in 2020 and 0.179 kt in 2023.

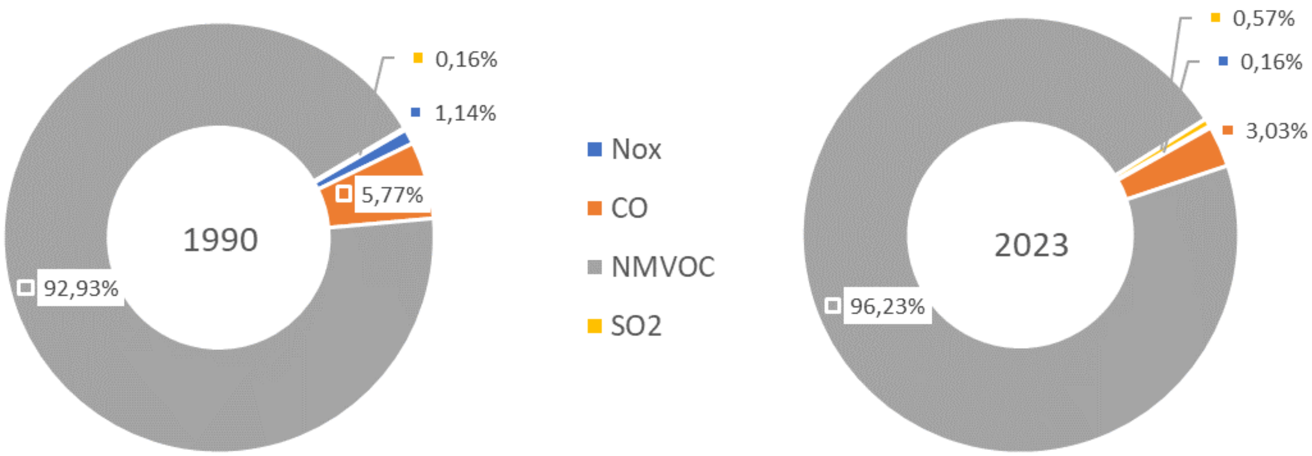


Figure 0.6. Comparison of precursor gas emissions in 1990 and 2023 for the IPPU sector

4.2.4 Uncertainties and Time Series Consistency

An important part of the analysis of GHG inventory results is the assessment of uncertainty. The overall uncertainty for each category consists of the uncertainty of the collected data and the uncertainty of the applied emission estimation method. For the applied estimation method (tier), this largely refers to the uncertainty of the emission factors used.

Since the estimation of GHG emissions was based on default emission factors recommended by the 2006 Guidelines, the main contribution to the uncertainty of the IPPU sector comes from uncertainties in activity data.

The following assumptions were made in assessing uncertainties:

- The uncertainty of data provided by the NSC is, in some cases, asymmetric. That is, NSC data are more likely to represent the minimum (or near-minimum) value of production volumes. This is because the list of enterprises obliged to regularly submit statistical reports in some industries is smaller than the total number of enterprises in a given industry (incomplete coverage). With full coverage of all small producers, the likelihood of data adjustment upward is higher than downward.
- The symmetry of activity data uncertainty was adjusted upward or downward through expert assessment of the state of a given industry.
- The uncertainty of emission factors was applied in accordance with the recommendations of the 2006 Guidelines. In cases of default uncertainty ranges (e.g., 20–30%), the mean or upper boundary value was selected based on expert judgment of the specific source category.

Uncertainty calculations for all considered IPPU sector categories were carried out using the Worksheet (2006 Guidelines, Vol. 1, Ch. 3, Table 3.2), with 1990 taken as the base year, as before.

Data provided by enterprises in the cement and glass industries are highly accurate due to the established technological processes and the collection of data through direct measurements. For example, the volume of glass mass produced is reported with an accuracy in some cases of up to 100 kg. Additionally, when collecting data from enterprises, information was requested on the margin of error of measurements used on industrial scales for technological purposes. According to the enterprises, the error margin ranges within 1%. This was confirmed by the estimates used in previous inventories.

For several categories, data for the base year are absent.

In 2023, the resulting uncertainty for the total GHG emissions in the IPPU sector over the period 1990–2023 amounts to: 29.350% for total emissions and 90.879% for trends. The maximum contribution to uncertainty comes from categories 2.D Non-energy products from fuels and 2.F Substitutes for ODS, where combined uncertainty exceeds 100%.

Table 0.5. Uncertainty Calculation of GHG Inventory for the IPPU Sector

IPCC Category	Gas	Emissions or Removals		Activity Data Uncertainty	Emission Factor/Parameter Uncertainty	Combined Uncertainty	Contribution to Variability by Category in Year t (2023)	Type A Sensitivity
		Base year	**t per year (2023)**					
		input data	input data	input data	input data	√(E^2+F^2)	(G*D)^2 ------------- (∑D)^2	
		kt CO_2e	kt CO_2e	%	%	%		%
2.A Mineral Product Manufacturing								
2.A.1 Cement Production	CO_2	591,5215	1396,1831	1,00%	2,00%	2,24%	0,0002	3,81%
2.A.2 Lime Production	CO_2	65,5358	20,2557	15,00%	2,00%	15,13%	0,0000	-14,99%
2.A.3 Glass Production	CO_2	69,2752	20,1230	0,50%	10,00%	10,01%	0,0000	-15,99%
2.A.4 Other								
2.A.4.a Ceramics Production	CO_2	144,7100	29,4856	15,00%	20,00%	25,00%	0,0000	-34,81%
2.C Metal Production								
2.C.8 Other	CO_2	0,5960	0,1905	10,00%	25,00%	26,93%	0,0000	-0,1357%
2.D Non-energy Use of Products								
2.D.1 Lubricants	CO_2		15,6339	50,00%	100,00%	111,80%	0,0001	1,79%
2.D.2 Paraffins	CO_2		0,0608	50,00%	100,00%	111,80%	0,0000	0,01%
2.F Substitutes for ODS	HFC		526,1101	100,00%	50,00%	111,80%	0,0858	60,36%
TOTAL		871,6385	2008,0428				0,0861	
% Uncertainty in the total inventory:							29,350%	

4.2.5. Recalculations

In the assessment of emissions, default emission factors were used, i.e., those recommended by the 2006 IPCC Guidelines or the 2019 EMEP/EEA Guidebook. The exception is category "2.C.8 Production of Other Metals", which includes secondary remelting of steel and cast iron, as well as the production of mercury and antimony (see details below). In previous inventories, secondary remelting and casting of steel and cast iron were included in category "2.C.1 Iron and Steel Production". However, since this category implies primary production from ores, it was decided to reallocate these emissions to category "2.C.8 Other Metal Production."

The preparation of the 1990–2018–2020 NID for the BUR1 and NC4 of the Kyrgyz Republic was marked by the transition from the 1996 IPCC Guidelines methodology, used earlier, to the 2006 IPCC Guidelines methodology. To assess the changes in total emissions estimates during this transition, global warming potential (GWP) values of various greenhouse gases from the IPCC Second Assessment Report (SAR, AR2) were used. In the current inventory, while maintaining the use of the 2006 IPCC methodology, emissions were recalculated using the GWP values from the IPCC Fifth Assessment Report (AR5). The result of the recalculation is presented graphically in Figure 4.7.

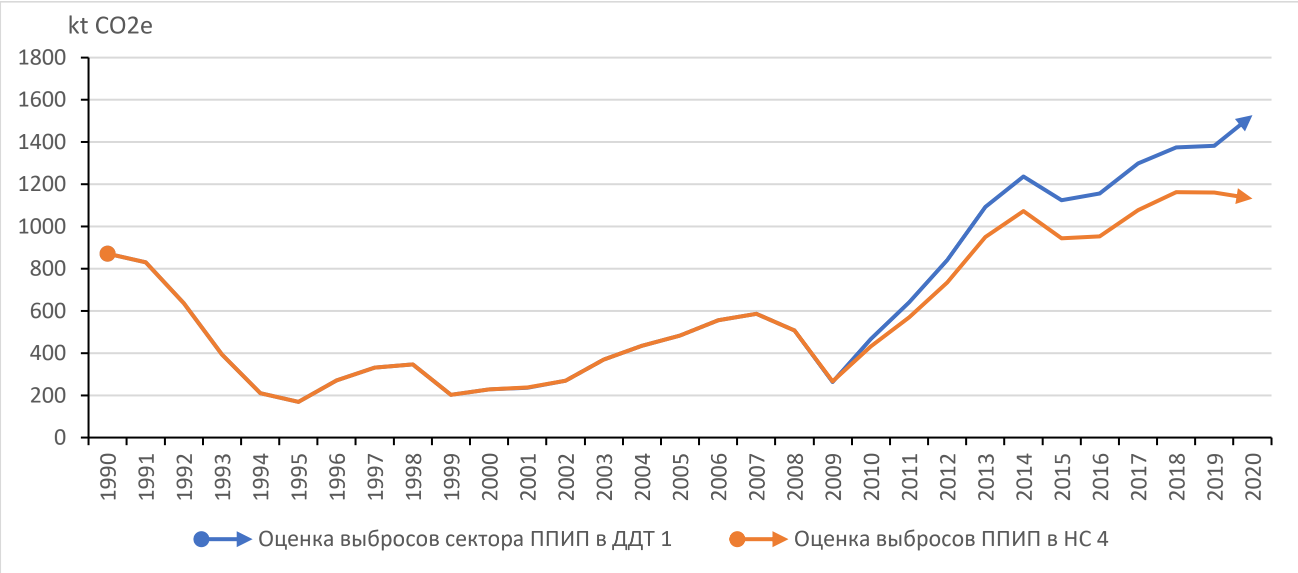


Figure 0.7. Comparison of Total Emissions of the Sector Using GWP from AR2 in NC4 and AR5 in BTR1

As can be seen from the figure, the difference between the two estimates is negligible. The difference arises from the change in GWP values for F-gases (HFCs) in category "2.F Use of ODS Substitutes" (Figure 4.8). The impact of changes in GWP for N_2O is insignificant, since the volumes of nitrous oxide are extremely small.

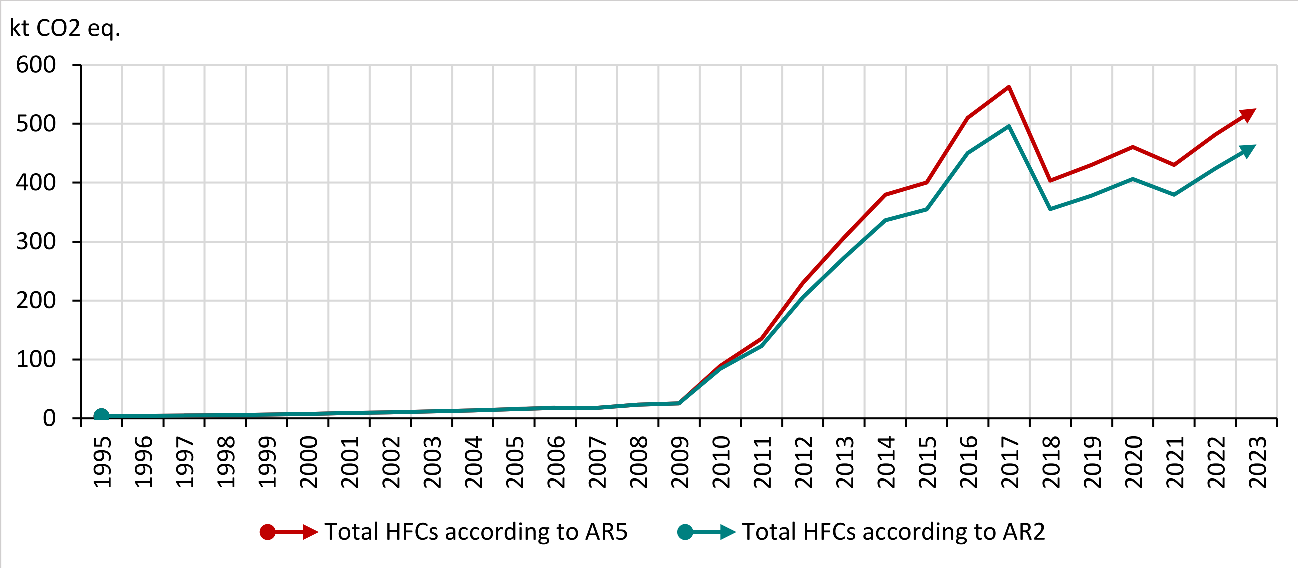


Figure 0.8 Comparison of HFC Emissions under Category "2.F Use of ODS Substitutes" According to AR2 and AR5

4.2.6. Planned Improvements

The process of preparing the current inventory revealed several areas for improvement, which are presented in Table 4.6. In addition to those listed in the table, a number of common issues relevant to the entire sector were also identified.

Table 0.6. Gaps and Proposed Improvements by Category

CRT Category	Gaps	Planned Improvements
2.A Mineral Products Manufacturing		
2.A.1 Cement Production	No gaps identified	No improvements planned
2.A.2 Lime Production	No statistical accounting by lime types	Introduce statistical accounting of production volumes by lime types
2.A.3 Glass Production	No gaps identified	No improvements planned
2.A.4 Other Uses of Carbonates		
2.A.4.a Ceramics	No statistical accounting in tons for brick production	Introduce corresponding statistical parameter
2.C Metal Production		
2.C.8 Other Metals		
2.D Use of Solvents and Low-Energy Products from Fuels		
2.D.1 Use of Lubricants 2.D.2 Use of Solid Paraffins 2.D.3 Use of Solvents	No access to disaggregated import data (up to 10-digit HS codes), as such data are restricted (confidential)	Conclude a permanent agreement between NSC and MPEETN on the provision of data for inventories
2.D.4 Other (Asphalt Production)	Missing activity data for 1990–2000	Fill in missing data for 1990–2000
2.F Use of Ozone-Depleting Substance Substitutes		
2.F.1 Refrigeration and Air Conditioning 2.F.1.a Refrigeration and Stationary Air Conditioning	Insufficiently developed regular statistical reporting on HFC import and use, especially regarding	Under the Kigali Amendment to the Montreal Protocol, introduce a statistical form for HFC accounting. Additionally,

CRT Category	Gaps	Planned Improvements
2.F.1.b Mobile Air Conditioning	equipment and products containing HFCs	develop a mechanism to maximize the coverage of HFC users required to submit this form. Conduct an HFC inventory.
2.F.2 Foam Blowing Agents		
2.F.3 Fire Protection		
2.F.4 Aerosols		
2.F.5 Solvents		
2.F.6 Other Applications (specify)		
2.G Production and Use of Other Products		
2.G.1 Electrical Equipment		
2.G.1.b Use of Electrical Equipment	No gaps identified	No improvements planned
2.G.1.c Disposal of Electrical Equipment		
2.G.3 N_2O from Product Use	Same as category 2.D.1–2.D.3	Same as category 2.D.1–2.D.3
2.H Other		
2.H.1 Pulp and Paper Industry	No gaps identified	pecify type of production technology to refine emission factors
2.H.2 Food and Beverage Production	No gaps identified	No improvements planned

4.2.7 Category "2.A.1 Cement Production"

4.2.7.1. Category Description

At present, there are five operating cement plants in the Kyrgyz Republic:

- South Kyrgyz Cement JSC
- Kant Cement Plant OJSC
- Xinji-Pirim LLC
- Southern Building Materials Plant LLC
- Terek-Tash LLC

The latter was commissioned in 2024 and is therefore not included in the current inventory.
The total number of enterprises in this sector is small, and all of them are large companies with well-established data accounting systems throughout the entire technological chain. In addition, the category "2.A.1 Cement Production" is a key category, contributing the largest share of GHG emissions in the IPPU sector. Therefore, starting with the FTR (First Biennial Transparency Report), a transition to the second methodological level was made. When carrying out the emission assessments (Table 4.7, Figure 4.9), actual enterprise data were used regarding the production of cement clinker and the volume of captured clinker dust.

Table 0.7. GHG Emissions [65]from Cement Production

Year	kt CO_2	Year	kt CO_2	Year	kt CO_2	Year	kt CO_2
1990	591.52	**1999**	165.03	**2008**	435.26	**2017**	684.36
1991	563.14	**2000**	193.11	**2009**	213.02	**2018**	915.98
1992	467.38	**2001**	200.26	**2010**	354.02	**2019**	886.87
1993	286.45	**2002**	227.33	**2011**	479.04	**2020**	1,016.40

1994	179.59	**2003**	319.21	**2012**	582.27	**2021**	1,238.72
1995	135.80	**2004**	370.78	**2013**	735.03	**2022**	1,415.69
1996	232.86	**2005**	415.12	**2014**	816.24	**2023**	1,396.18
1997	280.86	**2006**	485.22	**2015**	683.42		
1998	302.41	**2007**	509.66	**2016**	604.57		

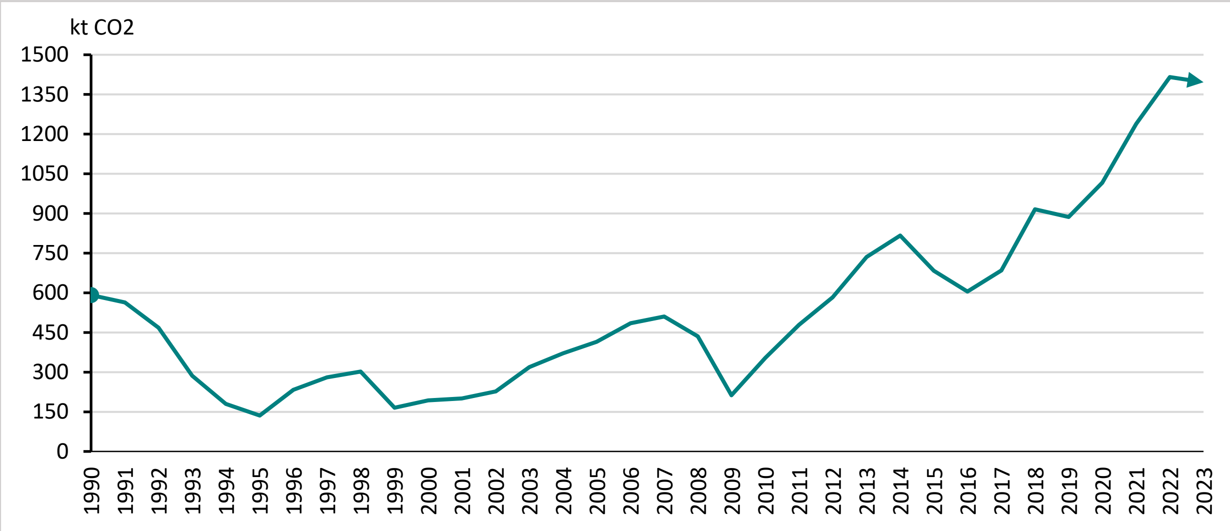


Figure 0.9. Greenhouse Gas Emissions from Cement Production for the Period 1990–2023

4.2.7.2. Methodology

The GHG inventory for this category is based on the 2006 IPCC Guidelines, Volume 3, Chapter 2, Section 2.2. The main equation for estimating emissions from this category is:

Equation 2.2

Tier 2: Estimation of Emissions Based on Clinker Production Data

$$CO2 \text{ Emissions} = Mcl \cdot EFcl \cdot CFckd$$

Where:

CO_2 Emissions = CO_2 emissions from cement production, tons

Mcl = weight (mass) of clinker produced, tons

EFcl = emission factor for clinker, tons CO_2 per tonne of clinker (see Section 2.2.1.2 “Choice of Emission Factors” for Tier 1 and Tier 2, IPCC 2006)

CFckd = correction factor for cement/clinker dust (CKD), dimensionless

As EFcl, the default value from the 2006 IPCC Guidelines was used: 0.51 tons CO_2 per tonne of clinker.

Calculation of the Correction Factor for CKD

Equation 2.5

Correction Factor for CKD Not Returned to the Kiln

$$CF_{ckd} = 1 + \left(\frac{M_d}{M_{cl}}\right) \cdot C_d \cdot F_d \cdot \left(\frac{EF_c}{EF_{cl}}\right)$$

Where:
Md = weight of CKD not returned to the kiln, tons
Mcl = weight of clinker produced, tons
Cd = fraction of raw carbonate in the CKD (i.e., prior to calcination), assumed as 1.0
Fd = fraction of calcined carbonate in the CKD, assumed as 1.0
EFc = emission factor for carbonate (Table 2.1), tons CO_2 per tonne carbonate (same as for clinker)
EFcl = emission factor for clinker without CKD correction (0.51 t CO_2/t clinker), tons CO_2 per tonne clinker

Notes:
a) It is assumed that 100% of CKD is initially captured. If any portion of CKD escapes into the atmosphere, that portion should be estimated and included in Md.
b) It may be assumed that the raw carbonate consists entirely of $CaCO_3$ and that the fraction of raw carbonate in CKD is the same as in the raw mix fed into the kiln.

Table 4.8 presents the aggregated activity data for the considered plants regarding the volumes of cement clinker production.

Table 0.8. Summary Data on Clinker Production

Year	Tons	Year	Tons	Year	Tons	Year	Tons
1990	1,137,104	**1999**	317,246	**2008**	836,724	**2017**	1,299,521
1991	1,082,546	**2000**	371,230	**2009**	406,205	**2018**	1,737,518
1992	898,456	**2001**	384,968	**2010**	675,727	**2019**	1,706,561
1993	550,662	**2002**	437,000	**2011**	910,000	**2020**	1,830,959
1994	345,232	**2003**	613,624	**2012**	1,103,312	**2021**	2,218,432
1995	261,050	**2004**	712,772	**2013**	1,394,815	**2022**	2,541,216
1996	447,640	**2005**	798,000	**2014**	1,551,659	**2023**	2,487,637
1997	539,902	**2006**	932,756	**2015**	1,297,264		
1998	581,328	**2007**	979,740	**2016**	1,149,982		

4.2.7.3. Uncertainties and Time Series Consistency

According to plant data, in-plant measurement uncertainty on weighing scales does not exceed 1%. The emission factor uncertainty for cement is not specified by the 2006 IPCC Guidelines. It was assumed that this factor corresponds to the emission factor for high-calcium and dolomitic lime, i.e., 2%. Full time series for the entire period from 1990 to 2023 were used for the assessment.

4.2.7.4. QA/QC Evaluation

Since no national emission factors have been developed, the default factor was applied in accordance with the 2006 IPCC Guidelines (Vol. 3, Ch. 2, Sec. 2.2.3.1). Activity data were cross-checked against cement producers' reports and the statistical tables of the National Statistical Committee of the Kyrgyz Republic.

At the same time, the inventory team adheres to the confidentiality agreement regarding data provided by individual enterprises.

4.2.7.5. Recalculations by Category

Despite the shift in the current inventory from GWP values of gases under the Second IPCC Assessment Report (SAR) to the Fifth IPCC Assessment Report (AR5), no recalculation was performed, since the GWP of CO_2 remained unchanged at 1.

4.2.7.6. Planned Improvements

In subsequent inventories, it is planned to obtain plant-level data on carbonate content in raw materials in order to refine emission factors.

4.2.8 Category 2.A.2 Lime Production

4.2.8.1. Category Description

Lime production volumes in Kyrgyzstan are minor and, for the period from 2000 to 2022, did not exceed 7–8 thousand tons per year. In 2023, production significantly increased to 26.9 thousand tons. According to the National Statistical Committee, as of 2023 production was located in four regions: Batken, Issyk-Kul, Osh, and Chui. Over the years, lime was also produced in other regions: Jalal-Abad (2009–2016), Naryn and Talas (1997), Bishkek (1990–1997), and Osh (2002–2003).

State statistics of the Kyrgyz Republic report the total volume of lime production in tons, without a breakdown by type. Throughout the inventory period, emissions from this category did not exceed 65.53 kt CO_2 (1990) and averaged 10.14 kt CO_2. The category's share in 2023 amounted to 0.43% of IPPU sector GHG emissions.

The total volume of emissions from the category is presented in Table 4.9 and Figure 4.10.

Table 0.9. Emissions from Lime Production

Year	kt CO_2	Year	kt CO_2	Year	kt CO_2	Year	kt CO_2
1990	65.54	**1999**	5.75	**2008**	6.67	**2017**	5.06
1991	53.04	**2000**	6.29	**2009**	3.60	**2018**	6.52
1992	27.98	**2001**	7.21	**2010**	4.98	**2019**	3.92
1993	10.19	**2002**	7.31	**2011**	1.99	**2020**	4.52
1994	6.75	**2003**	6.76	**2012**	2.07	**2021**	5.20
1995	4.60	**2004**	7.97	**2013**	1.92	**2022**	8.58
1996	3.07	**2005**	6.52	**2014**	2.38	**2023**	20.26
1997	15,71	**2006**	7.59	**2015**	3.83		
1998	6.44	**2007**	9.89	**2016**	4.83		

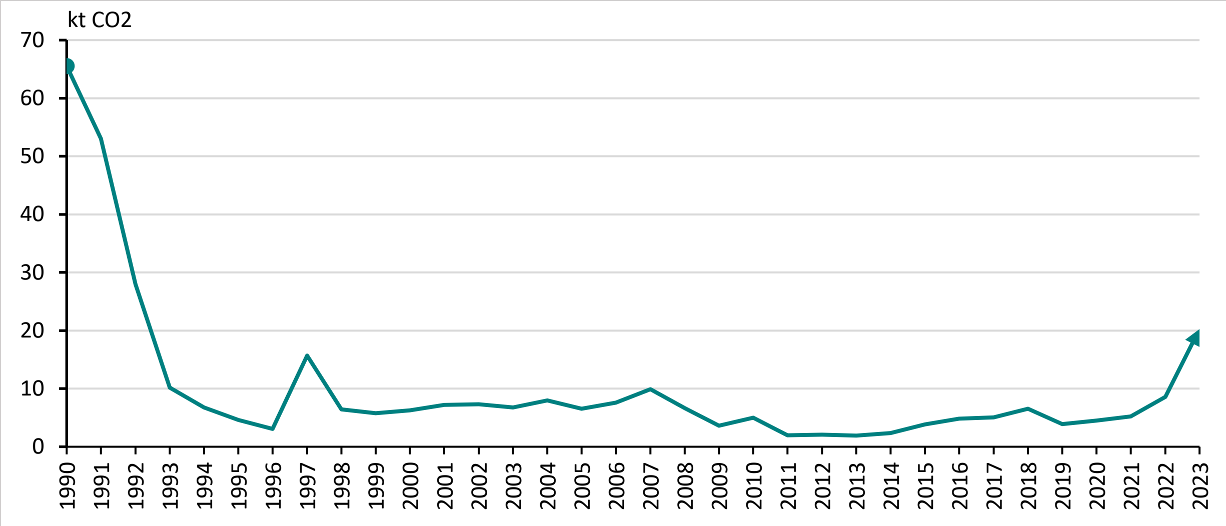


Figure 0.10. GHG Emissions from Lime Production, 1990–2023.

4.2.8.2. Methodology

As noted above, the application of Tier 2 methodology for category 2.A.2 Lime Production is not considered appropriate.

The basis for emission estimates in this category is the 2006 IPCC Guidelines, Volume 3, Chapter 2, Section 2.3. Since Tier 1 is applied for this category, the general equation takes the simplest form:

Emissions = Production Volume × Emission Factor.

For the calculations, the following assumptions recommended by the 2006 IPCC Guidelines (default values) were used:

- In the absence of official national data on the technology applied and the composition of raw materials, production is assumed to consist of 85% high-calcium lime and 15% dolomitic lime.
- To produce 1 ton of CaO, calcination of 1.785 tons of $CaCO_3$ is required, releasing 0.785 tons of CO_2 under complete calcination.
- Emission factors:
  - High-calcium lime: 0.75 t CO_2 / t lime
  - Dolomitic lime: 0.77 t CO_2 / t lime
    (Equation 2.8, IPCC 2006)

Activity data on lime production volumes were provided by the National Statistical Committee of the Kyrgyz Republic (see Table 4.10).

Table 0.10. Lime Production Volumes

Year	Tons	Year	Tons	Year	Tons	Year	Tons
1990	85,500	**1999**	7,500	**2008**	8,700	**2017**	6,600
1991	69,200	**2000**	8,200	**2009**	4,700	**2018**	8,500
1992	36,500	**2001**	9,400	**2010**	6,500	**2019**	5,200
1993	13,300	**2002**	9,542.2	**2011**	2,600	**2020**	5,400
1994	8,800	**2003**	8,814.2	**2012**	2,700	**2021**	6,900
1995	6,000	**2004**	10,400	**2013**	2,500	**2022**	11,400
1996	4,000	**2005**	8,500	**2014**	3,100	**2023**	26,900
1997	20,500	**2006**	9,900	**2015**	5,000		

Year	Tons	Year	Tons	Year	Tons	Year	Tons
1998	8,400	**2007**	12,900	**2016**	6,300		

4.2.8.3. Uncertainties and Consistency of Time Series

The uncertainty of emission factors is assessed by the 2006 IPCC Guidelines as 2% for both high-calcium and dolomitic lime. The uncertainty of activity data is estimated by expert judgment at around 15%, mainly due to uncertainty in the ratio of lime types produced.

The time series consistency can be considered good within the framework of using Tier 1. Data covering the entire period from 1990 to 2023 are homogeneous and reflect the overall trends in the IPPU sector: a sharp decline in production from 1990 to 1996, followed by relatively stable and minor production volumes from 1997 to the present.

4.2.8.4. Quality Assurance and Quality Control

The main supplier of data on lime production is the National Statistical Committee (NSC). Attempts to request data directly from enterprises during the current inventory were unsuccessful. While up-to-date contact information of company management is available in the NSC, it is not accessible due to confidentiality restrictions. Publicly available sources provide either sales department contacts or paid specialized resources requiring subscription. Moreover, sales departments categorically refused to provide management contacts, citing internal directives.

Since national emission factors were not developed, default IPCC emission factors were used. Activity data were provided by the NSC upon request and cross-checked against statistics published on the official NSC website.

4.2.8.5. Recalculations by Category

As with category 2.A.1 Cement Production, no recalculation was performed, since the CO_2 GWP remained unchanged (equal to 1).

4.2.8.6. Planned Improvements

In the next inventory cycle, efforts will be made to obtain data from enterprises in the following breakdown:

- Production volumes by lime type.
- Uncertainty/accuracy of raw material and product measurements applied at the plant.
- Data on the types of raw materials used.

To achieve this, an agreement between the NSC and the Ministry of Natural Resources, Ecology, and Technical Supervision (MNRETS) should be concluded on the provision of confidential data, including up-to-date contact information of production enterprises across industries. Access to such data will maximize enterprise coverage not only in this category but across the entire 2.A Mineral Products subsector.

4.2.9. Category "2.A.3 Glass Production"

4.2.9.1. Category Description

At present, four plants operate in this category in the Kyrgyz Republic, producing glass melt:

- Interglass LLC
- Chui Glass LLC
- Elite Glass LLC
- Mailuu-Suu Lamp Plant JSC

The first three specialize in flat glass and container glass. The last produces glass as an intermediate stage for its main product—electric lamps. The share of Interglass LLC in this category averages 95% or more, both in production volumes and associated CO_2 emissions.

Previously, two other plants existed: Aynek JSC – closed in 1998; after reorganization and reconstruction, re-opened in 2000 as Interglass LLC. Bishkek Glass Plant – liquidated in 1995; specialized in the production of glass containers and tableware. Data on enterprises were obtained from the state archive during the preparation of the FNC 1 / NC 4.

The total volume of emissions from this category in recent years has ranged from 12 to 25 kt CO_2, averaging 18.96 kt CO_2. In 2023, emissions from this category accounted for 1.23% of total emissions in the IPPU sector (see Table 4.11 and Figure 4.11).

Table 0.11. GHG Emissions from Glass Production

Year	kt CO_2	Year	kt CO_2	Year	kt CO_2	Year	kt CO_2
1990	69.28	**1999**	0.43	**2008**	15.15	**2017**	23.25
1991	66.50	**2000**	0.43	**2009**	0.32	**2018**	22.26
1992	74.03	**2001**	0.21	**2010**	0.41	**2019**	23.40
1993	59.60	**2002**	4.99	**2011**	0.44	**2020**	22.47
1994	3.94	**2003**	12.10	**2012**	12.05	**2021**	25.37
1995	5.62	**2004**	16.93	**2013**	20.59	**2022**	24.30
1996	6.46	**2005**	18.89	**2014**	19.60	**2023**	20.12
1997	5.28	**2006**	16.81	**2015**	13.90		
1998	4.70	**2007**	18.77	**2016**	16.07		

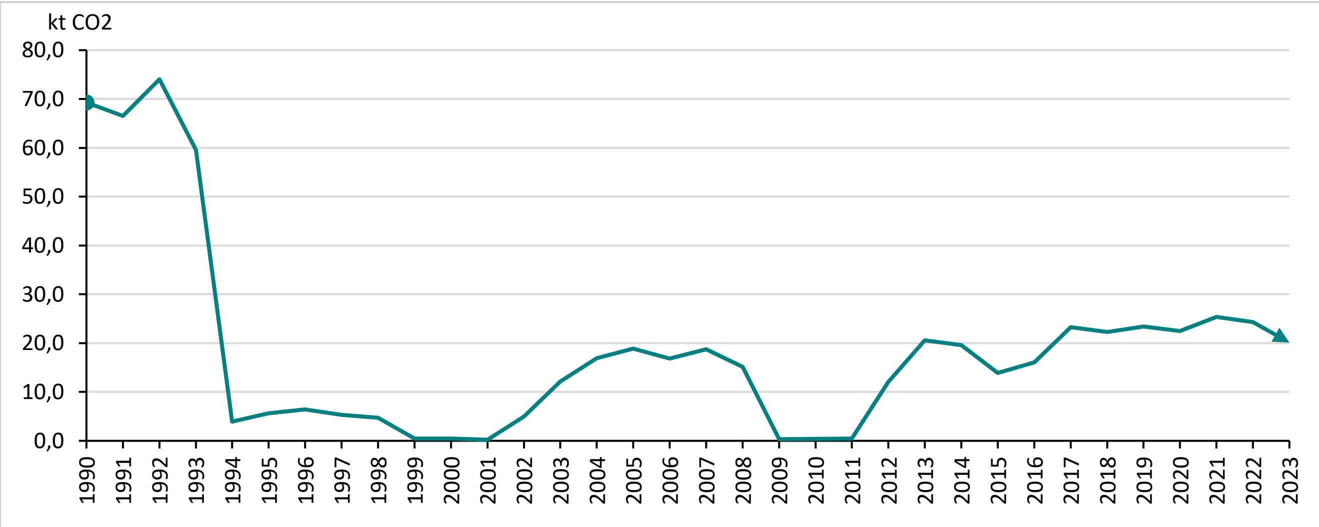


Figure 0.11. GHG Emissions from Glass Production, 1990–2023.

The sharp decline in 1999–2002 and 2009–2022 was due to reorganization and reconstruction (first period) and to the shutdown of Interglass LLC's production for furnace reconstruction (second period).

4.2.9.2. Methodology

The assessment of emissions from the category "2.A.3 Glass Production" is described in the 2006 IPCC Guidelines, Volume 3, Chapter 2, Section 2.4. The choice of methodological tier was based on the following considerations:
National statistics on the industry are practically unsuitable for GHG inventory purposes, since the data are reported as:

- Thousands of square meters – for flat glass, without any breakdown by sheet thickness.
- Thousands of units – for container glass, also without breakdown by size or type (jars, vials, bottles, etc. of different volumes).

Converting such data into tons of product is extremely difficult and yields inaccurate results.

Statistics also do not account for glass produced as an intermediate product for other manufacturing processes, e.g., glass produced by the Mailuu-Suu Lamp Plant for electric lamp production.

As noted earlier, the number of plants in this category is small, and each is a large-scale enterprise with well-established technological processes and direct data collection systems. Therefore, beginning with the BTR 1, a Tier 2 methodology was applied. For inventory purposes, actual data from enterprises on the volume of glass melt produced by type of glass and on the amount of cullet used were utilized.
The basic formula for the category's emission assessment is:

Equation 2.11
Tier 2: Calculation of Emissions Taking into Account Glass Production Technology

$$CO_2\ \text{Emissions} = \sum_i \left[M_{g,i} \cdot EF_i \cdot (1 - CR_i) \right]$$

Where:
CO_2 Emissions = CO_2 emissions from glass production, tons
Mg,i = mass of glass type i produced (e.g., flat, container, fiberglass, etc.), tons
EFi = emission factor for the production of glass type i, tons CO_2 per ton of glass produced
CRi = share of cullet in the production of glass type i, fraction
For flat and container glass mass, the emission factor is taken as 0.21 t CO_2/ton of glass.
For special-purpose glass mass (lamp glass), the emission factor is 0.20 t CO_2/ton of glass (Table 2.6, IPCC 2006).

The aggregated activity data are presented in Table 4.12. Data on individual enterprises are confidential.

Table 0.12. Production Volume of Glass Mass and Use of Cullet

Year	Glass mass, tons	Cullet, tons	Year	Glass mass, tons	Cullet, tons	Year	Glass mass, tons	Cullet, tons
1990	556,293.2	226,539.5	**2002**	55,665.7	23,401.3	**2014**	125,624.6	32,279.3
1991	517,428.0	200,907.8	**2003**	98,650.4	32,335.9	**2015**	92,568.5	26,374.9
1992	618,491.9	265,917.3	**2004**	126,356.1	37,345.0	**2016**	105,577.5	28,992.2
1993	504,131.0	220,361.5	**2005**	130,676.1	34,758.5	**2017**	145,703.2	34,938.1
1994	41,081.0	36,598.7	**2006**	118,339.6	32,368.6	**2018**	141,879.8	35,965.0
1995	57,267.4	30,524.1	**2007**	127,090.0	32,709.8	**2019**	140,667.2	29,277.9
1996	57,145.1	26,375.4	**2008**	105,988.7	28,650.9	**2020**	137,453.6	27,294.8
1997	56,392.9	31,269.8	**2009**	15,124.0	9,364.5	**2021**	152,683.1	30,111.2
1998	77,681.7	49,278.1	**2010**	17,966.3	11,017.5	**2022**	143,226.0	27,705.7
1999	22,048.9	13,613.4	**2011**	18,619.4	11,305.7	**2023**	117,250.0	23,258.8
2000	23,928.4	14,883.3	**2012**	81,147.1	23,750.8			
2001	24,670.2	16,051.0	**2013**	133,753.0	35,772.1			

4.2.9.3. Uncertainties and Time Series Consistency

Information on glass mass production has maximum accuracy and detail. The melting mass is measured with an accuracy of up to hundreds of kilograms, and in some cases for specialty glass – up to tens of kilograms. The use of cullet is recorded with an accuracy of one ton. Therefore, the uncertainty of activity data is assumed to be 0.5%.

Since the inventory used emission factors recommended by the 2006 IPCC Guidelines, the corresponding uncertainty was also taken from the Guidelines (Section 2.4.2.1) and equals 10%.

4.2.9.4. Quality Assurance and Quality Control

As part of the current inventory, activity data were obtained from two of the four listed plants: Interglass LLC and Mailuu-Suu Lamp Plant JSC. According to the previous inventory for 2020, this covered about 98% of the entire category.

Activity data from enterprises were received in the requested format and did not require transformation. Calculations were performed using the IPCC Inventory Software (latest version). Retrospective data from 1990 to 2020 were transferred from the database of earlier software versions.

In the absence of national emission factors, default emission factors were applied.

4.2.9.5. Recalculations by Category

As with category 2.A.1 Cement Production, no recalculation was performed.

4.2.9.6. Planned Improvements

In future inventories, it is planned to clarify the missing data from the remaining plants.

It is also proposed, within the framework of developing an updated National System of Environmental Reporting (NSER), to include statistical reporting on glass mass production by type of glass. This would formalize and improve the quality of activity data in subsequent inventories.

4.2.10 Category "2.A.4.a Ceramic Production"

4.2.10.1. Category Description

According to NSC data, the following types of activities are included in this category:

- Ceramic electrical insulators
- Hollow ceramic and silicate bricks and stones (1990–1991)
- Construction bricks (1990–2002)
- Non-refractory ceramic bricks (from 2003 to the present)
- Ceramic roofing tiles

Changes in statistical indicators in different years reflect the reform of statistical accounting classifiers throughout the period.

The statistical indicator "Ceramic sanitary ware" was excluded from the assessment, as according to information from the manufacturer provided during the previous inventory, this production does not involve kiln firing of products but represents casting of mineral mixtures. The situation has not changed since then.

The overall decline in the production of ceramic products and, consequently, CO_2 emissions from 1990 ended by 1994 (Table 4.13). Since then, the situation has remained largely unchanged (Figure 4.12).

Table 0.13. GHG Emissions from Ceramic Production

Year	kt CO_2	Year	kt CO_2	Year	kt CO_2	Year	kt CO_2
1990	144.71	**1999**	11.91	**2008**	14.74	**2017**	14.17
1991	146.49	**2000**	9.78	**2009**	9.74	**2018**	12.93
1992	58.68	**2001**	8.94	**2010**	9.31	**2019**	20.49
1993	25.86	**2002**	8.55	**2011**	12.85	**2020**	11.73
1994	12.63	**2003**	12.79	**2012**	12.88	**2021**	19.62
1995	12.51	**2004**	16.31	**2013**	15.81	**2022**	23.66
1996	13.41	**2005**	20.74	**2014**	15.37	**2023**	29.49
1997	13.55	**2006**	19.66	**2015**	12.92		
1998	15.02	**2007**	22.16	**2016**	12.63		

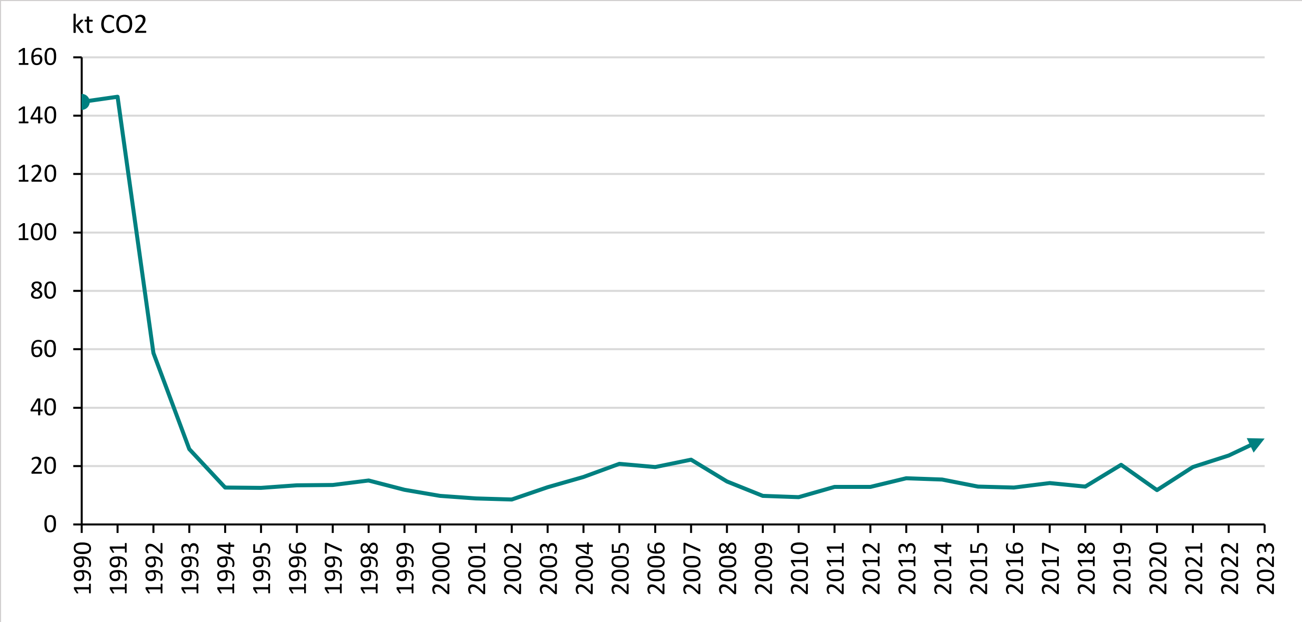


Figure 0.12. GHG Emissions from Ceramic Production during 1990–2023.

4.2.10.2. Methodology

For the category assessment, the Tier 1 method was applied. The choice of this method was based on the following assumptions:

- The industry involves a large number of enterprises of various scales, from large factories to small workshops, which does not allow for full coverage of the sector through direct enterprise surveys.
- Lack of access to up-to-date contacts (see Section 4.3.4 for details).
- Statistical accounting is maintained in the following units:
  - Thousands of pieces – “non-refractory ceramic bricks”
  - Thousands of standard bricks – “construction bricks”, “hollow ceramic and silicate bricks and stones”
  - Kilograms – “ceramic electrical insulators”
  - Tons – “ceramic roofing tiles”

For this category, the Tier 1 method is based on the following equation:

Equation 2.14

Tier 1: Calculation of emissions based on the mass of consumed carbonates

$$CO_2\ \text{Emissions} = M_c \cdot (0.85\, EF_{ls} + 0.15\, EF_d)$$

Where,

CO_2 emissions = CO_2 emissions from other processes using carbonates, tons
Mc = mass of consumed carbonates, tons
EFls or EFd= emission factor from calcination of limestone or dolomite, tons CO_2/ton of carbonate (see Table 2.1, IPCC 2006)

The unit of measurement "conventional brick" is not standardized in terms of dimensions and mass for possible conversion into tons of product. To resolve this issue, an external source was used. Since this unit of measurement has been applied since the Soviet period, and taking into account the general standardization of SNIP within the framework of the Eurasian Economic Union, the definition from the Resolution of the Ministry of Construction and Architecture of the Russian Federation No. 1 of January 4, 2013 was adopted as a reference. According to this document, a conventional brick has the following parameters: dimensions 250 × 120 × 65 cm, volume 1950 cm^3, and an average weight of 2.7695 kg.

According to the Belovodsky Brick Plant, the standard average weight of a solid ceramic brick is 3.7–3.8 kg. For calculations, an average value of 3.75 kg was adopted.

For calculations, the following parameters recommended by the 2006 IPCC Guidelines were used:

- Default carbonate content in clay = 0.1
- Proportion of calcite and dolomite = 85% and 15%, respectively
- CO_2 emission factors = 0.43971 for calcite and 0.47732 for dolomite

Activity data for 2021–2023 (Table 4.14) were provided by the National Statistical Committee upon request. For the period 1990–2020, statistical data obtained during the previous inventory were used.

Table 0.14. Volume of Ceramic Production in the Period 1990–2023.

	1990	1991	1992	1993	1994	1995	1996	199
Sanitary ceramic products, thousand pcs.	0	0	50.1	145.7	25.6	0	0	
Ceramic insulators, kg	0	0	0	0	0	0	0	
Hollow ceramic and silicate brick and stone, thousand conventional bricks	417,600	380,800	0	0	0	0	0	
Construction brick, thousand conventional bricks (1990–2002)	649,000	698,900	432,500	190,600	93,100	92,200	98,800	99
Non-refractory ceramic brick, thousand pcs. (from 2003 to present)								
Ceramic roofing tiles, tons	0	0	0	0	0	0	0	

	2002	2003	2004	2005	2006	2007	2008	
Sanitary ceramic products, thousand pcs.	1.1	0	0	2.3	1.9	0	0	
Ceramic insulators, kg	49,363	70,195	24,115	23,456	44,358.3	57,295	60,367	5,9
Hollow ceramic and silicate brick and stone, thousand conventional bricks	0	0	0	0	0	0	0	
Construction brick, thousand conventional bricks (1990–2002)	63,000							
Non-refractory ceramic brick, thousand pcs. (from 2003 to present)		69,600	88,800	112,900	107,000	120,609.1	80,017.9	52,8
Ceramic roofing tiles, tons	0	0	0	0	0	16.1	821.6	

	2014	2015	2016	2017	2018	2019	2020	
Sanitary ceramic products, thousand pcs.	17	11	7	3	5	0	0	
Ceramic insulators, kg	11,751.1	8,320.6	0	0	0	0	0	
Hollow ceramic and silicate brick and stone, thousand conventional bricks	0	0	0	0	0	0	0	
Construction brick, thousand conventional bricks (1990–2002)								
Non-refractory ceramic brick, thousand pcs. (from 2003 to present)	83,640	70,332.6	68,760.7	77,140.3	82,257.5	111,503.5	63,831.7	106,8
Ceramic roofing tiles, tons	0	0	0	52.9	160.6	17.8	30.2	

4.2.10.3. Uncertainties and Time Series Consistency

As noted above, the uncertainty of activity data is assessed as relatively high and equals 15%.

According to Section 2.5.2.1 of the 2006 IPCC Guidelines, the uncertainty of emission factors strongly depends on the uncertainty of activity data. Therefore, this uncertainty is also assessed as relatively high — 20%.

To harmonize the data series, all values were converted into uniform weight-based measurement units using the conversion coefficients mentioned in the previous section. Data completeness throughout the entire 1990–2023 period is considered good. Despite the fact that some statistical indicators cover different time intervals, the resulting series has no gaps requiring interpolation.

Due to the absence of national emission factors, default values were applied.

4.2.10.4. Quality Assurance and Quality Control

As described in Section 4.2.10.2, primary activity data were presented as time series expressed in different measurement units. A harmonization process was carried out to obtain a uniform dataset for further processing. All stages of data processing were checked in accordance with the 2006 IPCC Guidelines.

4.2.10.5 Recalculation by Category

As with category 2.A.1 Cement Production, retrospective recalculations for 1990–2020 were not performed.

4.2.10.6. Planned Improvements

Similar to Section 4.2.10.4.

4.2.11 Category "2.C. Metallurgical Industry"

4.2.11.1. Category Description

In Kyrgyzstan, metallurgical production includes gold, antimony, mercury, partial enrichment of zinc ore, and secondary smelting/casting of pig iron and steel. Over the past 10 years, the total emissions of the industry did not exceed 1.4 kt CO_2. As of 2023, the category contributes less than 0.01% to the country's total GHG emissions. In addition to CO_2, there are also emissions of precursor gases (excluding NMVOC), but their volumes are very small.

The smelting and casting of ferrous metals is carried out by a large number of enterprises. For some, it is the main type of activity, while for others — only part of the technological cycle, i.e., an intermediate stage of the main production process.

Zinc ore enrichment is performed at the Kyrgyz Chemical and Metallurgical Plant (OAO KHMZ) using a method not associated with thermal processing. The resulting concentrate is sent for further processing to Kazakhstan[66]. For this reason, emissions from zinc production were not assessed.

[66] Data from KHMC were requested for the previous inventory. In the current inventory cycle, it was not possible to obtain a response from the enterprise.

Gold is produced by Kumtor Gold Company CJSC, mercury — by the Khaidarkan Mercury Joint-Stock Company, and antimony — by Surmatash LLC. These enterprises are natural monopolies. Therefore, statistical data on the production of these metals are restricted, since the law on statistics prohibits the disclosure of information about a single enterprise. International data on sales/turnover of these metals by country (including Kyrgyzstan) are available online (both free and paid), but they are considered unreliable.

Total emissions from metal production are presented in Figure 4.13. The largest contribution comes from mercury production. Accordingly, due to the gradual reduction in mercury production, overall emissions have been declining since 2000.

Figure 0.13. GHG Emissions from the Metallurgical Industry for the Period 1990–2023.

The contribution from the production of other metals is negligible.

4.2.11.2. Methodology

For the assessment of emissions in this category, Methodological Level 1 was applied. The basic equation is the most general and simple:

Emissions=Production Volume*Emission Factor.

Below are the specific considerations for the assessment of different metals.

Secondary smelting and casting of pig iron and steel

Since the First National Communication, secondary production of pig iron and steel was previously attributed to category 2.C.1 Iron and Steel Production. However, the 2006 IPCC Guidelines classify this category only for primary production from ore and enriched concentrates, as well as open-hearth and converter steel production. Secondary processing of metal scrap by other methods, such as casting of ferrous metals at industrial facilities using electric induction furnaces, is not reflected in the IPCC methodology. The recommended EMEP/EEA Guide also does not contain standard emission factors for induction furnaces for pig iron/steel smelting.

Early CO_2 and precursor emission estimates were based on data from environmental passports of enterprises, which contained information on specific emissions per unit of production.

It was therefore decided to transfer the data on pig iron and steel casting into category 2.C.8 Other, along with emission estimates for mercury and antimony production.

Activity data were provided by the National Statistical Committee (see Table 4.15).

Table 0.15. Production (casting) of steel and pig iron, tons

Year	Casting of pig iron	Casting of steel	Year	Casting of pig iron	Casting of steel	Year	Casting of pig iron	Casting of steel
1990	40,691	989	**2002**	806.9	1,063.8	**2014**	1,919	485.2
1991	40,025	1,601	**2003**	753.8	1,069.6	**2015**	110	482.4
1992	22,851	1,339	**2004**	695.8	1,683.4	**2016**	150.6	906.2
1993	10,497	828	**2005**	799.3	1,682.9	**2017**	214.2	2,217.1
1994	2,257.1	691.7	**2006**	822.7	1,672.1	**2018**	282.1	3,170.2
1995	1,163.3	992.1	**2007**	640.9	3,198.1	**2019**	390.4	2,207.9
1996	1,307.2	1,188.7	**2008**	612.9	1,518.1	**2020**	371.9	1,297.5
1997	1,591.2	1,215.3	**2009**	5,753.8	973.3	**2021**	434.7	1,161.3
1998	627.7	621.2	**2010**	3,725.2	3,583.6	**2022**	423.8	698.0
1999	882.4	504.3	**2011**	145.2	3,436.2	**2023**	1,239.3	752.5
2000	789.9	422.9	**2012**	148.3	2,702.5			
2001	1,333.9	1,011.1	**2013**	1,822.1	635.2			

In the absence of national emission factors, for the processes of secondary smelting/casting of pig iron and steel, the data from the environmental passports of enterprises used in the NC 2, BUR 1, and NC 4 were adopted: carbon dioxide (CO_2) – 14.3 kg/ton, nitrogen dioxide (NO_2) – 1.8 kg/ton, carbon monoxide (CO) – 9.1 kg/ton.

Mercury and Antimony Production

The State Enterprise Khaidarkan Mercury Joint Stock Company provided data on mercury production volumes for the period from 2000 to 2023. Earlier data were taken from: 1992 – the annual publication of the U.S. Geological Survey on global raw materials market analysis[67;] 1993–1999 – data from the Third National Communication of the Kyrgyz Republic[68.]

Since the IPCC does not provide emission factors for mercury production, the calculated emission factors from BUR1 and NC4 were used for the assessment. These factors were developed during the preparation of the Third National Communication, based on the environmental passport of the enterprise.

Data on antimony production from Surmatash LLC could not be obtained. Third-party data from open sources were also extremely inaccurate and did not allow deriving any reliable trend for interpolating data for the period 2021–2023. Therefore, antimony production was excluded from the assessment.

Other Metals

In gold enrichment, hydrometallurgical processes are used, and smelting is carried out in closed-type induction furnaces; therefore, GHG emissions are extremely negligible or absent.

In zinc concentrate production, smelting is not used, and the concentrate, after enrichment, is sent for further processing to Kazakhstan. For this reason, emissions from zinc production were also not included.

[67] https://www.usgs.gov/centers/national-minerals-information-center/mercury-statistics-and-information

[68] Due to confidentiality, the activity data table and emission factors for mercury production are not provided.

4.2.11.3. Uncertainties and Time Series Consistency

The IPCC 2006 Guidelines do not provide standard levels of uncertainty for the processes considered in this category. Expert assessment estimates the uncertainty of activity data at up to 10%, and emission factors at up to 25%.

Data on pig iron and steel casting are consistent and continuous over the entire period.

4.2.11.4. Quality Assessment and Quality Control

For the harmonization of mercury data, information from various sources was analyzed and checked for mutual consistency and coherence.

In the absence of IPCC 2006 default factors, the emission factors from previous National Communications were used.

4.2.11.5. Recalculations by Category

Previously, in earlier inventories, due to the unavailability of mercury production data, U.S. Geological Survey data were used for the period 2003–2016. Once enterprise data were obtained, a recalculation was carried out based on actual values.

4.2.11.6. Planned Improvements

It is planned to refine data on antimony production.

4.2.12 “2.D.1 – Lubricant Use” and “2.D.2. Paraffin Wax Use”

4.2.12.1. Category Description

Since the categories “2.D.1. Lubricant Use” and “2.D.2. Paraffin and Wax Use” follow the same approach, both categories are considered together. All substances covered by this category are not produced in the Kyrgyz Republic and are fully imported.

According to the National Statistical Committee, regular import accounting for these product categories was established starting in 2006, with the launch of the database for import-export accounting of goods movement. Earlier information exists only in paper form and requires extremely labor-intensive processing.

In 2020, emissions amounted to 11.43 kt CO_2. By 2023, emissions reached 15.69 kt CO_2, or 1.38% of the total emissions of the IPPU sector (see Fig. 4.14).

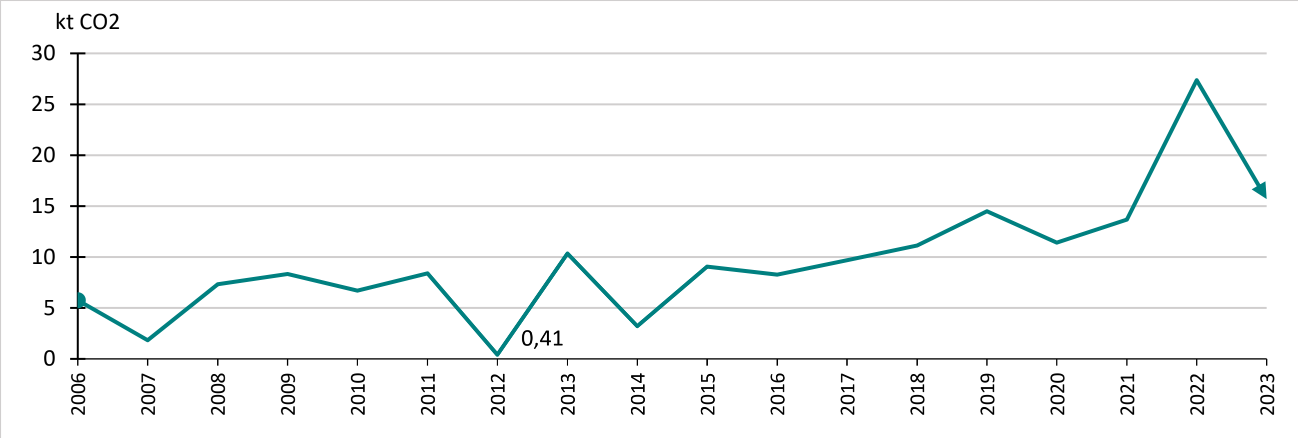


Figure 0.14. GHG Emissions from the Use of Lubricants, Paraffins, and Waxes (1990–2023)[69]

4.2.12.2. Methodology

The assessment of emissions for the categories under consideration is based on the IPCC 2006 Guidelines, Volume 3, Chapter 5, Sections 5.2–5.3. Methodological Tier 1 was applied.

CO_2 emissions are calculated according to Equations 5.2 and 5.4 of the IPCC 2006 Guidelines, using grouped default data for a limited number of known parameters and emission factors, based on the default ratio of oils and greases (in TJ). Since the calculation method for both categories is completely identical, the example below is presented only for one category:

Equation 5.2

Lubricants – Tier 1 Method

$$Emissions_{CO_2} = LC \cdot CC_{Lub} \cdot OXID_{Lub} \cdot \frac{44}{12}$$

Where:

CO_2 emissions = CO_2 emissions from lubricants, tones CO_2

LC = total lubricant consumption, TJ

$CC_{1u\beta}$ = carbon content of lubricants (default), tones C/TJ (= kg C/GJ)

$OXID_{1u\beta}$ = oxidation factor (based on the default ratio of oils and greases), fraction

44/12 = ratio of the molecular weight of CO_2 to C

Conversion from mass units to energy units was carried out using the default IPCC 2006 conversion factors (see the specific guidance in Section 1.4.1.2, Chapter 1, Volume 2 Energy, Table 1.3).

The default oxidation factor for both categories is 0.2 kg/GJ (IPCC 2006, Volume 3, Chapter 5, Table 5.2 and Section 5.3.2.2).

The activity data are presented in Table 4.15.

[69] As already mentioned, import data have been available since 2006. For 2012, a label was added to indicate a non-zero value.

4.2.12.3. Uncertainties and Time Series Consistency

The emission factor uncertainty for lubricants was taken by default at 50% (IPCC 2006, Volume 3, Section 5.2.3.1). For paraffins/waxes, the uncertainty is 100% (IPCC 2006, Volume 3, Section 5.3.3.1).

The activity data uncertainties were also evaluated by default: for countries with non-detailed statistics, 10–20% for both categories. The upper value of 20% was applied (IPCC 2006, Volume 3, Sections 5.2.3.2 and 5.3.3.2).

To ensure consistency across the entire time series, the calculation of emissions from lubricants was carried out using the same method with default emission factors.

4.2.12.4. Quality Assurance and Quality Control

Since there are no national statistics on consumption for this category, time series are based on import data.

4.2.12.5. Recalculations by Category

No retrospective recalculation was performed.

4.2.12.6. Planned Improvements

The National Statistical Committee refused to provide 2021–2023 data on imports/exports with a detailed breakdown to the 10-digit HS code, arguing that such data are classified as "for official use only". Data were provided only in aggregated form up to the 6-digit level. However, earlier in the inventories for BUR1 and NC4, the corresponding data were provided in full detail (10-digit HS code). Also, on the official website of the National Statistical Committee, import/export data were publicly available with a 10-digit HS breakdown up to 2021 inclusive.[70]. It is expected that this inconsistency will be resolved in favor of improving data quality.

[70] May-June 2025.

Table 0.16. Table: Imports of lubricants, paraffins, and waxes for 2006–2023 (tons)[71]

Import category, including HS code	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	201
Lubricants												
2710198200: For other purposes, motor oils, compressor lubricating oil, turbine lubricating oil	9,236.8	0	7,607	9,654.4	7,471	9,315.6	0	11,683.6	0	10,136.6	9,126	9,6
2710199800: Other lubricating oils and other oils	0	1,051.9	1,062.2	1,585.3	1,200	1,049.5	0	1,031.4	852.9	1,116.3	1,356.1	3,31
2710198800: Gear oil and reducer oil	0	819.8	998	1,903.5	1,979.9	2,606.9	0	2,765	2,646.9	2,265.3	2,420.7	2,63
2710198400: Hydraulic fluids	0	0	1192.9	174.1	217.3	373.5	0	714.5	979.7	993	526.6	404
2710197100: Lubricating oils; other oils, for specific processing operations	0	0	229.3	251.9	65.3	92	0	60.1	136.6	260.7	116.7	45
2712109000: Other petroleum jelly	0	23.3	22	25.5	36.2	24.4	235.1	289.6	279.5	75.3	62.3	125
2710199400: Electrical insulating oils	0	511.8	422	203.6	178.7	238.6	0	333.9	213.4	306.8	139.5	101
2710199200: Metalworking compounds, mold release oils, anticorrosion oils	0	0	169.5	162	45.6	40.1	0	30.3	45.7	5.2	55.7	0.
2710198600: Light oils, Vaseline oil	0	20.5	29.7	40.1	29.4	0.5	0	137.9	102.4	133.5	152.7	24
2712909900: Other petroleum jelly	0	619.5	671.5	84.7	119.1	441.1	444.3	375.5	142.5	4	0.1	23
2712101000: Crude petroleum jelly	0	0	0	0	0	0	0	28.6	6.6	0	9.2	7.
2710197500: Lubricating oils; other oils, for chemical transformations in processes other than those specified in the subheading	0	0	0	0	0	71.1	0	4.6	0	0	6.3	0
2712100000: Petroleum jelly	28.4	0	0	0	0	0	0	0	0	0	0	0
Paraffins/Waxes												
2712209000: Other paraffin with oil content less than 0.75 wt.%	0	36.4	1.5	47.2	0.2	1.9	2.1	19.7	7.6	2.5	18.2	58
2712903900: Other crude mineral waxes and similar products obtained by synthesis or other processes, colored or uncolored	0	0.1	0.9	0	0.3	0	0	29.6	23	18	0	26
3404900001: Prepared waxes, including sealing wax	0	0	3.2	0	0	3.3	3	11.8	5.9	2.9	6.9	0.
3404200000: Artificial waxes and prepared waxes of polyoxyethylene (polyethylene glycol)	0.1	0.1	0.2	0	0	0	0	0	0.7	0	0.9	0
2712200000: Paraffin with oil content less than 0.75 wt.%	5.6	0	0	0	0	0	0	0	0	0	0	0
2712201000: Synthetic paraffin with oil content less than 0.75 wt.%, with a molecular weight of 460 or more, but not more than 1559	0	0	0	0	0	0	0	0.8	0	22.3	16.9	0
2712900000: Other mineral waxes and similar products	478.5	0	0	0	0	0	0	0	0	0	0	0
2712901100: Ozokerite, lignite wax, or peat wax (natural products), crude	0	0	0	0	0	0	0	0	0	0	0	0
3404900002: Artificial and prepared waxes for aircraft engine production	0	0	0	0	0	0	0	0	0	0	0	0
3404900009: Artificial and prepared waxes: other	0	26.9	0	0	0	7.9	6.5	13	6.6	16.4	11.6	13

[71] The data for 2022–2023 reflect the fact stated in Section 4.6.7.

4.2.13 Category “2.D.3. Solvent Use”

4.2.13.1. Category Description

As with the previous two categories, there is no primary production of solvents in Kyrgyzstan. Existing paint and varnish manufacturing facilities either use ready-made imported solvents or are engaged in packaging imported paint and varnish products.

According to data from the National Statistical Committee, this category includes the following statistical positions:

- Production of paints and varnishes based on polymers
- Production of paints, varnishes, and prepared driers
- Production of paints, varnishes, and coatings

There are no greenhouse gas (GHG) emissions under this category. However, precursor gases are observed, specifically NMVOCs.

The volume of NMVOC emissions is presented in Table 4.17 and in Figure 4.15.

Table 0.17. NMVOC emissions from solvent use

Year	NMVOC, kt	Year	NMVOC, kt	Year	NMVOC, kt	Year	NMVOC, kt
1990	2.04	**1999**	0.01	**2008**	1.23	**2017**	0.48
1991	1,55	**2000**	0.003	**2009**	0.98	**2018**	0.71
1992	0.51	**2001**		**2010**	1.29	**2019**	0.68
1993	0.20	**2002**	0.71	**2011**	1.46	**2020**	0.85
1994	0.07	**2003**	0.82	**2012**	1.63	**2021**	0.31
1995	0.04	**2004**	0.99	**2013**	3.22	**2022**	0.58
1996	0.07	**2005**	1.10	**2014**	2.21	**2023**	1.25
1997	0.03	**2006**	1.17	**2015**	1.49		
1998	0.01	**2007**	1.37	**2016**	1.85		

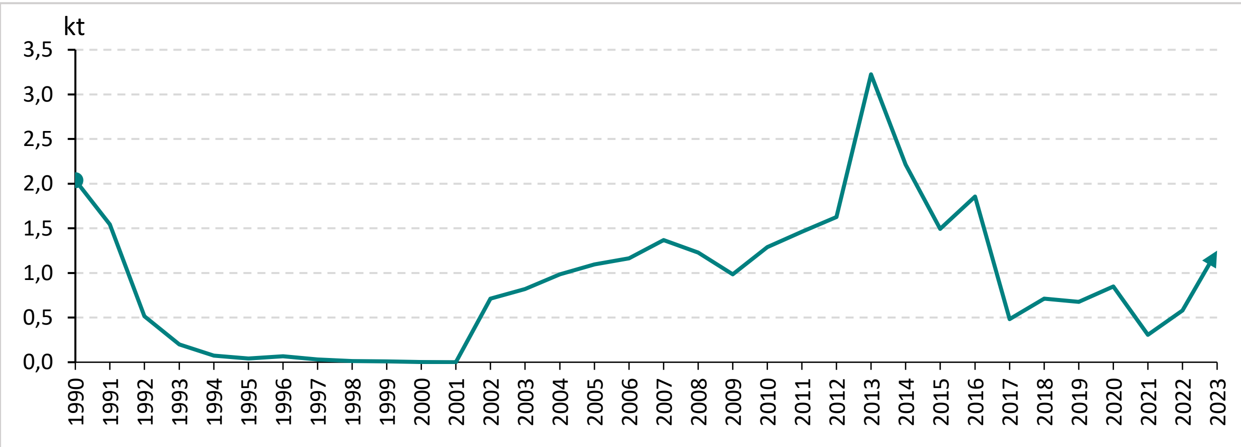


Figure 0.15. NMVOC Emissions from Solvent Use, 1990–2023.

4.2.13.2. Methodology

The 2006 IPCC Guidelines do not address emissions from solvent use, instead referring to the EMEP/EEA Air Pollutant Emission Inventory Guidebook of the European Environment Agency.

Since separate statistics on solvent use are not maintained in the Kyrgyz Republic, the assessment focused on the use of paint and varnish products produced domestically.

The EMEP/EEA Guidebook outlines the methodology for estimating NMVOC emissions from the use of paint and varnish products in industrial and domestic sectors under section 2.D.3.d Coating Application. For estimating NMVOC emissions, Tier 1 methodology of the EMEP/EEA Guidebook was applied.

The default Tier 1 approach consists of multiplying paint consumption by the corresponding emission factor. The general equation is:

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

Where,
$E_{pollutant}$ = emissions of the specified pollutant,
$AR_{production}$ = coating application rate (paint consumption),
$EF_{pollutant}$ = emission factor for the specified pollutant.

The EMEP/EEA Guideline recommends the following default NMVOC emission factors[72]:

- Decorative coating application – 150 g/kg or 0.15 t/t
- Industrial coating application – 400 g/kg or 0.40 t/t
- Other coating application – 200 g/kg or 0.20 t/t

Since no data are available in the Kyrgyz Republic on the proportion of the above applications, the average value of 0.25 t/t was adopted for the assessment.

Activity data were provided by the National Statistical Committee of the Kyrgyz Republic based on the above-mentioned statistical positions (Table 4.18).

Table 0.18. Production volume of paints and varnishes, tons

Year	Paints and varnishes production based on polymers	Production of paints, varnishes, and prepared driers	Production of paints, varnishes, and coatings	Total	Year	Paints and varnishes production based on polymers	Production of paints, varnishes, and prepared driers	Production of paints, varnishes, and coatings	Total
1990	8,154	0.0	0.0	8,154	**2007**	5,060.1	418.5	0.0	5,478.6
1991	6,182	0.0	0.0	6,182	**2008**	4,080.5	828.1	0.0	4,908.6
1992	2,056	0.0	0.0	2,056	**2009**	2,224.8	1,708.9	0.0	3,933.7
1993	802	0.0	0.0	802	**2010**	4,660.2	493.0	0.0	5,153.2
1994	292	0.0	0.0	292	**2011**	5,032.2	651.9	160.3	5,844.4
1995	171	0.0	0.0	171	**2012**	5,875.1	629.1	0.0	6,504.2
1996	260.1	0.0	0.0	260.1	**2013**	5,886.3	470.9	6542	12,899.2
1997	129.5	0.0	0.0	129.5	**2014**	4,332.8	0.0	4,517.3	8,850.1
1998	56.4	0.0	0.0	56.4	**2015**	2,877	0.0	3,093.8	5,970.8
1999	0.0	0.0	32.2	32.2	**2016**	3,605.5	0.0	3,813.2	7,418.7

[72] Руководство ЕМЕР/ЕЕА. 2019. стр.17.

Year	Paints and varnishes production based on polymers	Production of paints, varnishes, and prepared driers	Production of paints, varnishes, and coatings	Total	Year	Paints and varnishes production based on polymers	Production of paints, varnishes, and prepared driers	Production of paints, varnishes, and coatings	Total
2000	0.0	0.0	12.2	12.2	**2017**	1,930.4	0.0	0.0	1,930.4
2001	0.0	0.0	0.0	0	**2018**	2,846.4	0.0	0.0	2,846.4
2002	2,162.6	688.0	0.0	2,850.6	**2019**	2,701.3	0.0	0.0	2,701.3
2003	2,695.7	586.0	0.0	3,281.7	**2020**	3,388.2	0.0	0.0	3,388.2
2004	3,665.5	277.3	0.0	3,942.8	**2021**	1,042.3	183.7	0.0	1,226
2005	3,119.6	1,266.4	0.0	4,386	**2022**	1,325.3	995.2	0.0	2,320.5
2006	4,088.9	571.4	0.0	4,660.3	**2023**	1,211.2	3,790.7	0.0	5,001.9

4.2.13.3. Uncertainties and Time Series Consistency

The EMEP/EEA Guide does not provide any benchmark values for uncertainties in either emission factors or activity data, only noting that such uncertainties are generally very high. For the assessment, an expert judgment of 50% was applied for activity data and 10% for emission factors.

The consistency of time series was verified using statistical data.

4.2.13.4. Quality Assurance and Quality Control

The assessment was carried out using Tier 1 of the EMEP/EEA Guide, 2016 version.

4.2.13.5. Recalculations by Category

No recalculation of retrospective data was performed.

4.2.13.6. Planned Improvements

It is planned to take into account import/export volumes in the next inventory. To achieve this, the data provision issue outlined in Section 4.7.6 needs to be resolved.

4.2.14. Category “2.D.4 – Other: Asphalt Production”

4.2.14.1. Category Description

This category includes the following activities: production of asphalt-concrete mixtures for road paving and production of roofing materials based on bitumen. In Kyrgyzstan, relatively complete statistics are available only for the first activity mentioned. Therefore, in the current assessment, roofing materials based on bitumen are not considered.

The National Statistical Committee provided data on the production of “bituminous mixtures based on asphalt or bitumen” starting from 2002. In addition, data for 2000–2001 were reconstructed from various statistical compendiums of past years. The resulting data on asphalt concrete production volumes are presented in Figure 4.16.

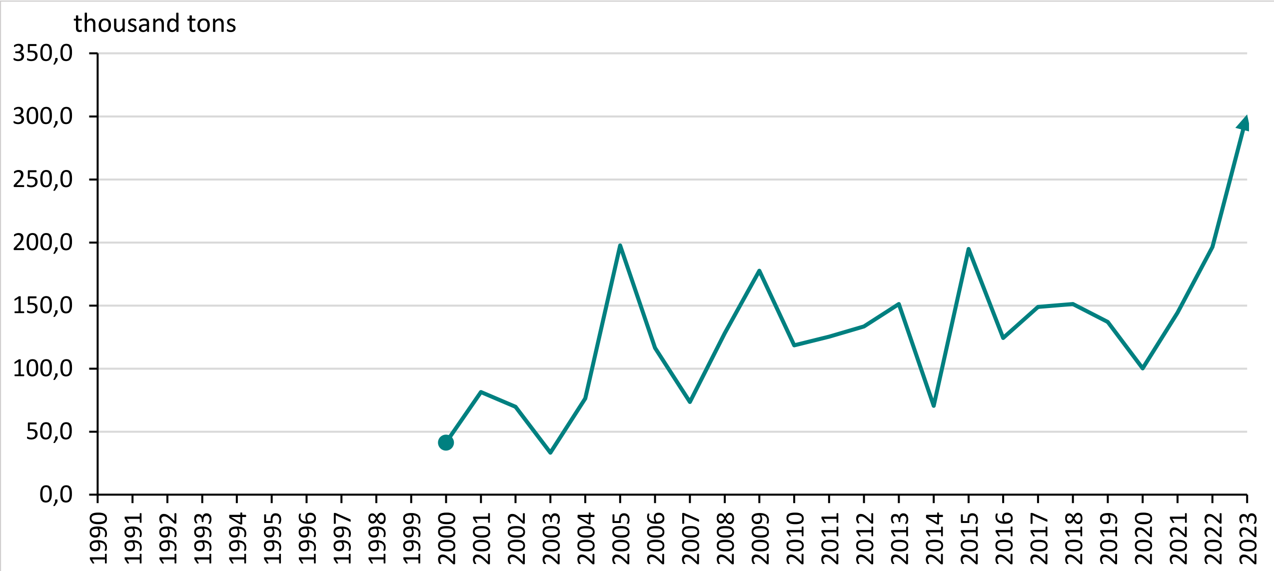


Figure 0.16. Volumes of asphalt concrete mixture production

Sharp fluctuations in production are explained by the uneven implementation of road construction and repair works. Since 2000, a steady increase has been observed, associated with large-scale government projects for the repair and development of the country's road infrastructure.

The main emissions in this category are NMVOC emissions. The total volume of NMVOC emissions from the industry is extremely small (Table 4.19) and does not exceed 0.005 kt NMVOC in 2023. This is due to the very low emission factor (see Section 4.2.14.2 for details).

Table 0.19. NMVOC emissions from asphalt concrete mixtures for the period 1990–2023

Year	Tons	Year	Tons	Year	Tons	Year	Tons
1990	NE	**1999**	NE	**2008**	0,00205	**2017**	0,00238
1991	NE	**2000**	0,00066	**2009**	0,00284	**2018**	0,00242
1992	NE	**2001**	0,00130	**2010**	0,00189	**2019**	0,00219
1993	NE	**2002**	0,00111	**2011**	0,00200	**2020**	0,00160
1994	NE	**2003**	0,00053	**2012**	0,00213	**2021**	0,00231
1995	NE	**2004**	0,00122	**2013**	0,00242	**2022**	0,00314
1996	NE	**2005**	0,00316	**2014**	0,00113	**2023**	0,00482
1997	NE	**2006**	0,00186	**2015**	0,00312		
1998	NE	**2007**	0,00118	**2016**	0,00199		

NE – not estimated, as the primary activity data were not provided.

4.2.14.2. Methodology

The methodology for estimating emissions and default emission factors for VOC and CO are presented in the sections "Roofing Materials" (SNAP[73] code 040610), "Road Materials" (SNAP code 040611), and "Asphalt Blowing" (SNAP code 060310) of the EMEP/EEA Guidebook. In this assessment, only the section "Road Materials" (SNAP code 040611) was used. The other two sections are related to the production of bitumen-containing roofing materials.

[73] Selected Nomenclature for reporting Air Pollution - SNAP

According to the EMEP/EEA Guidebook, the main NMVOC emissions occur not at the stage of preparing asphalt concrete mixtures (which takes place in a relatively sealed container), but during the process of laying the mixture in road construction and repair.

The Tier 1 approach to emissions during road paving uses the general equation:

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

Where,
$E_{pollutant}$ = emissions of the specified pollutant,
$AR_{production}$ = volume of asphalt concrete mixture laid for road surfacing,
$EF_{pollutant}$ = emission factor for the specified pollutant.

The emission factor for NMVOC is 16 grams per ton of asphalt mixture (EMEP/EEA 2016, Section 2D3b, Table 3.1).

Activity data, according to the National Statistical Committee, are presented in Table 4.20.

Table 0.20. Volumes of asphalt concrete mixture production for the period 1990–2023.

Year	Tons	Year	Tons	Year	Tons	Year	Tons
1990	NE	**1999**	NE	**2008**	128,031.1	**2017**	148,800.3
1991	NE	**2000**	41,200	**2009**	177,502.2	**2018**	151,266.7
1992	NE	**2001**	81,300	**2010**	118,322	**2019**	136,900
1993	NE	**2002**	69,623.2	**2011**	125,214.6	**2020**	100,100
1994	NE	**2003**	33,292	**2012**	133,353.6	**2021**	144,367.7
1995	NE	**2004**	76,249.7	**2013**	151,173.3	**2022**	196,347.3
1996	NE	**2005**	197,715	**2014**	70,560.1	**2023**	301,541.9
1997	NE	**2006**	116,489.5	**2015**	194,836.1		
1998	NE	**2007**	73,465.5	**2016**	124,320.6		

Note: NE – not estimated, as the primary activity data were not provided.

4.2.14.3. Uncertainties and Consistency of Time Series

The uncertainty in activity data is estimated at 0%, while for emission factors it is 100% (IPCC 2006, Volume 3, Chapter 5, Section 5.4.4).

Emission factors were taken as defaults from the EMEP/EEA Guidebook.

4.2.14.4. Quality Assurance and Quality Control

The assessment was carried out using Tier 1 of the EMEP/EEA Guidebook, 2016 version.

4.2.14.5. Recalculations for the Category

No recalculations of time series were carried out.

4.2.14.6. Planned Improvements

It is planned to refine the retrospective data series for the years 1990–2000.

4.2.15. Category “2.F. Products Use as Substitutes for Ozone-Depleting Substances”

4.2.15.1. Category Description

This category covers HFC emissions from the following subcategories:

- 2.F.1.a Refrigeration and stationary air conditioning
- 2.F.1.b Mobile air conditioners
- 2.F.2 Foam blowing agents
- 2.F.6 Other applications (servicing and maintenance)

The subcategory 2.F.3 Fire extinguishing foams is not included in the assessment, since, according to operators of the relevant firefighting foams and automatic fire extinguishing systems — the Ministry of Emergency Situations (MES), JSC Airports of Kyrgyzstan — there was no consumption of such agents during the reporting period.

For the subcategories 2.F.4 Aerosols and 2.F.5 Solvents, information is also unavailable.

The main data provider is the Ozone Center of the Kyrgyz Republic. Additional sources include the Fire Service under the MES, JSC Airports of Kyrgyzstan, and the National Statistical Committee.

In previous inventories, the assessment was carried out using GWP values from the Second IPCC Assessment Report (SAR, AR2). In the current inventory, a transition was made to GWP values from the Fifth IPCC Assessment Report (AR5). Accordingly, the time series was recalculated to reflect the updated GWP values.

Data on HFC emissions are presented in Table 4.21 and in Figure 4.17.

Table 0.21. HFC emissions by gases for the period 1990–2023.

Year	Emissions with GWP values from the IPCC Fifth Assessment Report (AR5)							
	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-227ea	HFC-245fa	HFC-365mfc	Total HFCs
ПГП	677	3,170	1,300	4,800	3,350	858	804	
1990	NE	NE	NE	NE	NE	NE	NE	NE
1991	NE	NE	NE	NE	NE	NE	NE	NE
1992	NE	NE	NE	NE	NE	NE	NE	NE
1993	NE	NE	NE	NE	NE	NE	NE	NE
1994	NE	NE	NE	NE	NE	NE	NE	NE
1995	NE	NE	3.64	NE	NE	NE	NE	3.64
1996	NE	NE	4.09	NE	NE	NE	NE	4.09
1997	NE	NE	4.72	NE	NE	NE	NE	4.74
1998	NE	NE	5.51	NE	NE	NE	NE	5.51
1999	NE	NE	6.47	NE	NE	NE	NE	6.47
2000	NE	NE	7.60	NE	NE	NE	NE	7.60
2001	NE	NE	8.90	NE	NE	NE	NE	8.90
2002	NE	NE	10.36	NE	NE	NE	NE	10.36
2003	NE	NE	11.99	NE	NE	NE	NE	11.99
2004	NE	NE	13.66	NE	NE	NE	NE	13.66
2005	NE	NE	15.76	NE	NE	NE	NE	15.76
2006	NE	NE	17.90	NE	NE	NE	NE	17.90
2007	NE	NE	17.90	NE	NE	NE	NE	17.90
2008	NE	NE	23.19	NE	NE	NE	NE	23.19

Year	Emissions with GWP values from the IPCC Fifth Assessment Report (AR5)							
	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-227ea	HFC-245fa	HFC-365mfc	Total HFCs
ПГП	677	3,170	1,300	4,800	3,350	858	804	
2009	NE	NE	25.50	NE	NE	NE	NE	25.50
2010	4.49	26.72	48.66	9.12	NE	NE	NE	88.99
2011	10.10	62.64	39.07	23.37	NE	NE	NE	135.17
2012	1354	84.09	45.03	35.56	51.71	NE	NE	229.92
2013	16.17	103.06	51.72	47.10	88.96	NE	NE	307.00
2014	18.86	120.77	57.64	55.87	126.38	NE	NE	379.52
2015	20.83	135.65	63.03	65.76	115.06	NE	NE	400.32
2016	22.60	148.97	69.58	74.53	194.41	NE	NE	510.10
2017	24.10	161.20	74.01	83.63	219.66	NE	NE	562.61
2018	25.27	170.48	79.28	90.19	34.53	0.44	3.54	403.74
2019	27.21	183.45	90.18	96.84	26.43	0.57	5.52	430.20
2020	29.51	197.25	99.65	102.01	26.59	0.71	4.90	460.60
2021	26.73	181.65	99.37	89.97	26.76	0.82	4.91	430.21
2022	26.73	197.20	113.02	110.94	26.93	0.96	5.80	481.59
2023	26.73	204.34	141.41	118.78	27.10	1.13	6.62	526.11

Note: NE – not estimated, since the corresponding gas was introduced later.

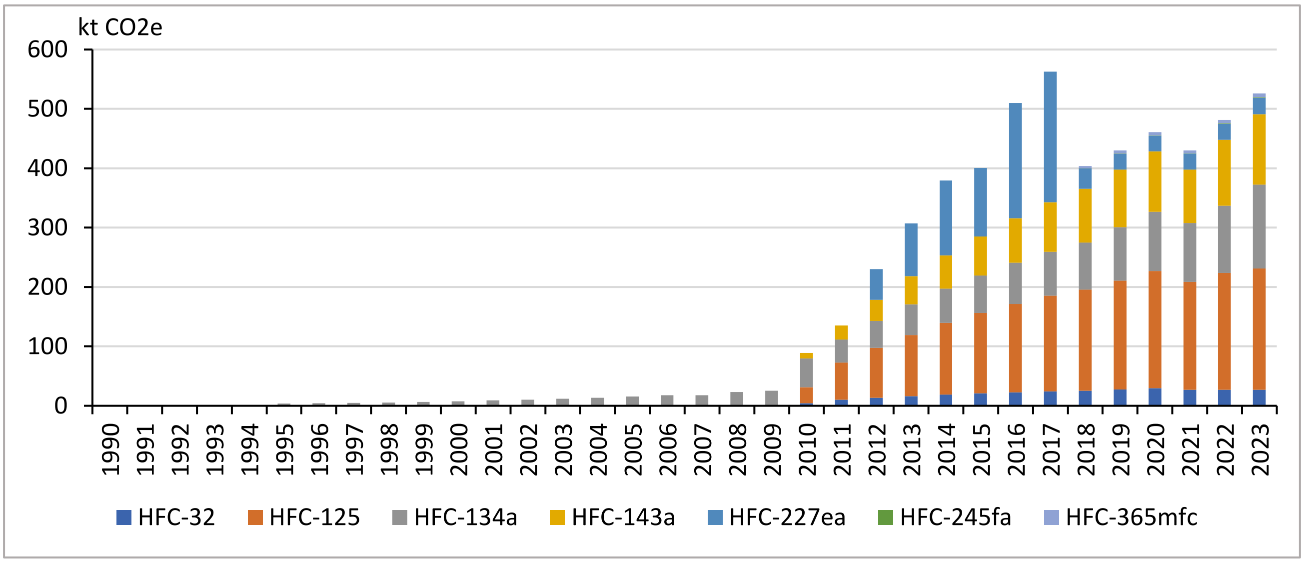


Figure 0.17. Total HFC emissions for the period 1990–2023.

4.2.15.2. Methodology

The methodology for assessing HFC emissions is described in Chapter 7, Volume 3 of the IPCC 2006 Guidelines. For the assessment of HFC emissions for all applications, methodological Tier 1a was used, as the simplest under Kyrgyzstan’s conditions. For Tier 1a, activity data are required at the application level rather than at the equipment or product type (sub-application) level. These activity data may consist of chemical composition data and, for applications with delayed emissions, bank data. The basic equations for Tier 1a are as follows:

Equation 7.1 Calculation of net consumption of a chemical for a specific application

Net consumption = Production + Import - Export - Destruction

In the conditions of Kyrgyzstan, however, this equation is substantially simplified using the following data:

Production = 0;
Import = import of gases, both in pure form and as part of goods and equipment;
Export = 0
Destruction = 0 - the volume of HFC collected and disposed.

Thus, consumption is equal to the volume of imports.

Equation 7.2
Calculation of emissions of a chemical for a specific application
Annual emissions = Net consumption * Combined EF

Where,
Net consumption = net consumption for a specific application;
Combined EF = combined emission factor for a specific application.

For the assessment, standard assumptions and Tier 1 emission factors were applied from:

2.F.1.a – 2.F.1.b – IPCC 2006, Section 7.5;
2.F.2 – IPCC 2006, Section 7.4.

All calculations were performed using IPCC Inventory Software (version 2.970, April 28, 2025).

Emissions of HFC blends were recalculated into their components, according to the percentage composition of the mixture and the GWP of individual gases:

- HFC-404a – HFC-125 44%, HFC-134a 4%, HFC-143a 52%;
- HFC-407c – HFC-32 23%, HFC-125 25%, HFC-134a 52%;
- HFC-410a – HFC-32 50%, HFC-125 50%;
- HFC-507a – HFC-125 50%, HFC-143a 50%.

For the total assessment of HFC emissions in CO2 equivalent, global warming potential values from the IPCC Fifth Assessment Report (AR5) were applied:

- HFC-32 – 677;
- HFC-125 – 3,170;
- HFC-134a – 1,300;
- HFC-143a – 4,800;
- HFC-227ea – 3,350;
- R-245fa – 858;
- R-365mfc – 804.

Due to the lack of reliable statistical data on the import of equipment and materials containing ODS substitutes (HFC and PFC) by subcategory 2.F.1, 2.F.2, and 2.F.6, research data on HFC/PFC imports and consumption provided by the Ozone Center of the Kyrgyz Republic were used. In addition, JSC "Airports of Kyrgyzstan," which maintains a small bank of HFC in fire protection systems, and the Fire Service under the Ministry of Emergency Situations were surveyed regarding the possible use of special fire mixtures and devices.

4.2.15.3. Uncertainties and Time Series Consistency

The uncertainty of activity data is assessed as high, since the accounting of HFC imports and usage in Kyrgyzstan is underdeveloped. It is assumed that uncertainty is asymmetric – from -10% to +100%. This assumption arises from the premise that available HFC data likely reflect the lower bound of possible usage rather than the middle or upper bound. That is, improvement of the HFC accounting system will very likely add previously unaccounted volumes of HFC by applications.

The uncertainty of emission factors is assessed at 50%. This includes uncertainties in GWP values – the transition from AR2 to AR5 values – as well as default assumptions about average equipment lifetime, annual leakage rates, etc.

HFC emission calculations were carried out using the same method for all time series.

4.2.15.4. Quality Assurance and Quality Control

Emission estimates were made using Tier 1a, IPCC 2006, Volume 3, Chapter 7.

4.2.15.5. Category Recalculations

Due to the transition to AR5 global warming potentials, all the time series were recalculated with the new GWP values. Calculations were performed using IPCC Inventory Software (version 2.970, April 28, 2025). The transition to AR5 GWPs also made it possible to compare the obtained emissions with those from the previous inventory. The recalculation results are presented in Table 4.22 and Figure 4.18.

Table 0.22. Comparison of HFC emissions with GWPs from AR2 and AR5

Year	AR 2, kt	AR 5, kt	Difference, %	Year	AR 2, kt	AR 5, kt	Difference, %
1990	NE	NE	NE	**2007**	17.90	17.90	0.00%
1991	NE	NE	NE	**2008**	23.19	23.19	0.00%
1992	NE	NE	NE	**2009**	25.50	25.50	0.00%
1993	NE	NE	NE	**2010**	83.79	88.99	5.84%
1994	NE	NE	NE	**2011**	122.59	135.17	9.31%
1995	3.64	3.64	0.00%	**2012**	205.22	229.92	10.75%
1996	4.09	4.09	0.00%	**2013**	272.57	307.00	11.22%
1997	4.72	4.72	0.00%	**2014**	336.06	379.52	11.45%
1998	5.51	5.51	0.00%	**2015**	354.50	400.32	11.45%
1999	6.47	6.47	0.00%	**2016**	450.17	510.10	11.75%
2000	7.60	7.60	0.00%	**2017**	495.90	562.61	11.86%
2001	8.90	8.90	0.00%	**2018**	355.42	403.74	11.97%
2002	10.36	10.36	0.00%	**2019**	377.89	430.20	12.16%
2003	11.99	11.99	0.00%	**2020**	405.98	460.60	11.86%
2004	13.66	13.66	0.00%	**2021**	379.88	430.21	11.70%
2005	15.76	15.76	0.00%	**2022**	424.02	481.59	11.95%
2006	17.90	17.90	0.00%	**2023**	465.06	526.11	11.60%

Note: NE – not estimated, since the first HFC was introduced into circulation in 1995.

As can be seen from the table, the difference between the estimates in the Second Assessment Report (SAR, AR2) and the Fifth Assessment Report (AR5) of the IPCC appeared starting from 2010.

This is due to the inclusion of new types of HFCs. Before that, only HFC-134a was used, for which the GWP in both AR2 and AR5 remained unchanged at 1300.

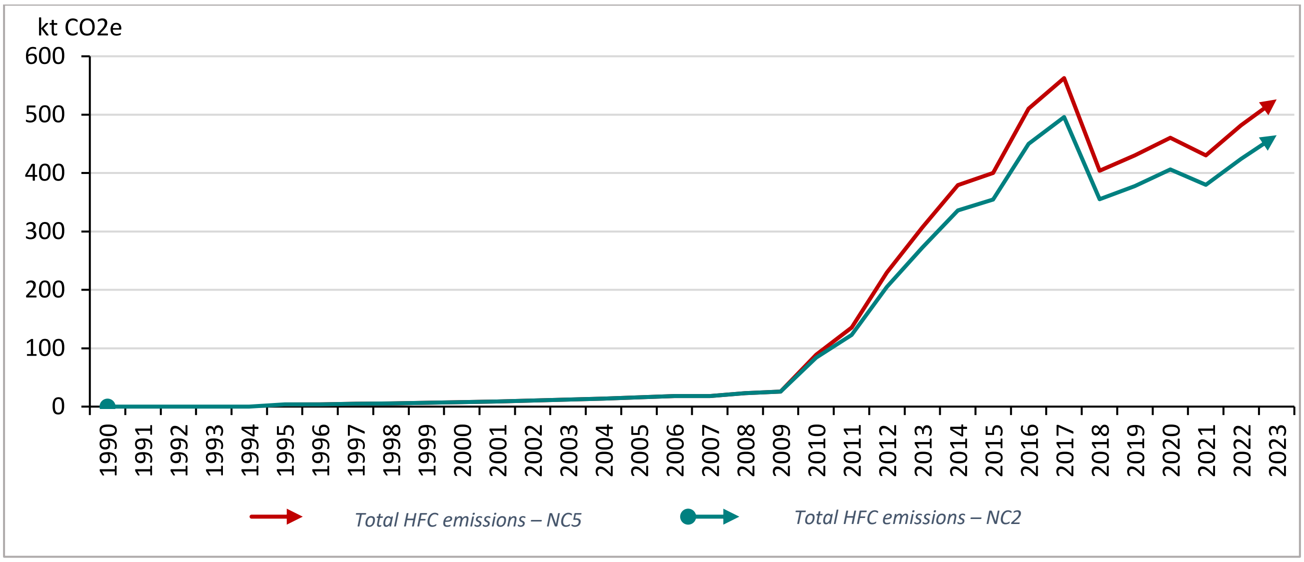


Figure 0.18. Comparison of HFC emissions with GWP according to SAR and AR5

4.2.15.6. Planned improvements

No improvements in conducting the inventory are planned. At the same time, it is proposed to include in the development of a new version of the “Nationally Determined Contribution to the Paris Agreement” an activity for conducting a National HFC Inventory. The last such inventory was carried out by the Ozone Center in 2016–2017 and covered the period from 2010 to 2015.

4.2.16. Category “2.G.2. SF_6 and PFC from Other Product Use”

Since the development of NC4, the situation with the use of sulfur hexafluoride has not changed: there is no SF6 production in Kyrgyzstan. The entire volume of the gas is imported in cylinders, or as part of equipment for high-voltage electrical substations and networks. According to operators, all equipment was imported into the country relatively recently, has significant warranty service life, and has not been subject to repair, refilling, or disposal. No SF_6 emissions are observed in Kyrgyzstan.

According to the National Center of Oncology and Hematology under the Ministry of Health of the Kyrgyz Republic, in 2021, during the installation and commissioning of Synergy and Synergy Platform linear electron accelerators, 2 standard cylinders of sulfur hexafluoride of 72 kg each were imported. No information has been provided on the consumption of this stock of gas.

4.2.17. Category “2.G.3. N_2O from product use”

4.2.17.1. Category Description

According to the Ministry of Health and Social Protection of the Kyrgyz Republic, nitrous oxide is not used for medical purposes (anesthesia) in the country.

A small volume of nitrous oxide is imported as part of various aerosol products. The specifics of customs accounting for such products do not allow the estimation of imported volumes of gas contained in different products. Also, in the HS classification there is only one category “2811-29-

300-0 – nitrogen oxides," which may include nitrous oxide itself as well as other oxides. This category does not provide for further disaggregation.

In previous inventories, it was assumed that the entire volume of imported gas under the above-mentioned import category was nitrous oxide, as the most demanded on the market among all nitrogen oxides.

The National Statistical Committee refused to provide import data for this category, referring to the recently introduced confidentiality rule for import data with disaggregation above the 5th digit of HS. The provided data grouped at the 5-digit HS level do not allow identification and assessment of the "nitrogen oxides" category. Therefore, the data for 2021–2023 were not updated.

4.17.2. Category Recalculation

Due to the transition to GWP values from the Fifth IPCC Assessment Report (AR5), all data series were recalculated with the new GWP values. The calculations were carried out using the IPCC Inventory Software (version 2.97 of April 28, 2025). The transition to AR5 GWP also made it possible to compare the obtained emissions with the data of the previous inventory. The recalculation results are presented in Table 4.23.

Table 0.23. Comparison of nitrous oxide emissions for the period 1990–2023 according to AR2 and AR5

Year	SAR, kt	AR5, kt	Year	SAR, kt	AR5, kt	Year	SAR, kt	AR5, kt
1990	NE	NE	**2002**	NE	NE	**2014**	0,0000	0,0000
1991	NE	NE	**2003**	NE	NE	**2015**	0,1705	0,1458
1992	NE	NE	**2004**	NE	NE	**2016**	0,0000	0,0000
1993	NE	NE	**2005**	NE	NE	**2017**	0,0000	0,0000
1994	NE	NE	**2006**	NE	NE	**2018**	0,0000	0,0000
1995	NE	NE	**2007**	NE	NE	**2019**	3,0845	2,63675
1996	NE	NE	**2008**	0,0930	0,0795	**2020**	NE	NE
1997	NE	NE	**2009**	0,2790	0,2385	**2021**	NE	NE
1998	NE	NE	**2010**	0,0000	0,0000	**2022**	NE	NE
1999	NE	NE	**2011**	0,0310	0,0265	**2023**	NE	NE
2000	NE	NE	**2012**	0,1860	0,1590			
2001	NE	NE	**2013**	0,2945	0,2518			

Note: NE – not estimated, since data were not provided by the National Statistical Committee.

As the activity data did not change during recalculation, the difference in recalculation results is equal to the ratio of the GWP of nitrous oxide according to SAR and AR5 – 310/265.

4.17.3. Planned Improvements

See section 4.7.6 for details.

4.2.18. Category "2.H.1. Pulp and paper industry"

4.2.18.1. Category Description

In Kyrgyzstan, there is production of paper and cardboard from recycled raw materials. This type of activity is reflected in national statistics with the following statistical indicators:

- Cardboard (including corrugating paper), tons – from 1990 to 2001;

- Processed paper and cardboard, tons – from 2002 to present;
- Uncoated paper and cardboard for graphic purposes (offset paper), tons – from 2002 to present;
- Toilet paper, tons – from 2002 to present.

For the reason indicated in section 4.7.6, it is not possible to obtain data from enterprises on the details of the technology.
No GHG emissions from this category are observed. Only precursor gas emissions are present: CO, NOx, NMVOC, SO2. The total volume of emissions is insignificant (Table 4.24).

Table 0.24. Precursor gas emissions from paper production

Year	NOx	CO	NMVOC	SO2	Year	NOx	CO	NMVOC	SO2
1990	0.005	0.0304	0.011	0.0110	**2007**	0.003	0.015	0.006	0.006
1991	0.004	0.0262	0.009	0.0095	**2008**	0.002	0.012	0.004	0.004
1992	0.004	0.0232	0.008	0.0084	**2009**	0.002	0.011	0.004	0.004
1993	0.002	0.0113	0.004	0.0041	**2010**	0.002	0.012	0.005	0.004
1994	0.000	0.0047	0.001	0.0017	**2011**	0.002	0.013	0.005	0.005
1995	0.0005	0.0029	0.001	0.0010	**2012**	0.002	0.012	0.005	0.005
1996	0.0006	0.0037	0.001	0.0013	**2013**	0.002	0.013	0.005	0.005
1997	0.0006	0.0033	0.001	0.0012	**2014**	0.003	0.015	0.005	0.005
1998	0.0003	0.0021	0.000	0.0007	**2015**	0.003	0.016	0.006	0.006
1999	0.0002	0.0012	0.000	0.0004	**2016**	0.003	0.014	0.005	0.005
2000	0.0002	0.001	0.0004	0.0004	**2017**	0.003	0.017	0.006	0.006
2001	0.0001	0.0008	0.0003	0.0003	**2018**	0.003	0.018	0.007	0.007
2002	0.002	0.015	0.005	0.005	**2019**	0.002	0.013	0.005	0.007
2003	0.002	0.015	0.005	0.005	**2020**	0.003	0.016	0.006	0.006
2004	0.002	0.014	0.005	0.005	**2021**	0.008	0.046	0.017	0.017
2005	0.002	0.011	0.004	0.004	**2022**	0.005	0.027	0.010	0.010
2006	0.003	0.016	0.006	0.006	**2023**	0.004	0.023	0.008	0.008

4.2.18.2. Methodology

The assessment of precursor gas emissions is described in the chapter “2.H.1 Pulp and Paper Industry” of the EMEP/EEA Guidebook. Methodological Tier 1 was chosen for the assessment.

The Tier 1 approach to emissions from paper production uses the general equation:

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

Where,
$E_{pollutant}$ = emission of the specified pollutant,
$AR_{production}$ = volumes of paper production,
$EF_{pollutant}$ = emission factor for the given pollutant.

The following default emission factors were used: nitrogen oxides (NOx) – 1 kg/ton of paper, carbon monoxide (CO) – 5.5 kg/ton, NMVOC – 2 kg/ton, sulfur dioxide (SO2) – 2 kg/ton (according to EMEP/EEA 2016 version).

Statistical activity data are presented in Table 4.25.

Table 0.25. Volume of paper production

Year	Cardboard (including corrugating paper), tons	Processed paper and cardboard, tons	Uncoated paper and cardboard for graphic purposes (offset paper), tons	Toilet paper, tons	Year	Cardboard (including corrugating paper), tons	Processed paper and cardboard, tons	Uncoated paper and cardboard for graphic purposes (offset paper), tons	Toilet paper, tons
1990	5,538.0	NE	NE	NE	**2007**	NE	365.4	804.4	1,616.4
1991	4,767.0	NE	NE	NE	**2008**	NE	302.1	439.0	1,376.3
1992	4,229.0	NE	NE	NE	**2009**	NE	68.8	802.3	1,120.0
1993	2,063.0	NE	NE	NE	**2010**	NE	104.3	993.4	1,149.5
1994	857.0	NE	NE	NE	**2011**	NE	201.3	1,047.8	1,038.6
1995	527.0	NE	NE	NE	**2012**	NE	223.4	819.0	1,226.8
1996	685.0	NE	NE	NE	**2013**	NE	277.4	800.1	1,365.8
1997	608.0	NE	NE	NE	**2014**	NE	246.2	1,219.4	1,194.0
1998	391.0	NE	NE	NE	**2015**	NE	273.1	1,163.3	1,466.5
1999	222.0	NE	NE	NE	**2016**	NE	467.7	910.0	1,129.2
2000	222.0	NE	NE	NE	**2017**	NE	450.7	948.4	1,675.0
2001	155.0	NE	NE	NE	**2018**	NE	940.1	780.5	1,513.9
2002	NE	161.2	849.9	1,791.0	**2019**	NE	1,218.4	0.0	1,052.5
2003	NE	159.2	640.1	2,005.1	**2020**	NE	1,397.4	0.0	1,570.1
2004	NE	16.5	382.3	2,259.3	**2021**	NE	6,773.1	0.0	1,549.0
2005	NE	630.6	0.0	1,486.6	**2022**	NE	2,972.4	0.0	1,945.2
2006	NE	792.5	326.9	1,878.8	**2023**	NE	1,439.0	0.0	2,710.2

Note: NE – not estimated, since the corresponding statistical parameter was not applied in the respective year.

4.2.18.3. Uncertainties and Time Series Consistency

The expert assessment of uncertainty of activity data is estimated at ~10%. The uncertainty of emission factors is high – 100%, due to the absence of data on the type of technology.

Consistency of the time series was verified by comparing the data obtained from the National Statistical Committee with the data from previous inventories.

4.2.18.4. Quality Assurance and Quality Control

The assessment was carried out using the same Tier 1 method of the EMEP/EEA Guidebook, 2016 version.

4.2.18.5. Category Recalculation

No recalculation for the category was performed.

4.2.18.6. Planned Improvements

It is necessary to clarify the type of production technology in order to refine the emission factors.

4.2.18 Category "2.H.2. Food and beverages industry"

4.14.1. Category Description

The production of food products and beverages is one of the traditional industries in Kyrgyzstan. Statistical accounting in the sector is conducted according to a large number of parameters, which include various categories of food products and beverages. The list is periodically updated due to changes in the State Classifier of Economic Activities (SCEA). Currently, SCEA-3 is in effect. Data on production volumes of the sector are available on the official website of the National Statistical Committee in the section "Industry," subsection "Dynamic tables," table 1.05.01.01.

In this category, only NMVOC emissions are taken into account. The volume of emissions is shown in Figure 4.19.

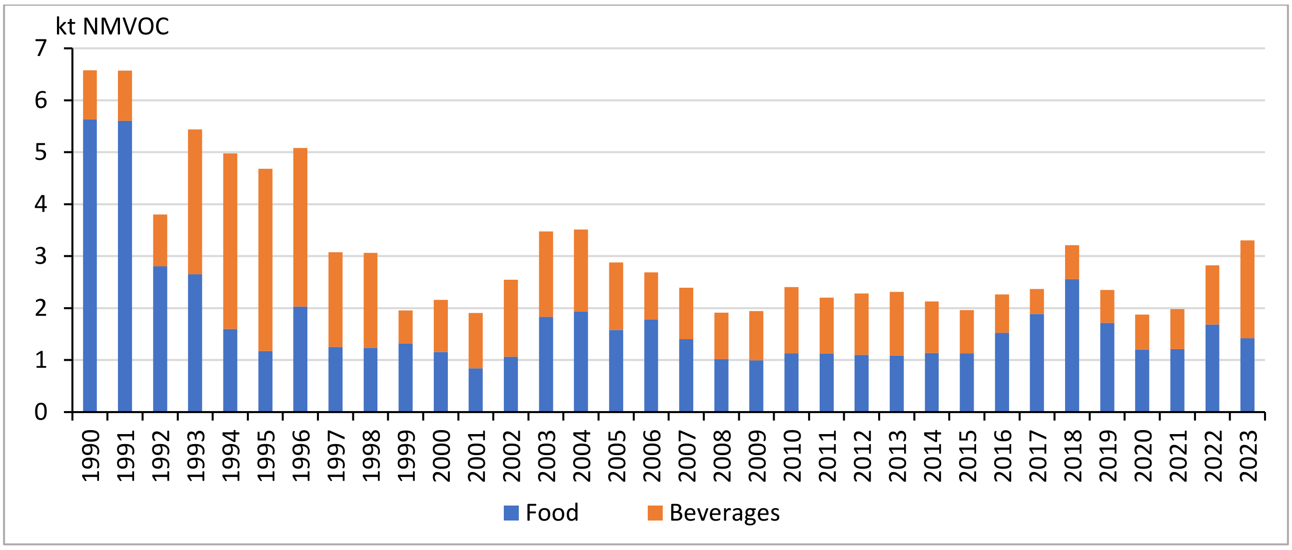


Figure 0.19. NMVOC Emissions from Food and Beverage Production

4.2.18.2. Methodology

The assessment of precursor gas emissions is described in the chapter "2.H.2 Food and Beverages Production" of the EMEP/EEA Guidebook. Methodological Tier 2 was chosen for the assessment, since detailed statistics are available by type of products and beverages.

The Tier approach to emissions in the food industry uses the general equation:

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

Where,
$E_{pollutant}$ = emission of the specified pollutant (NMVOC),
$AR_{production}$ = production volume of the food product or beverage,
$EF_{pollutant}$ = emission factor for NMVOC.

In the next step, emissions from each type of product are summed.

For the calculations, the following NMVOC emission factors were used (according to EMEP/EEA 2023 version). See Table 4.26.

Table 0.26. NMVOC emission factors for food products and beverages.

Products	Average value	Unit of measurement
Sponge cakes and biscuits	8	kg/ton
White bread	4,5	kg/ton
White bread (shortened process)	2	kg/ton
Whole meal bread	3	kg/ton
Light rye bread	3	kg/ton
Cakes, cookies, and breakfast cereals	1	kg/ton
Meat, fish, and poultry	0,3	kg/ton
Sugar	10	kg/ton
Margarine and solid cooking fats	10	kg/ton
Pet food	1	kg/ton
Coffee roasting	0,55	kg/ton
Wine, unspecified color	0,08	kg/hectoliter
Red wine	0,08	kg/hectoliter
White wine	0,035	kg/hectoliter
Beer (including non-alcoholic)	0,035	kg/hectoliter
Alcohol	15	kg/hectoliter
Malt whisky	15	kg/hectoliter
Grain whisky	7,5	kg/hectoliter
Brandy	3,5	kg/hectoliter
Other spirits	0,4	kg/hectoliter

Activity data were provided by the National Statistical Committee upon request and verified with information published on the official website of the statistical agency[74].

4.2.18.3 Uncertainties and Time Series Consistency

The expert assessment of uncertainty gives 10% for activity data and 100% for emission factors.

For time series consistency, statistical indicators were grouped and aligned with the emission factor table from the EMEP/EEA Guidebook.[75].

4.2.18.4. Quality Assurance and Quality Control

The assessment of emissions for the entire period from 1990 to 2023 was carried out using Tier 2 of the EMEP/EEA Guidebook.

4.2.18.5. Category Recalculation

No recalculation for this category was performed.

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[74] Since the data table is large — more than 30 statistical items over 34 years — it is not included in the text of this report. The data are available on the official website of the National Statistical Committee in the section Statistics/“Industry,” subsection Dynamic Tables, Table 1.05.01.01.

[75] The number of statistical indicators for accounting of food and beverages is significantly greater than the tabular emission factor values in the EMEP/EEA Guidebook.

4.2.18.6. Planned Improvements

No improvements for GHG inventory in this category are planned.

5. Agriculture (CRT 3.)

5.1. Sector Overview

Agriculture is one of the main traditional sectors of the economy of the Kyrgyz Republic. Over the past 10 years, there has been a general trend of decreasing share of agriculture in the country's GDP – from 14.64% in 2013 to 9.49% in 2023[76]. At present, the agriculture sector in terms of production output includes:

- Livestock
- Crop production
- Fisheries (fish farming)
- Forestry

From the perspective of current state administration, water management is also included in agriculture. Forestry is considered in a separate chapter devoted to land use.

The total output of agricultural production for the period 1990–2023 by main directions is presented below (Figure 5.1).[77.]

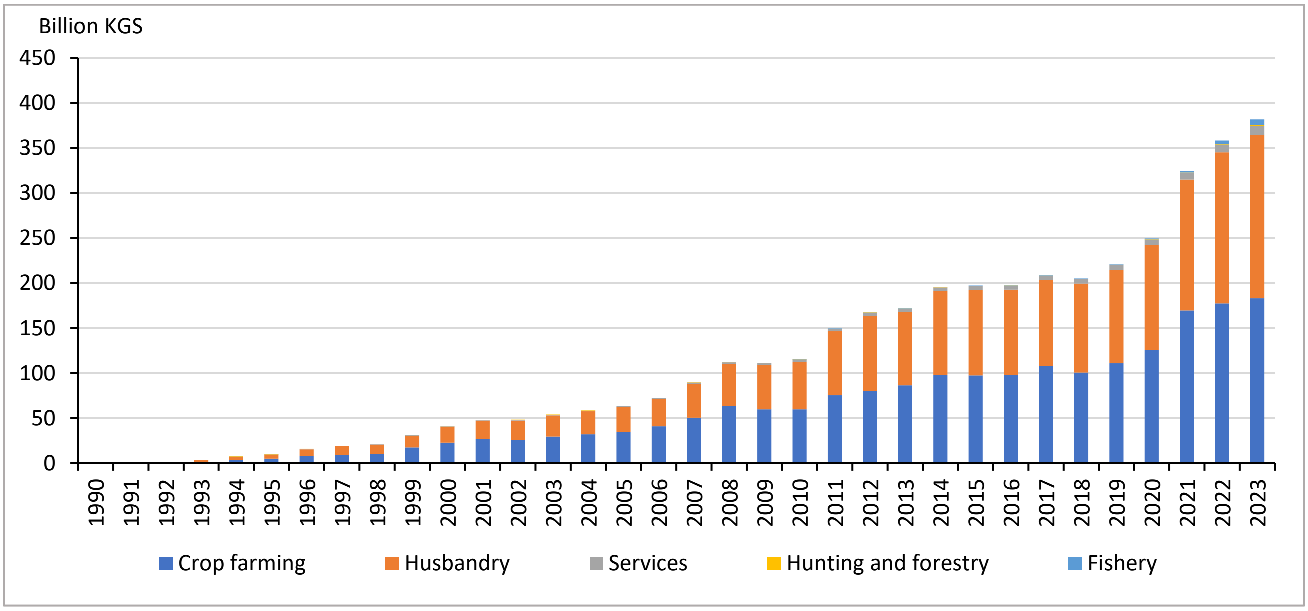

Figure 0.1. Total output of agriculture, hunting and forestry

As can be seen from the figure, the contributions of livestock and crop production are approximately equal throughout the entire period under review.

According to the 2006 IPCC Guidelines, within this BTR the subsectors "Livestock" and "Agricultural soils" are considered in detail, with emission estimates including the source categories presented in Table 5.1.

[76] NSC website, section Statistics/Agriculture/Dynamic Tables, table "1.01.00.11. GDP structure by type of economic activity at current prices."

[77] NSC website, section Statistics/Agriculture/Dynamic Tables, table "1.04.02.01 Gross output of agriculture, hunting and forestry by categories of farms of the Kyrgyz Republic."

Table 0.1. List of GHG emission source categories and information providers.[78]

CRT Category	Providers (in order of priority)	Methodological tier and emission factor	Greenhouse gases and precursor gases
3.A. Enteric fermentation	NSC, MWRAPI	T1, D	CH_4
3.B. Manure management	NSC, MWRAPI	T1, D	CH_4, N_2O
3.B.5. Indirect N2O emissions from manure management	NSC, MWRAPI	T1, D	N_2O
3.C. Rice cultivation	NSC, MWRAPI	T1, D	CH_4
3.D. Agricultural soils			
3.D.1. Direct N2O emissions from soils	NSC, MWRAPI	T1, D	N_2O
3.D.2. Indirect N2O emissions from soils	NSC, MWRAPI	T1, D	N_2O
3.H. Urea application	NSC, MWRAPI	T1, D	CO_2

The methodological basis for conducting this GHG inventory in the "Agriculture" sector consisted of the following documents:

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
- 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands Methodological Guidance for Wetland Drainage and Rewetting and Constructed Wetlands for Wastewater Treatment.

According to the key category analysis, categories 3.A., 3.B., 3.C. and 3.D. are key both in terms of emission levels and trends. However, due to the absence of national emission factors and detailed disaggregated data, Tier 1 methodology of the 2006 IPCC Guidelines was applied for the calculation of emissions for these categories.

In addition to methodological literature, materials and results of previous assessments obtained under the Kyrgyz Republic's NC3 and NC4 were used.[79].

Automation of calculations and data accounting for all GHG emission source categories was carried out using the IPCC Inventory Software.

This GHG emissions and removals assessment for the First Biennial Transparency Report of the Kyrgyz Republic on climate change covers the period from 1990 to 2023.

According to the results of the previous inventory covering the period 1990–2020, the "Agriculture" sector is the second largest in total GHG emissions after the "Energy" sector. Since 1990, the sector's contribution to national emissions has changed from 5,746.39 kt CO2 eq in 1990 (NSC data) to 5,754.41 kt CO2 eq in 2023. At the same time, the share of emissions, excluding LULUCF, changed from 20.6% to 29.7% (Figure 4.2).

According to the GHG inventory results in Kyrgyzstan, the agriculture sector accounts for emissions of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Precursor gas emissions are absent.

The dynamics of GHG emission volumes for the period 1990–2023 are presented below.

[78] The table includes only those categories that are covered in the GHG inventories. The other categories are either absent in the territory of the Kyrgyz Republic or are not accounted for.

[79] UNFCCC website. https://unfccc.int/documents/644907

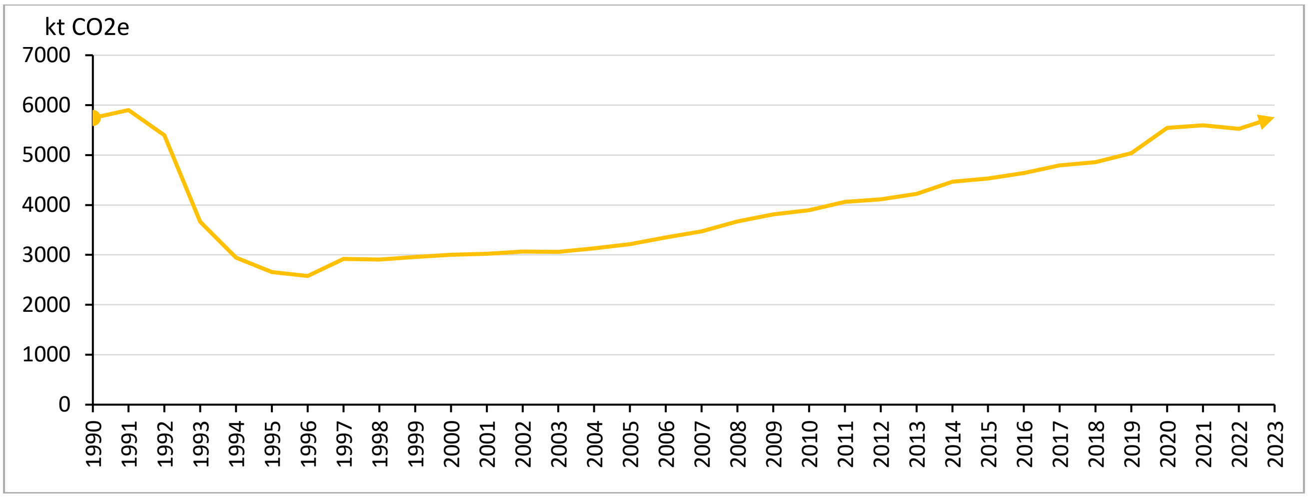

Figure 0.2. Dynamics of total GHG emissions from the “Agriculture” sector

The overall dynamics of changes in GHG emissions are not uniform across different source categories. The largest contributions come from two categories: “3.A. Enteric fermentation” and “3.D. Manure management” (see Figure 5.3).

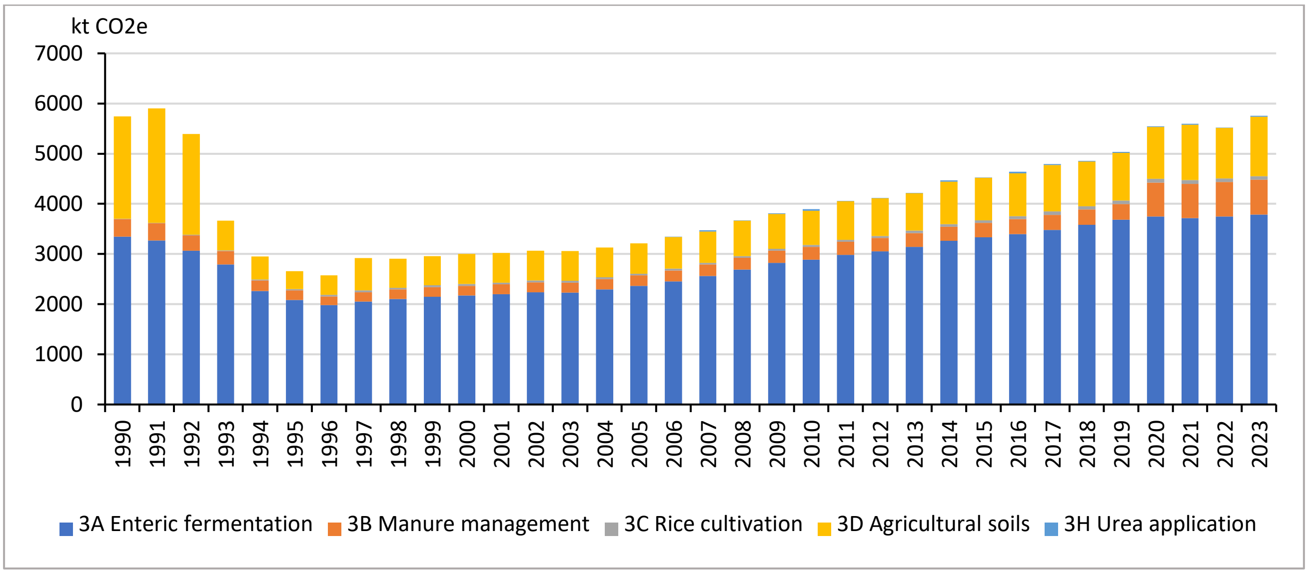

Figure 0.3. Dynamics of GHG emissions of the “Agriculture” sector for the period 1990–2023 by categories

The estimated values of GHG emissions by main categories for the entire period from 1990 to 2023 in kt CO2 eq are presented in Table 5.2.

Table 0.2. GHG emissions from the “Agriculture” sector[80]

Year	Emissions, kt CO_2e					
	3.A. Enteric fermentatio n	3.B. Manure management	3.C. Rice cultivation	3.D. Agricultural soils	3.H. Urea application	TOTAL
1990	3,346.96	350.68	7.45	2,041.31	NE	5,746.39
1991	3,272.66	339.65	10.49	2,278.58	NE	5,901.38

[80] The table includes data only for those categories for which GHG emission estimates are available.

Year	Emissions, kt CO_2e					
	3.A. Enteric fermentation	3.B. Manure management	3.C. Rice cultivation	3.D. Agricultural soils	3.H. Urea application	TOTAL
1992	3,065.35	307.75	11.23	2,010.417	NE	5,394.75
1993	2,789.48	269.00	14.66	592.681	NE	3,665.83
1994	2,264.66	206.94	18.16	458.426	NE	2,948.18
1995	2,086.70	189.73	26.77	352.886	NE	2,656.09
,1996	1,979.86	177.31	32.12	388.249	NE	2,577.53
1997	2,052.86	184.03	36.48	646.017	NE	2,919.39
1998	2,102.75	189.69	32.74	582.915	NE	2,908.10
1999	2,145.46	193.47	36.34	581.032	NE	2,956.31
2000	2,171.72	195.26	38.42	596.900	NE	3,002.30
2001	2,199.39	196.23	33.66	591.653	NE	3,020.93
2002	2,234.91	199.28	40.62	593.536	NE	3,068.34
2003	2,229.02	197.67	37.28	593.913	NE	3,057.88
2004	2,294.65	203.36	36.94	595.190	NE	3,130.15
2005	2,365.30	207.61	35.12	606.612	NE	3,214.64
2006	2,455.05	215.22	37.99	633.845	6.06	3,348.15
2007	2,564.77	223.95	36.91	621.365	24.26	3,471.25
2008	2,690.43	233.14	36.07	702.744	9.97	3,672.35
2009	2,822.01	244.55	37.61	695.872	10.46	3,810.51
2010	2,884.57	255.64	39.42	681.590	36.04	3,897.25
2011	2,985.28	259.36	38.65	770.571	9.25	4,063.11
2012	3,052.98	265.17	43.48	751.317	1.32	4,114.27
2013	3,144.63	273.40	47.31	747.076	9.45	4,221.86
2014	3,260.77	282.71	48.61	852.539	24.70	4,469.33
2015	3,330.93	288.72	51.54	846.421	10.30	4,527.92
2016	3,400.48	294.16	59.29	852.962	32.73	4,639.62
2017	3,482.58	300.32	64.12	927.084	20.94	4,795.03
2018	3,579.52	307.63	67.96	887.055	14.78	4,856.95
2019	3,683.62	314.80	67.66	953.329	19.49	5,038.90
2020	3,746.99	679.71	71.44	1,033.478	12.29	5,543.90
2021	3,715.50	683.32	74.59	1,105.348	16.69	5,595.44
2022	3,746.02	688.02	69.69	1,011.951	7.35	5,523.02
2023	3,783.69	697.46	70.62	1,187.713	14.92	5,754.41

Note: NE – not estimated, since data for this period were not provided.

GHG emissions by gas types in 1990 and 2023 are shown in Figure 5.4. Despite the overall increase in emissions from the sector, the ratio of methane to nitrous oxide contribution changed by less than 10%. Carbon dioxide emissions from urea application for 1990 were not estimated, since data on urea imports for 1990–2005 were not provided.

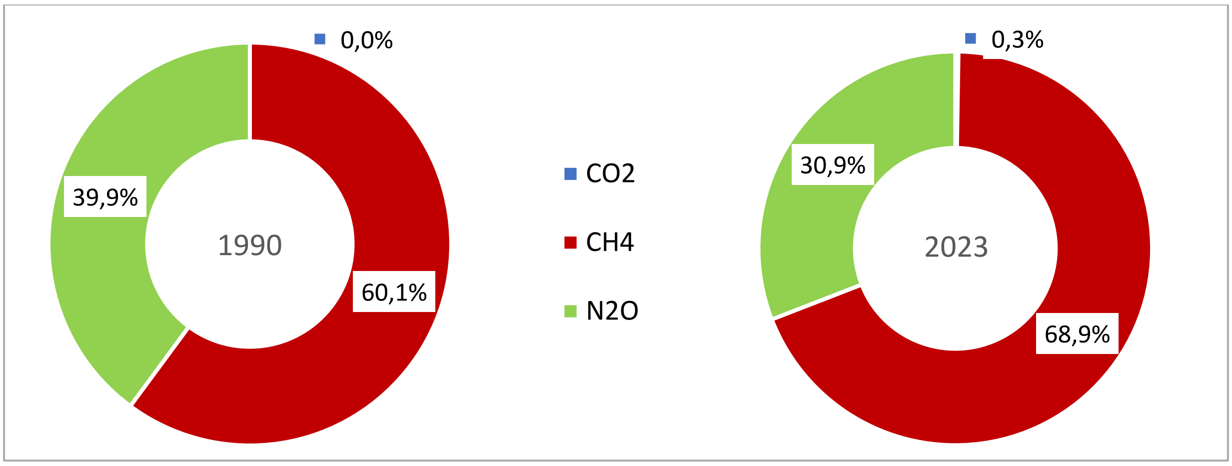

Figure 0.4. GHG emissions in 1990 and 2023 by gas types.

The estimated values of GHG emissions for the period 1990–2023 by all gases are presented in Table 5.3.

Table 0.3. GHG emissions from the "Agriculture" sector by types of gases

Year	Emissions, kt CO_2 eq.				Year	Emissions, kt CO_2 eq.			
	CO_2	CH_4	N_2O	Total		CO_2	CH_4	N_2O	Total
1990	NE	3,454.63	2,291,76	5,746,39	**2007**	24.26	2,678.33	768.67	3,471.25
1991	NE	3,381.13	2,520,26	5901,32	**2008**	9.97	2,806.15	856.23	3,672.35
1992	NE	3,166.18	2,228.57	5,394.75	**2009**	10.46	2,942.82	857.22	3,810.51
1993	NE	2,885.21	780.62	3,665.83	**2010**	36.04	3,008.67	852.54	3,897.25
1994	NE	2,349.39	598.80	2,948.18	**2011**	9.25	3,111.31	942.54	4,063.11
1995	NE	2,176.25	479.84	2,656.09	**2012**	1.32	3,185.73	927.23	4,114.27
1996	NE	2,071.85	505.69	2,577.53	**2013**	9.45	3,283.70	928.72	4,221.86
1997	NE	2,151.43	767.96	2,919.39	**2014**	24.70	3,404.41	1,040.22	4,469.33
1998	NE	2,199.77	708.40	2,908.10	**2015**	10.30	3,479.50	1,038.11	4,527.93
1999	NE	2,247.70	708.61	2,956.31	**2016**	32.73	3,558.76	1,048.13	4,639.62
2000	NE	2,276.88	725.42	3,002.30	**2017**	20.94	3,648.07	1,126.03	4,795.03
2001	NE	2,300.39	720.54	3020.93	**2018**	14.78	3,751.64	1,090.53	4,856.95
2002	NE	2,344.06	724.28	3,068.34	**2019**	19.49	3,858.14	1,161.26	5,038.90
2003	NE	2,334.15	723.73	3,057.88	**2020**	12.28	3,927.15	1,604.46	5,543.90
2004	NE	2,401.40	728.75	3,130.15	**2021**	16.69	3,896.04	1,682.71	5,595.44
2005	NE	2,471.75	742.90	3,214.64	**2022**	7.35	3,922.36	1,593.31	5,523.02
2006	6.06	2,566.84	775.25	3,348.15	**2023**	14.92	3,962.54	1,776.95	5,754.41

In the emission assessment, default emission factors in accordance with the 2006 IPCC Guidelines were used. For the assessment, global warming potentials were applied according to the Fifth IPCC Assessment Report on Climate Change (AR5).

5.2 Uncertainty Assessment

An important part of the analysis of GHG inventory results is the assessment of uncertainty. The following assumptions were made for the uncertainty assessment:

- The uncertainty of data provided by the National Statistical Committee is assessed as low (not exceeding 10%).
- The uncertainty of data on average livestock weight, manure management systems, etc. is assessed as medium (approximately 20–40%).

- Data on annual fertilizer application to soils are absent. Therefore, it was assumed that the entire volume of imported fertilizers is consumed in the same year. This increases uncertainty, since in practice part of the fertilizers is carried over to the following year, especially if they are imported after the end of the growing season.
- The uncertainty of emission factors was used according to the 2006 IPCC Guidelines. In cases where a default uncertainty range was provided (e.g., 20–30%), the mean or the upper boundary value was chosen, applying a conservative approach.

The calculation of uncertainty for all considered categories of the "Agriculture" sector was carried out using the Work Sheet (2006 Guidelines, Volume 1, Chapter 3, Table 3.2) and is presented in Table 5.4. As before, 1990 was taken as the base year.

For the category "Urea application," data for 1990–2005 are absent, since the National Statistical Committee did not provide the corresponding data.[81]. Therefore, the notation key "NE" was used for this category for 1990–2005.

In 2023, the resulting uncertainty for total greenhouse gas emissions in the "Agriculture" sector for the period 1990–2023 is: 25.707% for total emissions, 20.977% for the trend.

[81] The table includes data only for those categories for which GHG emission estimates are available.

Table 0.4. Worksheet for Approach 1 – Uncertainty Calculation

Base year - 1990 г.; year t - 2023 г.

IPCC Category	Gas	Emissions or Removals		Activity Data Uncertainty	Emission Factor/Parameter Uncertainty	Combined Uncertainty	Contribution to Variability by Category in Year t	Type A Sensitivity	Type B Sensitivity	National Trend Uncertainty from EF/Parameter	National Trend Uncertainty from Activity Data	Uncertainty Introduced into the National Emission Trend
		Base year	per year **t**									
		input data	input data	input data	input data	√(E^2+F^2)	(G*D)^2 ------------- (∑D)^2	Note Б	|D/∑C|	I*F	J*E*2^√2	K^2+L^2
		kt CO2 eq.	kt CO2 eq.	%	%	%		%	%	%	%	%
3A Enteric fermentation	CH_4	3346,956	3783,694	20,0000%	30,0000%	36,06%	0,0562	7,48%	65,84%	2,2426%	18,6237%	3,5187%
3B Manure management	CH_4	100,226	108,231	50,0000%	30,0000%	58,31%	0,0001	0,14%	1,88%	0,0411%	1,3318%	0,0178%
	N_2O	250,449	589,233	35,1731%	25,9750%	43,72%	0,0020	5,89%	10,25%	1,5291%	5,1006%	0,2835%
3C Rice cultivation	CH_4	7,451516	70,61883	10,00%	40,00%	41,23%	0,0000	1,10%	1,23%	0,4396%	0,1738%	0,0022%
3D Agricultural soils	N_2O	2041,307	1187,713	16,7587%	39,1501%	42,59%	0,0077	-14,85%	20,67%	-5,8143%	4,8986%	0,5780%
3H Urea application	CO_2	0	14,92429	10,0000%	50,0000%	50,99%	0,0000	0,26%	0,26%	0,1299%	0,0367%	0,0002%
TOTAL		**5746,389**	**5754,413**				**0,0661**					**4,400%**
						Uncertainty in the total inventory:	**25,707%**				**Trend uncertainty:**	**20,977%**

5.3 Quality Assurance and Quality Control

QA/QC procedures are described for each category in the corresponding section.

5.4 Time Series Recalculation

The inventories for BUR1 and the NC highlighted the transition from the 1996 IPCC methodology previously used to the 2006 IPCC methodology. To assess changes in total emission estimates under such a transition, GWPs from the Second IPCC Assessment Report (SAR) were applied. In the current inventory, while maintaining the 2006 IPCC methodology, a transition was made to GWPs from the IPCC Fifth Assessment Report (AR5). A complete recalculation of the time series with the new GWPs was carried out. The GWP value for methane increased from 21 to 28, while the GWP value for nitrous oxide, on the contrary, decreased from 310 to 265. The recalculation result is presented in Figure 5.5 and Table 5.5.

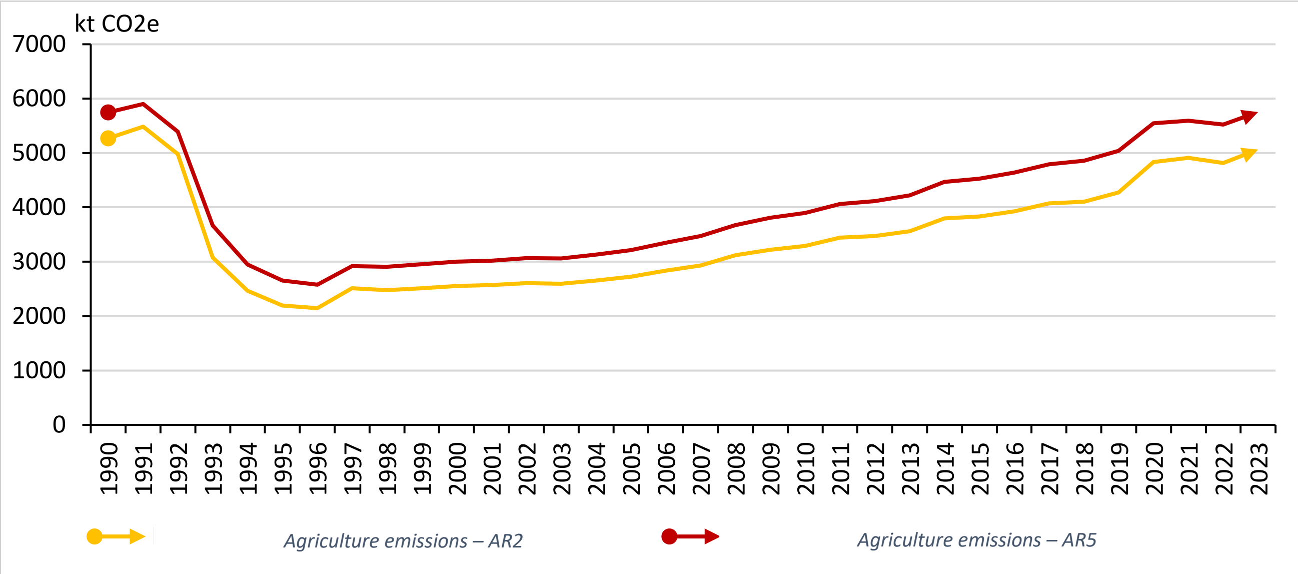

Figure 0.5. Comparison of total sector emissions with GWPs according to SAR and AR5

As can be seen from the table, the difference between the two estimates is quite significant, reaching more than 17% in certain years.

Table 0.5. Comparison of sector emissions with GWPs according to SAR and AR5

Year	kt			kt CO_2 eq.						Difference between AR 2 and AR 5, %
				SAR			AR5			
	CO_2	CH_4	N_2O	CH_4= 21	N_2O = 310	ВСЕГО	CH_4= 28	N_2O = 265	TOTAL	
1990	NE	123.38	8.65	2,590.98	2,680.92	5,271.90	3,454.63	2,291.76	5,746.39	8.26%
1991	NE	120.75	9.51	2,535.84	2,948.22	5,484.07	3,381.13	2,520.26	5,901.38	7.07%
1992	NE	113.08	8.41	2,374.63	2,607.01	4,981.64	3,166.18	2,228.57	5,394.75	7.66%
1993	NE	103.04	2.95	2,163.91	913.18	3,077.08	2,885.21	780.62	3,665.83	16.06%
1994	NE	83.91	2.26	1,762.04	700.48	2,462.52	2,349.39	598.79	2,948.18	16.47%
1995	NE	77.72	1.81	1,632.19	561.32	2,193.51	2,176,25	479.84	2,656.09	17.42%
1996	NE	73.99	1.91	1,553.88	591.56	2,145.44	2,071.85	505.69	2,577.53	16.76%
1997	NE	76.84	2.90	1,613.57	898.37	2,511.94	2,151.43	767.96	2,919.39	13.96%

Year	kt			kt CO_2 eq.						Difference between AR 2 and AR 5, %
				SAR			AR5			
	CO_2	CH_4	N_2O	CH_4= 21	N_2O = 310	ВСЕГО	CH_4= 28	N_2O = 265	TOTAL	
1998	NE	78.56	2.67	1,649.82	828.61	2,478.44	2,199.76	708.33	2,908.09	14.77%
1999	NE	80.28	2.67	1,685.78	828.93	2,514.71	2,247.70	708.60	2,956.31	14.94%
2000	NE	81.32	2,74	1,707.66	848.60	2,556.27	2,276.88	725.42	3,002.30	14.86%
2001	NE	82.16	2.72	1,725.30	842.90	2,568.19	2,300.39	720.54	3,020.93	14.99%
2002	NE	83.72	2.73	1,758.05	847.27	2,605.31	2,344.06	724.28	3,068.34	15.09%
2003	NE	83.36	2.73	1,750.61	846.63	2,597.24	2,334.15	723.73	3,057.88	15.06%
2004	NE	85.76	2.75	1,801.05	852.50	2,653.55	2,401.39	728.75	3,130.15	15.23%
2005	NE	88.28	2.80	1,853.81	869.05	2,722.86	2,471.75	742.90	3,214.64	15.30%
2006	6.06	91.67	2.93	1,925.13	906.90	2,838.09	2,566.84	775.25	3,348.15	15.23%
2007	24.26	95.65	2.90	2,008.74	899.20	2,932.20	2,678.32	768.67	3,471.25	15.53%
2008	9.97	100.22	3.23	2,104.61	1,001.62	3,116.21	2,806.15	856.23	3,672.35	15.14%
2009	10.46	105.10	3.23	2,207.11	1,002.79	3,220.37	2,942.82	857.22	3,810.51	15.49%
2010	36.04	107.45	3.22	2,256.51	997.31	3,289.85	3,008.67	852.54	3,897.25	15.59%
2011	9.25	111.12	3.56	2,333.49	1,102.60	3,445.33	3,111.31	942.54	4,063.11	15.20%
2012	1.32	113.78	3.50	2,389.29	1,084.68	3,475.29	3,185.73	927.23	4,114.27	15.53%
2013	9.45	117.27	3,50	2,462.77	1,086.42	3,558.64	3,283.70	928.72	4,221.86	15.71%
2014	24.70	121.59	3.93	2,553.31	1,216.87	3,794.87	3,404.41	1,040.22	4,469.33	15.09%
2015	10.30	124.27	3.92	2,609.62	1,214.40	3,834.32	3,479.50	1,038.11	4,527.92	15.32%
2016	32.73	127.10	3.96	2,669.07	1,226.11	3,927.91	3,558.76	1,048.13	4,639.62	15.34%
2017	20.94	130.29	4.25	2,736.05	1,317.24	4,074.23	3,648.07	1,126.02	4,795.03	15.03%
2018	14.78	133.99	4.12	2,813.73	1,275.71	4,104.23	3,751.64	1,090.53	4,856.95	15.50%
2019	19.49	137.79	4.38	2,893.60	1,358.46	4,271.56	3,858.14	1,161.26	5,038.90	15.23%
2020	12.28	140.26	6.05	2,945.36	1,876.92	4,834.56	3,927.15	1,604.46	5,543.90	12.79%
2021	16.69	139.14	6.35	2,922.03	1,968.45	4,907.17	3,896.04	1,682.71	5,595.44	12.30%
2022	7.35	140.08	6.01	2,941.77	1,863.87	4,812.99	3,922.36	1,593.31	5,523.02	12.86%
2023	14.92	141.52	6.71	2,971.91	2,078.69	5,065.52	3,962.54	1,776.95	5,754.41	11.97%

Note: NE – not estimated, since data on urea imports were not provided.

5.5. Planned Improvements

The process of preparing the current inventory revealed several areas for improvement, presented in Table 5.6. In addition to those listed in the table, general sector-wide issues were identified, as noted in Chapter 4 – regarding the provision of import data with disaggregation up to the 10-digit HS code[82].

Table 0.6. Gaps and proposed improvements by categories

Category	Gaps	Planned improvements
3.A Enteric fermentation	No gaps	No improvements planned
3.B Manure management	No gaps	No improvements planned
3.B.5 Indirect N2O emissions from manure management	No gaps	No improvements planned
3.C Rice cultivation	No gaps	No improvements planned
3.D Agricultural soils		

[82] Commodity Nomenclature of Foreign Economic Activity

Category	Gaps	Planned improvements
3.D.1 Direct N2O emissions from managed soils	No data on urea for 1990–2005. No access to disaggregated import data (10-digit HS code), since such data are considered restricted.	Obtain urea data for 1990–2005. Establish a permanent agreement between NSC and MNETR on the provision of restricted (confidential) data for inventories.
3.D.2 Indirect N2O emissions from managed soi		
3.H Urea application		

5.6. Category "Enteric Fermentation" (CRT 3.A.)

5.6.1. Category Description

The category "Enteric fermentation" is a source of methane (CH4) emissions. Methane is released as a result of physiological processes in the digestive tract of herbivorous animals. The amount of methane produced depends on the type of digestive system, the age and weight of the animal, as well as the quality and quantity of feed consumed.

The main source of methane is ruminant livestock (e.g., cattle, sheep). A smaller amount of methane is produced by non-ruminant livestock (e.g., pigs, horses).

In Kyrgyzstan, animal husbandry has been a traditional type of economic activity for many centuries. Currently, livestock breeding, along with crop production, is one of the most important areas of agriculture. All types of domestic animals, characteristic of the temperate zone of the Northern Hemisphere are raised in the country.

In category 3.A. "Enteric fermentation," CH4 emissions are considered for the following types of domestic animals:

- Cattle
- Yaks
- Goats, sheep
- Camels
- Horses
- Asses and mules
- Pigs

Annual livestock population statistics are maintained in Kyrgyzstan. Data on the main livestock species are publicly available on the website of the National Statistical Committee of the Kyrgyz Republic. Extended data, including statistics on yaks and camels, were provided by the National Statistical Committee upon official request.

The largest contribution to methane emissions from enteric fermentation comes from the ruminant population, primarily cattle. Emissions from this category are presented in Table 5.7 and Figure 5.6.

Table 0.7. CH4 emissions from category 3.A. "Enteric Fermentation"

Year	kt CO_2e	Year	kt CO_2e	Year	kt CO_2e	Year	kt CO_2e
1990	3,346.96	**1999**	2,145.46	**2008**	2,690.43	**2017**	3,482.58
1991	3,272.66	**2000**	2,171.72	**2009**	2,822.01	**2018**	3,579.52
1992	3,065.35	**2001**	2,199.39	**2010**	2,884.57	**2019**	3,683.62
1993	2,789.48	**2002**	2,234.92	**2011**	2,985.28	**2020**	3,746.99
1994	2,264.66	**2003**	2,229.02	**2012**	3,052.98	**2021**	3,715.50
1995	2,086.70	**2004**	2,294.65	**2013**	3,144.63	**2022**	3,746.02

Year	kt CO_2e	Year	kt CO_2e	Year	kt CO_2e	Year	kt CO_2e
1996	1,979.86	**2005**	2,365.30	**2014**	3,260.77	**2023**	3,783.69
1997	2,052.86	**2006**	2,455.05	**2015**	3,330.93		
1998	2,102.75	**2007**	2,564.77	**2016**	3,400.48		

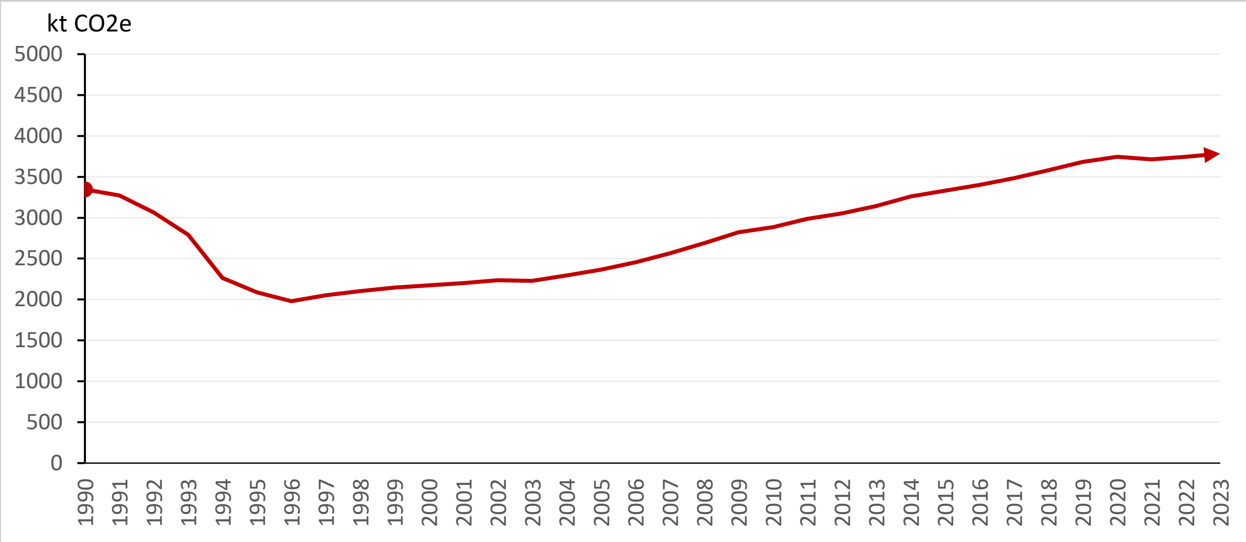

Figure 0.6. GHG Emissions from Category 3.A. “Enteric Fermentation”

The IPCC Guidelines do not provide a methodology for estimating CH_4 emissions from poultry; therefore, these emissions are not calculated.

5.2.2. Methodology

The estimation methodology is based on the 2006 IPCC Guidelines, Volume 4 “Agriculture, Forestry and Other Land Use”, Chapter 10 “Livestock”. A Tier 1 approach was applied.

This approach uses national livestock population data and default emission factors taken from the 2006 IPCC Guidelines.

To estimate total emissions, the established emission factors are multiplied by the corresponding livestock population values:

Equation 10.19

Emissions from Enteric Fermentation of Livestock in the Given Category

$$Emissions = EF_{(T)} \cdot \frac{N_{(T)}}{10^6}$$

Where,
Emissions = methane emissions from enteric fermentation, kt CH_4/year;
EF(T) = emission factor for the specified livestock population, kg CH_4/head × year;
N(T) = number of heads of livestock species/category T in the country;
T = livestock species/category.

Equation 10.20
Total Emissions from Livestock due to Enteric Fermentation

$$\text{Total } CH_{4,\text{enteric}} = \sum_i E_i$$

Where,

Total $CH_{4enteric}$.= total methane emissions from enteric fermentation, kt CH_4/year;;

E_i = emissions for the i-th categories and subcategories of livestock.

5.2.2.1 Activity Data

For the calculations, NSC data on domestic livestock were used (see Table 5.8).

Table 0.8. Livestock and Poultry Population, heads

Year	Dairy cows	Non-dairy cattle	Yaks	Sheep and goats	Camels	Horses	Asses	Pigs	Poultry[83]
1990	506,159	644,052	55,100	9,969,374	200	312,676	14,100	393,447	13,914,670
1991	518,312	614,703	57,204	9,524,935	307	320,468	15,078	354,937	13,571,195
1992	514,581	552,547	55,256	8,741,508	283	313,005	14,153	245,422	10,420,586
1993	511,282	497,352	53,649	7,322,345	110	322,025	17,100	169,443	6,916,647
1994	480,893	389,029	50,209	5,076,012	200	299,044	21,300	117,790	2,208,323
1995	470,834	357,419	40,756	4,274,898	284	308,168	20,455	113,871	2,031,782
1996	459,858	354,725	33,058	3,716,081	193	314,066	23,371	88,040	2,121,973
1997	473,507	388,588	22,681	3,803,876	187	325,279	21,827	92,165	2,329,362
1998	492,238	400,400	17,926	3,810,580	155	335,232	28,240	105,476	2,727,486
1999	511,472	404,055	16,746	3,806,544	152	349,811	27,203	104,830	2,979,896
2000	523,798	406,368	16,856	3,799,191	129	353,860	31,319	101,053	3,063,672
2001	535,633	417,598	16,318	3,744,217	170	354,423	35,208	86,619	3,454,338
2002	547,460	423,243	17,313	3,765,434	184	360,701	37,077	87,159	3,647,552
2003	533,920	452,129	18,314	3,679,202	202	340,535	38,342	82,770	4,332,163
2004	548,193	469,650	17,047	3,773,619	434	347,178	48,562	82,659	4,510,941
2005	565,134	489,815	19,815	3,876,002	276	345,174	44,488	77,786	4,278,987
2006	584,941	509,893	21,899	4,046,949	258	347,526	51,049	79,567	4,472,582
2007	607,197	538,436	22,393	4,251,813	291	355,553	54,324	74,918	4,589,190
2008	635,598	566,175	22,790	4,502,651	338	362,433	60,911	63,328	4,364,777
2009	664,294	589,023	24,753	4,815,390	337	372,951	64,795	61,315	4,535,762
2010	666,450	603,259	29,116	5,037,715	337	378,448	68,570	59,791	4,749,854
2011	684,157	625,001	29,425	5,288,115	338	388,971	72,640	59,202	4,815,308
2012	699,339	636,590	31,537	5,423,881	311	398,796	73,222	55,380	5,076,559
2013	718,516	654,727	30,925	5,641,214	311	407,381	77,187	51,777	5,385,713
2014	744,336	677,857	36,184	5,829,024	264	432,972	63,492	50,782	5,420,033
2015	757,423	702,697	32,397	5,929,529	258	449,614	53,639	50,345	5,586,212
2016	769,933	719,353	38,477	6,022,554	235	467,249	43,040	51,082	5,673,607
2017	789,796	742,701	42,937	6,077,775	228	481,329	33,144	52,169	5,910,418
2018	812,596	767,867	46,833	6,167,949	246	498,684	28,941	51,265	6,009,697
2019	835,270	794,900	50,580	6,266,739	247	522,611	28,441	34,750	6,211,184
2020	855,050	806,819	53,907	6,278,736	256	539,644	27,586	29,465	6,057,262
2021	868,820	824,443	57,204	6,278,104	261	547,253	27,613	29,508	5,891,906
2022	885,673	839,501	58,295	6,200,961	250	533,979	26,829	25,640	6,368,695
2023	902,244	840,913	59,142	6,216,125	219	542,527	27,024	29,676	6,988,968

[83] Although poultry is not included in the category "Enteric Fermentation," data on its numbers are provided, as they are further used in Section 5.3, "3.A.2 Manure Management."

The dynamics of livestock population change are presented in Figures 5.7–5.9.

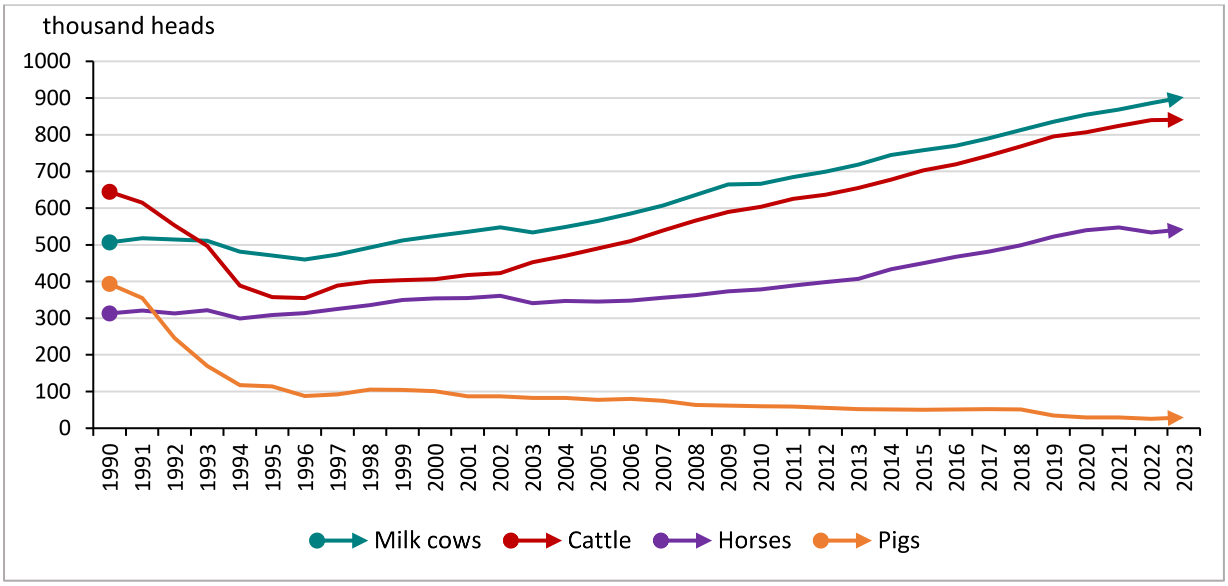

Figure 0.7. Dynamics of Dairy Cows, Cattle, Horses, and Pigs Population

Similar trends are observed for dairy cattle and horses on the one hand, and for non-dairy cattle and pigs on the other. This is explained by the fact that during the period from 1990 to 1995–1997, following the collapse of the USSR, the meat-oriented livestock population was actively reduced in order to sell meat due to the financial difficulties of rural households. At the same time, dairy cattle and horses were preserved as much as possible: dairy cows as a source of milk, and horses as a traditional measure of wealth and a particularly valuable and liquid asset. Starting from 1996–1997, the cattle and horse populations have been steadily increasing. The pig population, however, has been declining due to reduced demand for pork among the local population and decreased export volumes.

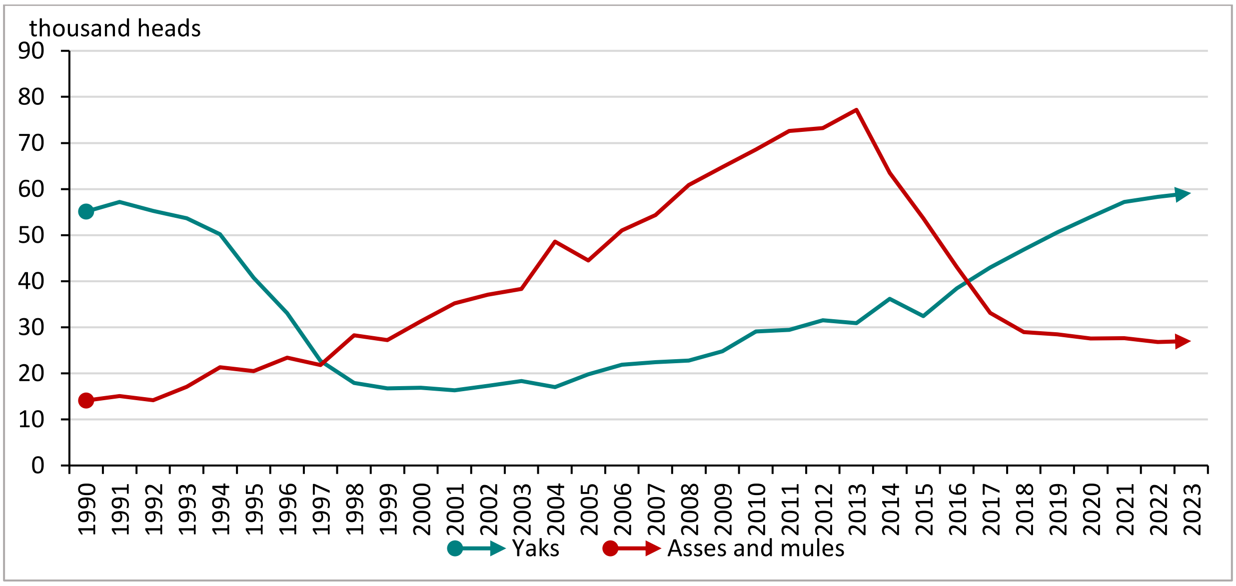

Figure 0.8. Dynamics of Yaks, Asses and Mules number.

The dynamics of yak, sheep, goat, and poultry populations are explained by the same trends as for meat-oriented cattle. The available information does not allow a reliable explanation of the changes in the donkey population.

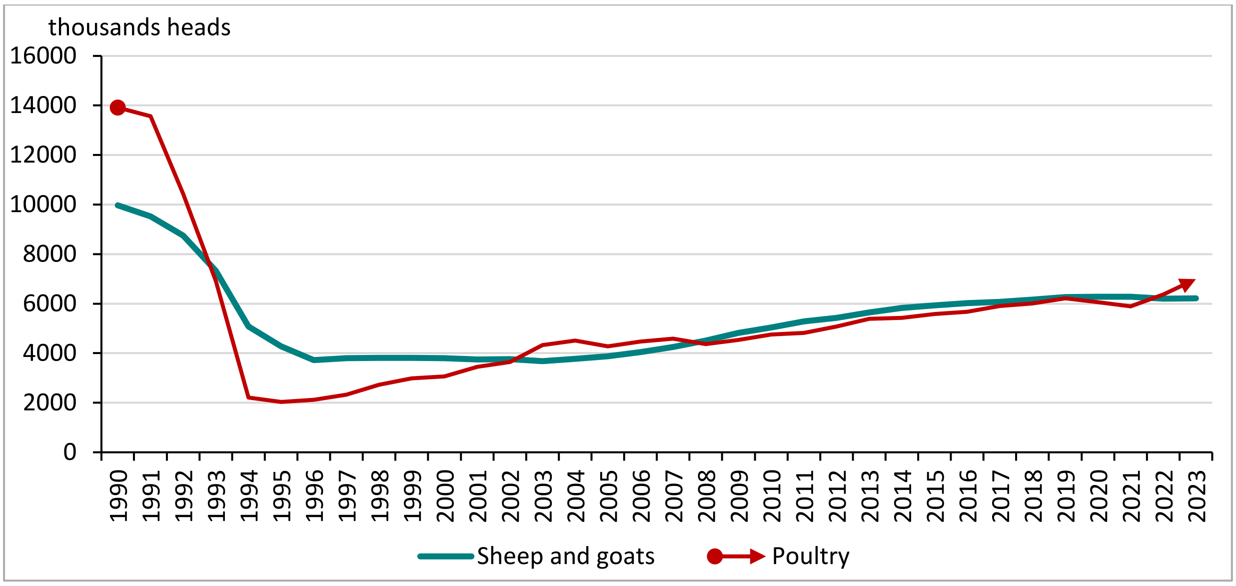

Figure 0.9. Dynamics of Sheep and Goats and Poultry Populations

Data on camels are not reflected in the figures presented, as their total population is extremely small.

5.2.2.1 Emission Factors and Parameters

Additional parameters were used in the calculations:

Table 0.9. Average Weight of Livestock and Poultry, kg

Period	Dairy cows	Non-dairy cattle	Yaks	Sheep and goats	Camels	Horses	Donkeys	Pigs	Poultry[24]
1990-2019	272	232	173	32	217	237	130	79	1.5
2020-2023	600	350	370	60	550	500	130	79	1.5

Data on the average live weight of animals for the period from 1990 to 2020 were approved by the interagency working group during the previous inventory. During the current inventory, in response to a request to clarify/revise the values of average live weight, the Kyrgyz Research Institute of Animal Husbandry and Pastures recommended using updated values starting from 2020.

For all livestock categories, except yaks, default emission factors recommended by the 2006 IPCC Guidelines were used. The emission factor for yaks was approved at a meeting of the Interagency Working Group (IWG) during the previous inventory for NC 4[84].

Table 0.10. Emission Factors for the Category "Enteric Fermentation"

Livestock category	Emission factor, kg CH_4/head/year	Source
Dairy cows	61	2006 IPCC Guidelines, Vol. 4, Ch. 10, Table 10.11
Non-dairy cattle	47	
Yaks	43	Approved by IWG, NC 4
Sheep and goats	5	2006 IPCC Guidelines, Vol. 4, Ch. 10, Table 10.10
Camels	46	

[84] Minutes of the BUR meeting, electronic archive of the NSC, MNRETSN, unpublished.

Livestock category	Emission factor, kg CH_4/head/year	Source
Horses	18	
Donkeys	10	
Pigs	1	
Poultry	-	

No revision of emission factors was carried out as part of the current inventory.

5.2.3. Uncertainties and Time Series Consistency

The uncertainty of activity data is estimated at 20% (2006 IPCC Guidelines, Vol. 4, Ch. 10, Section 10.2.3). The uncertainty of the 2006 IPCC emission factors for enteric fermentation is estimated at 30–50% (Vol. 4, Ch. 10, Section 10.3.3). A value of 50% was applied.

Activity data, emission factors, and the level of uncertainties described in Section 5.2.2 were used for complete time series covering the entire period from 1990 to 2023.

5.2.4. Quality Assurance and Quality Control

The quality control procedures for this category correspond to those presented in Table 6.1, Chapter 6, Volume 1 of the 2006 IPCC Guidelines. Particular attention was paid to checking the accuracy of data during their transfer into the calculation file.

The activity data were verified by the Agriculture sector compiler against data from the National Statistical Committee of the Kyrgyz Republic. The quality control procedures for this category correspond to those outlined in Table 6.1, Chapter 6, Volume 1 of the 2006 IPCC Guidelines.

5.2.5. Recalculations for the Category

A transition was made from the GWPs of the Second Assessment Report (SAR) to the GWPs of the Fifth Assessment Report (AR5). The recalculation was carried out for the sector as a whole. See Section 5.1, Figure 5.5 for details.

5.2.6. Planned Improvements

No improvements are planned for this category.

5.3 Category “Manure Management” (CRT 3.B.)

5.3.1. Category Description

The category “Manure Management” is a key source of N_2O emissions. This category accounts for CH_4 and N_2O emissions that arise directly from livestock and during the storage and use of manure, as well as indirect N_2O emissions from manure, for example, when excreted by animals on pastures. The term “manure” in this context includes both dung/manure and urine, i.e., both solid and liquid substances excreted by livestock. Emissions associated with the burning of manure as fuel (covered under the Energy sector) or burning without energy recovery (covered under the Waste sector) are not included in the Manure Management category.

CH_4 emissions are considered from the same types of domestic animals as in Section 5.2, as well as from poultry. Direct N_2O emissions occur as a result of manure collection, storage, and use. Indirect N_2O emissions are accounted for in category CRT 3.B.5 Indirect N_2O Emissions from Manure Management, which is addressed in Section 5.7.

Emissions from manure management make only a minor contribution to the total emissions of the sector (see Figure 5.3). Total emissions from the category are presented in Table 5.11, and the dynamics of emissions are shown in Figure 5.10.

Table 0.11. CH_4 Emissions from the Category "Manure Management" for the Period 1990–2023.

Year	kt CO_2e	Year	kt CO_2e	Year	kt CO_2e	Year	kt CO_2e
1990	350.68	**1999**	193.47	**2008**	233.14	**2017**	300.32
1991	339.65	**2000**	195.26	**2009**	244.55	**2018**	307.63
1992	307.75	**2001**	196.23	**2010**	255.64	**2019**	314.80
1993	269.00	**2002**	199.28	**2011**	259.36	**2020**	679.71
1994	206.94	**2003**	197.67	**2012**	265.17	**2021**	683.32
1995	189.73	**2004**	203.36	**2013**	273.40	**2022**	688.02
1996	177.31	**2005**	207.61	**2014**	282.71	**2023**	697.46
1997	184.03	**2006**	215.22	**2015**	288.72		
1998	189.69	**2007**	223.95	**2016**	294.16		

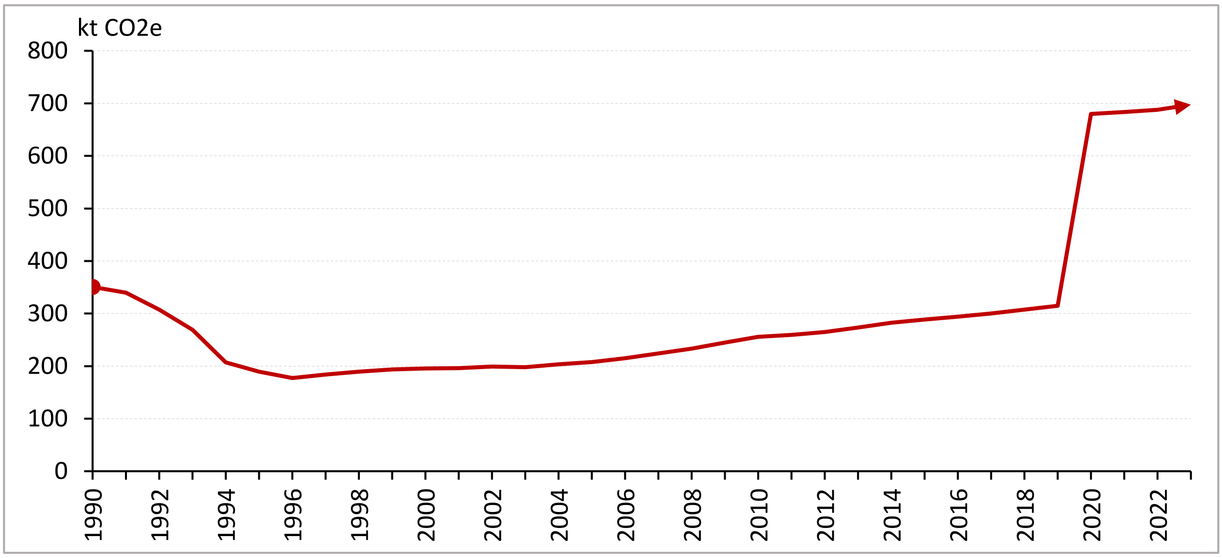

Figure 0.10. Dynamics of Emissions from the Category "Manure Management"

The sharp change in dynamics since 2020 is due to the revision of the parameter "average live weight of animals" (see Section 5.2.2, Table 5.9 for details).

5.3.2. Methodology

The estimation methodology is based on the 2006 IPCC Guidelines, Volume 4 "Agriculture, Forestry and Other Land Use", Chapter 10 "Livestock". A Tier 1 approach was applied.

- When assessing emissions, the 2006 IPCC Guidelines consider separately:
- CH_4 emissions from manure collection, storage, and use – Section 10.4;

Direct and indirect N_2O emissions from manure collection, storage, and use – Section 10.5.

5.3.2.1 Methane (CH_4) Emissions from Manure Collection, Storage, and Use

The main factors influencing CH_4 emissions are:

- the amount of manure produced, which depends on animal body mass, feeding characteristics, and metabolic rate;
- the proportion of manure that undergoes anaerobic decomposition.

The first factor depends on the waste production rate per animal and the number of animals, while the second depends on how manure is collected, stored, and used.

The Tier 1 method requires only livestock population data, broken down by species/categories of animals, climatic regions, or temperature conditions, combined with default IPCC emission factors. Since some emissions from manure collection, storage, and use systems are highly dependent on temperature, data on the average annual temperature in the areas where manure management occurs are required.

Equation 10.22

CH_4 Emissions from Manure Collection, Storage, and Use

$$CH_{4,\text{manure}} = \sum_{(T)} \frac{EF_{(T)} \cdot N_{(T)}}{10^6}$$

Where,

$CH_{4Manure}$ = CH_4 emissions from manure collection, storage, and use for the specified livestock population, kt CH_4/year,

$EF_{(T)}$ = emission factor for the specified livestock population, kg CH_4/head × year;

$N_{(T)}$ = number of heads of livestock species/category T in the country;

T = livestock species/category.

5.3.2.2 Nitrous Oxide (N_2O) Emissions from Manure Collection, Storage, and Use

5.3.2.2.1 Direct N_2O Emissions

To estimate N_2O emissions from manure collection, storage, and use, the Tier 1 method assumes multiplying the total amount of nitrogen excreted (by all livestock species/categories) in each type of manure management system by the emission factor for that type of system. The emissions are then summed across all such systems.

Equation 10.25

Direct N_2O Emissions from Manure Collection, Storage, and Use

$$N_2O_{D(mm)} = \left[\sum_{S}\sum_{T}\left(N_{(T)} \cdot Nex_{(T)} \cdot MS_{(T,S)}\right) \cdot EF3_{(S)}\right] \cdot \frac{44}{28}$$

Where,

$N_2O_{D(mm)}$ = direct N_2O emissions from manure collection, storage, and use in the country, kg N_2O/year;

$N_{(T)}$ = number of heads of livestock species/category T in the country;

$Nex_{(T)}$ = annual average nitrogen excretion per head of livestock species/category T in the country, kg N/animal × year;
MS(T,S) = fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless;
$EF_{3(S)}$ = emission factor for direct N_2O emissions from manure management system S in the country, kg N_2O–N/kg N in system S;
S = manure management system;
T = livestock species/category;
44/28 = conversion factor from $(N_2O\text{-}N)_{(mm)}$ to $N_2O_{(mm)}$.

5.3.2.2.2 Indirect N_2O Emissions

The Tier 1 method is based on multiplying the amount of nitrogen excreted (by all livestock species/categories) and managed in each manure management system by the fraction of nitrogen volatilized as NH_3 and NO_x. The equation is as follows:

Equation 10.26

Nitrogen Losses through Volatilization from Manure Collection, Storage, and Use

$$N_{\text{volatilization–MM}} = \sum_{S}\left[\sum_{T}\left(N_{(T)} \cdot Nex_{(T)} \cdot MS_{(T,S)}\right) \cdot \left(\frac{Frac_{gasMS}}{100}\right)_{(T,S)}\right]$$

Where,
$N_{\text{volatilization-MMS}}$ = amount of nitrogen lost from manure through volatilization of NH_3 and NO_x, kg N/year;
$N_{(T)}$ = number of heads of livestock species/category T in the country;
$Nex_{(T)}$ = annual average nitrogen excretion per head of livestock species/category T in the country, kg N/animal × year;
$MS_{(T,S)}$ = fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless;
$Frac_{gasMS}$ = percentage of nitrogen in managed manure of livestock category T that volatilizes as NH_3 and NO_x in manure management system S, %

Indirect N_2O emissions resulting from nitrogen volatilization in the form of NH_3 and NO_x ($N_2O_{G(mm)}$) are estimated using the following equation

Equation 10.27

Indirect N_2O Emissions Associated with Nitrogen Volatilization from Manure Collection, Storage, and Use

$$N_2O_{G(mm)} = \left(N_{\text{volatilization–MM}} \cdot EF_4\right) \cdot \frac{44}{28}$$

Where,
$N_2O_{G(mm)}$ = indirect N_2O emissions associated with nitrogen volatilization from manure collection, storage, and use in the country, kg N_2O/year;

EF_4 = emission factor for N_2O emissions resulting from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O–N/kg volatilized NH_3–N + NO_x–N. The default value is 0.01 kg N_2O–N/kg volatilized NH_3–N + NO_x–N, as provided in Table 11.3, Chapter 11, Volume 4.

Emission calculations were performed using the IPCC Inventory Software.

5.3.2.3 Activity Data

The livestock population and average animal weight data used are the same as for the category "Enteric Fermentation". The relevant data are presented in Tables 5.8 and 5.9 (Section 5.2).

5.3.2.4 Emission Factors and Parameters

The determining parameter for selecting emission factors is the definition of the geographic zone. Depending on the annual average temperature, different emission factors are selected for each livestock category. For the calculations, the following climatic zone values were applied:

- Climate: cold,
- Annual average temperature: ≤10°C.

The choice of these parameters was confirmed by an official letter from the Hydrometeorological Service under the Ministry of Emergency Situations of the Kyrgyz Republic.

For Kyrgyzstan, three manure management systems were identified as the most commonly used:

5.3.2.5 Direct N_2O Emissions

For livestock:

- *Pasture/range/paddock* – manure from animals grazing on pasture or range remains unmanaged and uncollected.
- *Dry lot* – manure is stored for a period of several months, typically in piles or stacks outside. Manure can be stacked due to the presence of sufficient bedding material or moisture loss through evaporation.

For poultry:

- *Poultry manure without litter* – similar to uncovered pits in enclosed livestock housing, or may be developed and used for drying manure as it accumulates. The latter system is known as a high-rise poultry housing system and represents a form of passive composting in compost windrows when properly designed and managed.

Data on the use of other manure management systems described in the 2006 IPCC Guidelines (Vol. 4, Ch. 10, Table 10.21) are not available for Kyrgyzstan. A recalculation was performed for the category "Poultry".

Table 0.12. Share of Manure Management System Types, % of year

Livestock category	1990-2020 yy.		2020-2023 yy.[25]		
	Pasture/Range/Paddock	Dry lot	Pasture/Range/Paddock	Dry lot	Poultry manure without litter
Dairy cows	60%	40%	0%	100%	0%
Non-dairy cattle	60%	40%	60%	40%	0%

Livestock category	1990-2020 yy.		2020-2023 yy.[25]		
	Pasture/Range/Paddock	Dry lot	Pasture/Range/Paddock	Dry lot	Poultry manure without litter
Yaks	100%	0%	100%	0%	0%
Sheep and goats	60%	40%	60%	40%	0%
Camels	60%	40%	100%	0%	0%
Horses	60%	40%	60%	40%	0%
Donkeys	60%	40%	60%	40%	0%
Pigs	0%	100%	0%	100%	0%
Poultry	0%	100%	0%	0%	100%

Table 0.13. Methane emission factors from manure management

Livestock category	Emission factor, kg CH_4/head/year	Source
Dairy cows	2	2006 IPCC Guidelines, Vol. 4, Ch. 10, Table 10.14
Non-dairy cattle	1	
Yaks	0.8	Approved by IWG, NC 4
Sheep and goats	0.1	2006 IPCC Guidelines, Vol. 4, Ch. 10, Table 10.15
Camels	1.28	
Horses	1.09	
Donkeys	0.6	
Pigs	1	
Poultry	0.01	

Table 0.14. Nitrogen Excretion Rates by Animal Live Weight

Livestock category	Emission factor, kg CH_4/head/year	Source
Dairy cows	0.47	2006 IPCC Guidelines, Vol. 4, Ch. 10, Table 10.19
Non-dairy cattle	0.34	
Yaks	0.34	
Sheep and goats	1.17	
Camels	0.46	
Horses	0.46	
Donkeys	0.46	
Pigs	0.42	
Poultry	0.82	

The default emission factor for direct N_2O emissions from manure collection, storage, and use for the selected manure management systems is (2006 IPCC Guidelines, Vol. 4, Ch. 10, Table 10.21):

- Dry lot – 0.005 kg N_2O–N per kg of N excreted;
- Poultry manure without litter – 0.001 kg N_2O–N per kg of N excreted.

5.3.2.6 Indirect N_2O Emissions

The default emission factor for volatilization and leaching leading to indirect N_2O emissions from soils is 0.01 (2006 IPCC Guidelines, Vol. 4, Ch. 11, Table 11.3).

Table 0.15. Nitrogen Loss Factor through Volatilization of NH_3 and NO_x

Livestock category	Loss factor, %	Source
Dairy cows	30%	2006 IPCC Guidelines, Vol. 4, Ch. 10, Table 10.22
Non-dairy cattle	45%	
Yaks	-	
Sheep and goats	12%	
Camels	12%	
Horses	12%	
Donkeys	12%	
Pigs	45%	
Poultry	55%	

5.3.3. Uncertainties and Time Series Consistency

The uncertainty of activity data is estimated at 20% (2006 IPCC Guidelines, Vol. 4, Ch. 10, Section 10.2.3).

The uncertainty of data on manure management systems is estimated by the 2006 IPCC Guidelines at 25–50%. For the assessment, a value of 50% was applied.

The uncertainty of default CH_4 and N_2O emission factors is estimated at 30% for Tier 1 (2006 IPCC Guidelines, Vol. 4, Ch. 10, Section 10.4.4).

The activity data, emission factors, and uncertainty values described in Section 5.3.2 were used for complete time series for the entire period considered, from 1990 to 2023.

5.3.4. Quality Assurance and Quality Control

The QA/QC procedures for this category correspond to those presented in Table 6.1, Chapter 6, Volume 1 of the 2006 IPCC Guidelines. Particular attention was paid to checking the data during their transfer into the calculation file.

The activity data were verified by the Agriculture sector compiler against data from the National Statistical Committee of the Kyrgyz Republic. The QA/QC procedures for this category correspond to those outlined in Table 6.1, Chapter 6, Volume 1 of the 2006 IPCC Guidelines.

5.3.5. Recalculations for the Category

A transition was made from the GWPs of the IPCC Second Assessment Report (SAR) to those of the IPCC Fifth Assessment Report (AR5). The recalculation was carried out for the sector as a whole. See Section 5.1, Figure 5.5 for details.

All changes and corrections were introduced into the database, and emissions for the category were recalculated. The recalculation results are presented in Table 5.16 and in Figure 5.11.

Table 0.16. Results of Recalculation of Emission Estimates for the Category “Manure Management”

Year	NC 4 - SAR	NIR 1 - AR 5	Difference %	Year	NC 4 - SAR	NIR 1 - AR 5	Difference %
1990	368.65	350.68	-4.88	**2006**	220.78	215.22	-2.5
1991	344.24	339.65	-1.33	**2007**	229.80	223.95	-2.5
1992	322.39	307.75	-4.54	**2008**	239.29	233.14	-2.6

Year	NC 4 - SAR	NIR 1 - AR 5	Difference %	Year	NC 4 - SAR	NIR 1 - AR 5	Difference %
1993	280.65	269.00	-4.15	**2009**	251.15	244.55	-2.6
1994	214.13	206.94	-3.36	**2010**	257.44	255.64	-0.7
1995	195.59	189.73	-2.99	**2011**	266.71	259.36	-2.8
1996	182.29	177.31	-2.73	**2012**	272.73	265.17	-2.8
1997	189.22	184.03	-2.74	**2013**	281.30	273.40	-2.8
1998	194.62	189.69	-2.53	**2014**	290.82	282.71	-2.8
1999	192.62	193.47	0.44	**2015**	297.01	288.72	-2.8
2000	200.40	195.26	-2.56	**2016**	302.56	294.16	-2.8
2001	201.28	196.23	-2.51	**2017**	308.75	300.32	-2.7
2002	204.35	199.28	-2.48	**2018**	316.14	307.63	-2.7
2003	202.75	197.67	-2.51	**2019**	323.39	314.80	-2.7
2004	208.59	203.36	-2.51	**2020**	332.72	679.71	104.3
2005	212.92	207.61	-2.49				

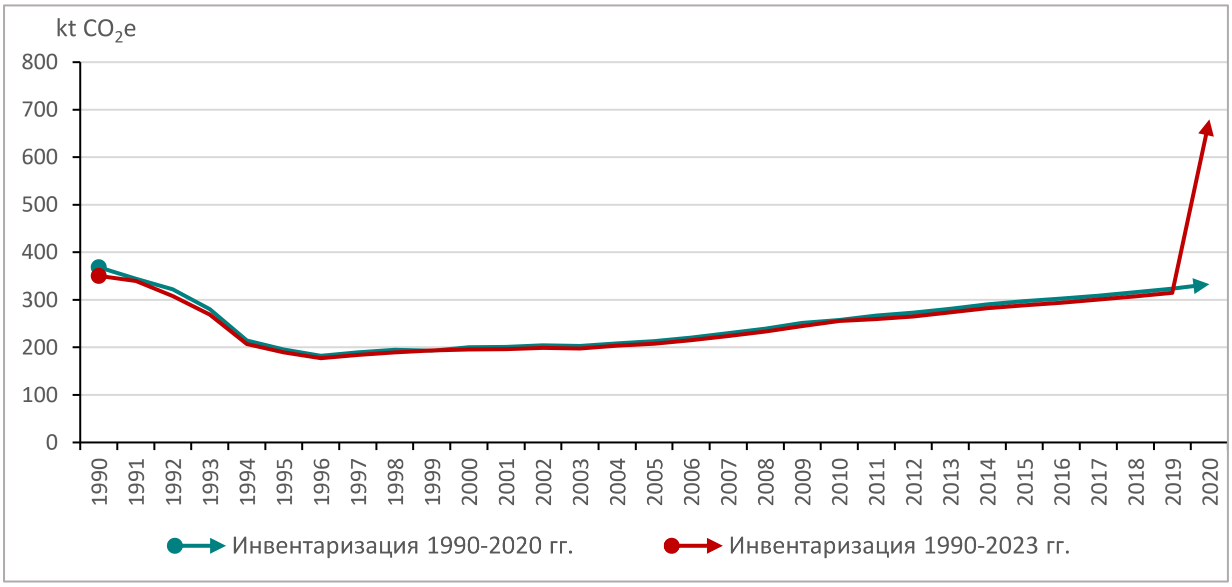

Figure 0.11. Results of Recalculation of Emissions for the Category "Manure Management" for the Period 1990–2020.

5.3.6. Planned Improvements

No improvements are planned for this category.

5.4. Category "Rice Cultivation" (CRT 3.C.)

5.4.1. Category Description

This category accounts for methane (CH_4) emissions resulting from anaerobic decomposition of organic matter in flooded rice fields.

Methane emissions from rice cultivation are presented in Table 5.17 and in Figure 5.12. Overall, a steady increase is observed for this category.

Table 0.17. CH_4 Emissions from Rice Cultivation

Year	Kt CO2e	Year	Kt CO2e	Year	Kt CO2e	Year	Kt CO2e
1990	7.45	**1999**	36.34	**2008**	36.07	**2017**	64.12
1991	10.49	**2000**	38.42	**2009**	37.61	**2018**	67.96
1992	11.23	**2001**	33.66	**2010**	39.42	**2019**	67.66
1993	14.66	**2002**	40.62	**2011**	38.65	**2020**	71.44
1994	18.16	**2003**	37.28	**2012**	43.48	**2021**	74.59
1995	26.77	**2004**	36.94	**2013**	47.31	**2022**	69.69
1996	32.12	**2005**	35.12	**2014**	48.61	**2023**	70.62
1997	36.48	**2006**	37.99	**2015**	51.54		
1998	32.74	**2007**	36.91	**2016**	59.29		

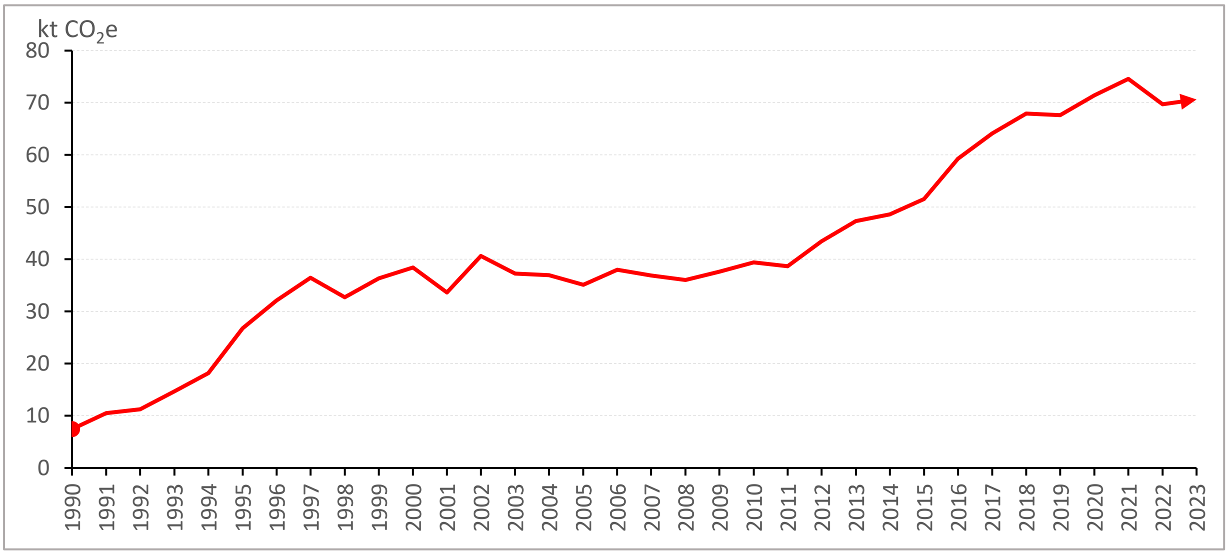

Table 0.18. Dynamics of CH_4 Emissions from Rice Cultivation

The increase in emissions from rice cultivation is most likely explained by the growing demand for rice as a food product.

5.4.2. Methodology

The category "Rice Cultivation" is not a key category. The estimation methodology is presented in the 2006 IPCC Guidelines, Vol. 4, Chapter 5, Section 5.5. Since national emission factors are not available in Kyrgyzstan, a Tier 1 approach was applied.

Tier 1 uses national data on rice cultivation areas and on the water regime during cultivation. The latter includes the type of ecosystem and the flooding pattern. The main equation for estimation is:

Equation 5.1

Methane Emissions from Rice Cultivation

$$CH_{4,rice} = \sum_{i,j,k} \left(EF_{i,j,k} \cdot t_{i,j,k} \cdot A_{i,j,k} \cdot 10^{-6} \right)$$

Where,

$CH_{4\ Рис}$ = annual methane emissions from rice cultivation, kt CH_4/year

EF_{ijk} = daily emission factor for conditions i, j, and k, kg CH_4/ha × day
t_{ijk} = cultivation period of rice under conditions i, j, and k, days
A_{ijk} = annual harvested area of rice under conditions i, j, and k, ha/year
i, j и k = represent different ecosystems, water regimes, type and amount of organic amendments, and other conditions affecting CH_4 emissions from rice production

The daily emission factor is calculated using the following equation:

Equation 5.2

Adjusted Daily Emission Factor

$$EF_i = EF_c \cdot SF_w \cdot SF_p \cdot SF_o \cdot SF_{s,r}$$

Where,
EF_i = adjusted daily emission factor for a specific harvested area
EF_c = baseline emission factor for continuously flooded fields without organic amendments
SF_w = scaling factor to account for differences in water regimes during the cultivation period (from Table 5.12, 2006 IPCC Guidelines, Vol. 4, Ch. 5)
SF_p = scaling factor to account for differences in water regime prior to the cultivation period, before the growing season (from Table 5.13, 2006 IPCC Guidelines, Vol. 4, Ch. 5)
SF_o = scaling factor that varies according to the type and amount of organic amendment applied (from Equation 5.3 and Table 5.14, 2006 IPCC Guidelines, Vol. 4, Ch. 5)
$SF_{s,r}$ = scaling factor for soil type, rice cultivar, etc., if data are available.

The scaling factor SF_0 is calculated using the following equation:

Equation 5.3

Adjusted Scaling Factors for CH_4 Emissions from Organic Amendments

$$SF_o = \left(1 + \sum_i ROA_i \cdot CFOA_i\right)^{0.59}$$

Where:
SF_o = scaling factor for both the type and amount of organic amendment applied
ROA_i = application rate of organic amendment i, expressed as dry matter for straw and as fresh weight for other organic amendments, t/ha
$CFOA_i$ = conversion factor for organic amendment i (in terms of relative effect compared to straw applied shortly before cultivation), as given in Table 5.14, 2006 IPCC Guidelines, Vol. 4, Ch. 5.

5.4.2.1 Activity Data

Data on rice cultivation areas are provided by the National Statistical Committee[85] and are presented below in Table 5.19. The dynamics of rice cultivation area for the period 1990–2023 are shown in Figure 5.12.

[85] NSC website, section Statistics/Agriculture, subsection Dynamic Tables, table 1.05.02.06

Table 0.19. Rice Cultivation Area

Year	Rice cultivation area, ha	Year	Rice cultivation area, ha	Year	Rice cultivation area, ha	Year	Rice cultivation area, ha
1990	1,245	**1999**	6,072	**2008**	6,026	**2017**	10,713
1991	1,753	**2000**	6,419	**2009**	6,284	**2018**	11,355
1992	1,877	**2001**	5,624	**2010**	6,586	**2019**	11,304
1993	2,450	**2002**	6,786	**2011**	6,457	**2020**	11,936
1994	3,034	**2003**	6,229	**2012**	7,264	**2021**	12,462
1995	4,473	**2004**	6,172	**2013**	7,904	**2022**	11,644
1996	5,366	**2005**	5,868	**2014**	8,122	**2023**	11,799
1997	6,095	**2006**	6,347	**2015**	8,611		
1998	5,470	**2007**	6,167	**2016**	9,906		

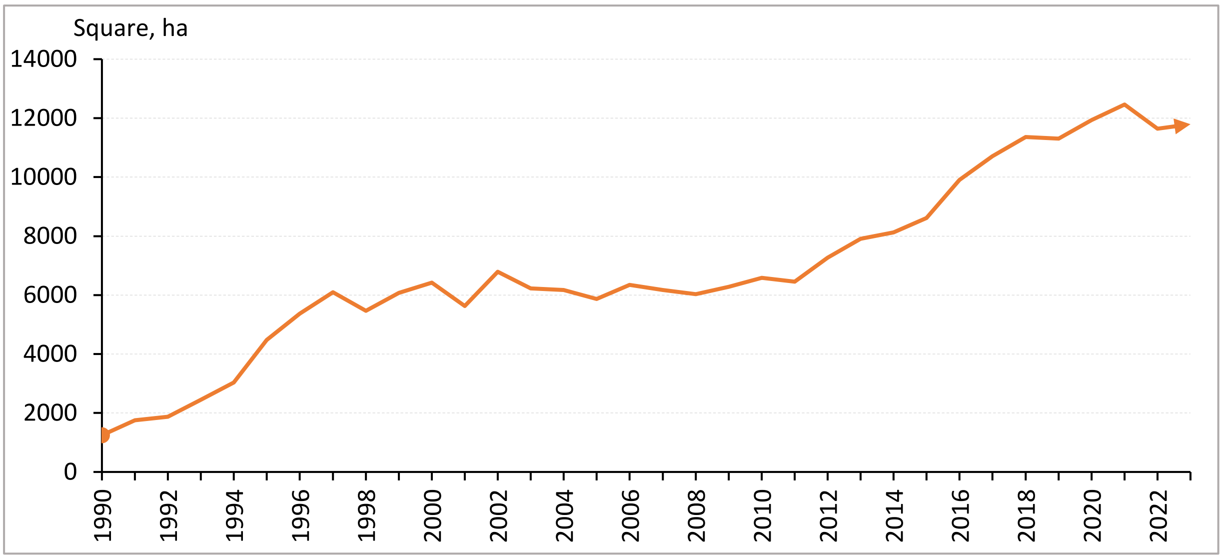

Figure 0.12. Dynamics of Rice Cultivation Area for the Period 1990–2023.

5.4.2.1 Emission Factors and Parameters

For the calculations, the default emission factors recommended in the 2006 IPCC Guidelines were used (see Table 5.20).

Table 0.20. Emission Factors and Parameters for Estimating CH_4 Emissions from Rice Cultivation

Description	Designation	Value	Source
Ecosystem type	-	Irrigated	Approved by BUR inventory 1990–2020[86]
Water regime	-	Continuously flooded	
Rice cultivation period	t	110	
Emissions CH_4 (kg CH_4/ha x day)		1.3	IPCC 2006, Volume 4, Chapter 5, Table 5.11
Scaling factor for water regime	SF_w	1	IPCC 2006, Volume 4, Chapter 5, Table 5.12

[86] Minutes of the BUR meeting, electronic archive of NC 4, MNRETSN, unpublished.

Description	Designation	Value	Source
Scaling factor for CH4 emissions for the water regime before the rice cultivation period	SF_p	0.68	IPCC 2006, Volume 4, Chapter 5, Table 5.13
Application rate of organic fertilizer i, in dry matter for straw and fresh weight for other organic fertilizers, tons/ha	ROA_i	20	Approved by BUR inventory 1990–2020
Conversion factor for organic fertilizer	$CFOA_i$	0.14	IPCC 2006, Volume 4, Chapter 5, Table 5.14
Scaling factor for soil type, rice variety	$SF_{s,r}$	1	Approved by BUR inventory 1990–2020

5.4.3. Uncertainties and Consistency of Time Series

The default emission factor uncertainty for the category "Rice Cultivation" as a whole is not provided in the IPCC 2006 Guidelines. However, the default coefficient tables indicate uncertainty ranges for each recommended value. Based on these data, the uncertainty can be determined in the range of 30–50%. For the assessment, the upper value of 50% was used, applying a conservative approach.

The activity data uncertainty for this category is also not provided in the IPCC Guidelines. Therefore, based on the fact that the primary data come from a single source (the National Statistical Committee), the uncertainty range was assessed similarly to other categories, within 10–20%. For the assessment, the upper value of 20% was used.

The activity data, emission factors, and uncertainty values described in Section 5.4.2 were used for the complete time series for the entire period from 1990 to 2023.

5.4.4. Quality Assurance and Quality Control

Quality control procedures for the category correspond to those presented in Table 6.1 of Chapter 6, Volume 1 of the IPCC 2006 Guidelines. The main focus was on verifying the data during their transfer into the calculation file.

The activity data were verified by the Agriculture sector compiler using the data of the National Statistical Committee of the Kyrgyz Republic. Quality control procedures for the category correspond to those presented in Table 6.1 of Chapter 6, Volume 1 of the IPCC 2006 Guidelines.

5.4.5. Category Recalculations

A transition was made from GWP in SAR to GWP in AR5 of the IPCC. The recalculation was carried out for the sector as a whole. For details, see Section 5.1, Figure 5.5.

5.4.6. Planned Improvements

No improvements are planned for the category.

5.5. Category “Agricultural Soils” (CRT 3.D.)

5.5.1. Category Description

This category accounts for N_2O emissions from soils resulting from the use of nitrogen-containing fertilizers in various forms:

- synthetic nitrogen fertilizers (FSN)
- organic fertilizers (FA)
- manure deposited by grazing animals on pastures and paddocks (FPRP)
- decomposition of crop residues left on fields (FCR)

The category “Agricultural Soils” is divided into two subcategories:

- 3.D.1. Direct N_2O emissions from managed soils;
- 3.D.2. Indirect N_2O emissions from managed soils.

The total emissions from the categories for the period 1990–2023 are presented in Table 5.21 and Figure 5.13.

Table 0.21. N_2O Emissions from Subcategories of the “Agricultural Soils” Category

Year	3.D.1. Direct N_2O emissions from managed soils	3.D.2 Indirect N_2O emissions from managed soils	TOTAL kt CO_2e	Year	3.D.1. Direct N_2O emissions from managed soils	3.D.2 Indirect N_2O emissions from managed soils	TOTAL kt CO_2e
1990	1,669.60	371.70	2,041.31	**2007**	481.96	139.40	621.36
1991	1,862.86	415.72	2,278.58	**2008**	547.18	155.57	702.74
1992	1,643.78	366.64	2,010.42	**2009**	540.15	155.72	695.87
1993	449.57	143.11	592.68	**2010**	527.64	153.95	681.59
1994	348.91	109.52	458.43	**2011**	599.05	171.52	770.57
1995	265.55	87.34	352.89	**2012**	582.65	168.67	751.32
1996	296.26	91.99	388.25	**2013**	578.16	168.91	747.08
1997	505.76	140.26	646.02	**2014**	663.10	189.44	852.54
1998	453.87	129.04	582.91	**2015**	657.47	188.95	846.42
1999	452.03	129.00	581.03	**2016**	662.23	190.73	852.96
2000	464.83	132.07	596.90	**2017**	722.12	204.96	927.08
2001	460.57	131.08	591.65	**2018**	688.79	198.27	887.06
2002	461.84	131.70	593.54	**2019**	742.04	211.29	953.33
2003	462.51	131.41	593.91	**2020**	736.17	297.31	1,033.48
2004	462.93	132.26	595.19	**2021**	810.19	295.16	1,105.35
2005	471.81	134.80	606.61	**2022**	733.90	278.05	1,011.95
2006	493.15	140.69	633.84	**2023**	876.29	311.42	1,187.71

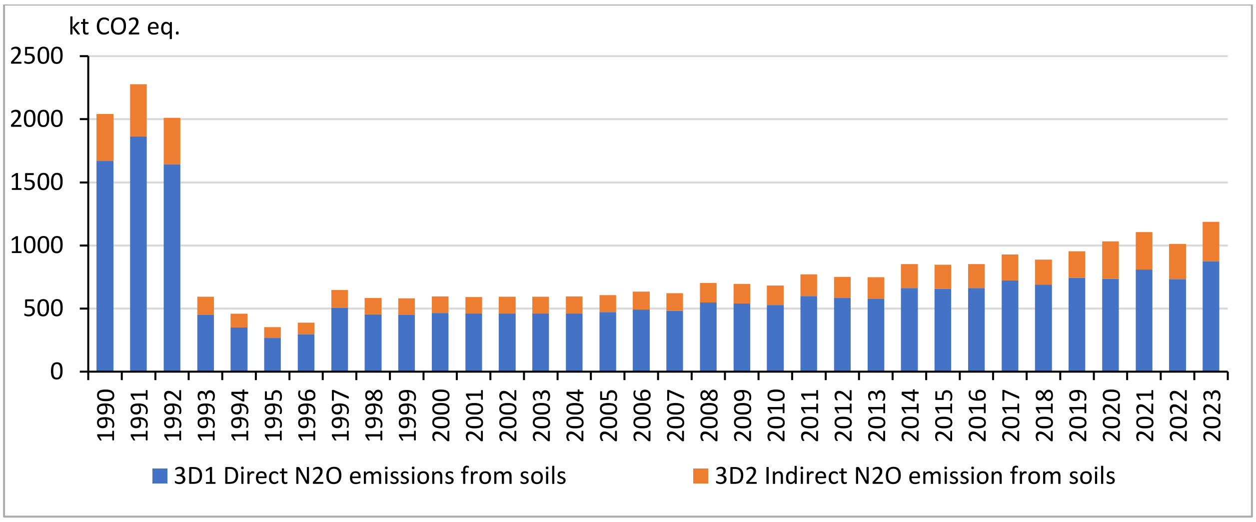

Figure 0.13. Dynamics of N_2O emissions from the categories "Direct N_2O emissions from managed soils" and "Indirect N_2O emissions from managed soils" for the period 1990–2023

The emission trend for the category fully reflects the general trends observed in other sectors, related to economic processes resulting from the collapse of the USSR and the subsequent gradual recovery of the national economy starting from 1995–1997.

5.5.2. Methodology

N_2O emissions from cultivated soils, both direct and indirect, are key categories for the Kyrgyz Republic. However, since national emission factors and parameters for the category "Agricultural Soils" have not yet been developed, the IPCC 2006 Tier 1 methodology (Volume 4, Chapter 11) was applied for calculating direct and indirect N_2O emissions.

5.5.2.1 Subcategory 3.D.1 "Direct N_2O emissions from managed soils"

Nitrous oxide emissions from cultivated soils are estimated according to the following equation:

Equation 11.1

Direct N_2O emissions from managed soils (Tier 1)

$$N_2O_{Прям.}\text{–}N = N_2O\text{–}N_{N\,поступл.} + N_2O\text{–}N_{OS} + N_2O\text{–}N_{PRP}$$

где:

$$N_2O\text{–}N_{N\,поступл.} = \begin{bmatrix} \left[(F_{SN} + F_{ON} + F_{CR} + F_{SOM}) \bullet EF_1\right] + \\ \left[(F_{SN} + F_{ON} + F_{CR} + F_{SOM})_{FR} \bullet EF_{1FR}\right] \end{bmatrix}$$

$$N_2O\text{–}N_{OS} = \begin{bmatrix} (F_{OS,CG,Temp} \bullet EF_{2CG,Temp}) + (F_{OS,CG,Trop} \bullet EF_{2CG,Trop}) + \\ (F_{OS,F,Temp,NR} \bullet EF_{2F,Temp,NR}) + (F_{OS,F,Temp,NP} \bullet EF_{2F,Temp,NP}) + \\ (F_{OS,F,Trop} \bullet EF_{2F,Trop}) \end{bmatrix}$$

$$N_2O\text{–}N_{PRP} = \left[(F_{PRP,CPP} \bullet EF_{3PRP,CPP}) + (F_{PRP,SO} \bullet EF_{3PRP,SO})\right]$$

Where,

$N_2O_{Прям.}$ –N = annual direct N_2O–N emissions from cultivated soils, kg N_2O–N/year;

N_2O –$N_{Nпоступл.}$ = annual direct N_2O–N emissions resulting from nitrogen inputs to cultivated soils, kg N_2O–N/year;

N_2O-N_{OS} = annual direct N_2O–N emissions from cultivated organic soils, kg N_2O–N/year;
N_2O-N_{PRP} = annual direct N_2O–N emissions resulting from inputs of urine and dung to soils under grazing, kg N_2O–N/year;
F_{SN} = annual amount of synthetic nitrogen fertilizers applied to soils, kg N/year,
F_{ON} = annual amount of manure, compost, sewage sludge and other organic nitrogen additions applied to soils (note: when including sewage sludge, a cross-check with the Waste sector must be carried out to avoid double-counting of N_2O emissions), kg N/year;
F_{CR} = annual amount of nitrogen in crop residues (above-ground and below-ground), including from nitrogen-fixing crops and from renewal/restoration of forage crops/pastures, returned to soils, kg N/year;
F_{SOM} = annual amount of nitrogen in mineral soils that mineralizes due to soil carbon loss from soil organic matter as a result of land-use or management change, kg N/year;
F_{OS} = annual area of cultivated/drained organic soils, ha (note: subscripts CG, F, Temp, Trop, NR and NP refer respectively to croplands and pastures, forest land, temperate zones, tropical zones, nutrient-rich and nutrient-poor conditions);
F_{PRP}= annual amount of nitrogen in urine and dung deposited on pasture, range and paddock by grazing animals, kg N/year (note: subscripts CPP and SO refer respectively to cattle, poultry and swine (CPP), and sheep and other animals (SO));
EF_1 = emission factor for N_2O emissions from nitrogen inputs, kg N_2O–N/kg N input (IPCC 2006, Vol. 4, Ch. 11, Table 11.1);
EF_{1FR} = emission factor for N_2O emissions from nitrogen inputs to irrigated rice, kg N_2O–N/kg N input (IPCC 2006, Vol. 4, Ch. 11, Table 11.1);
EF_2 = emission factor for N_2O emissions from drained/cultivated organic soils, kg N_2O–N/ha × year (IPCC 2006, Vol. 4, Ch. 11, Table 11.1) (note: subscripts CG, F, Temp, Trop, NR and NP refer respectively to croplands and pastures, forest land, temperate zones, tropical zones, nutrient-rich and nutrient-poor conditions);
EF_{3PRP} = emission factor for N_2O emissions from nitrogen in urine and dung deposited on pasture, range and paddock by grazing animals, kg N_2O–N/kg N input (IPCC 2006, Vol. 4, Ch. 11, Table 11.1) (note: subscripts CPP and SO refer respectively to cattle, poultry and swine (CPP), and sheep and other animals (SO));

5.5.2.2 Subcategory 3.D.2. “Indirect N_2O emissions from managed soils”

Volatilization of N_2O due to atmospheric deposition of nitrogen volatilized from cultivated soils is estimated using the equation:

Equation 11.9

N_2O emissions from atmospheric deposition of nitrogen volatilized from managed soils (Tier 1)

$$N_2O_{(ATD)}-N = [(F_{SN} \bullet Frac_{GASF}) + ((F_{ON} + F_{PRP}) \bullet Frac_{GASM})] \bullet EF_4$$

Where,
$N_2O_{(ATD)}$–N = annual amount of N_2O–N formed as a result of atmospheric deposition of nitrogen volatilized from cultivated soils, kg N_2O–N/year;
F_{SN} = annual amount of synthetic fertilizer nitrogen applied to soils, kg N/year;

$Frac_{GASF}$ = fraction of applied synthetic fertilizer nitrogen that volatilizes as NH_3 and NO_x, kg volatilized N/kg applied N (Table 11.3, Vol. 4, Ch. 11);

F_{ON} = annual amount of nitrogen in properly prepared and applied manure, compost, sewage sludge, and other organic nitrogen additions, kg N/year;

F_{PRP} = annual amount of nitrogen in urine and dung deposited on pasture, range and paddock by grazing animals, kg N/year;

$Frac_{GASM}$ = fraction of applied organic nitrogen fertilizers (FON), as well as nitrogen in urine and dung deposited by grazing animals (FPRP), that volatilizes as NH_3 and NO_x, kg volatilized N/kg applied or deposited N (Table 11.3, Vol. 4, Ch. 11);

EF_4 = emission factor for N_2O emissions resulting from atmospheric deposition of nitrogen on soils and water surfaces, kg $N–N_2O$/kg volatilized $NH_3–N + NO_x–N$ (Table 11.3, Vol. 4, Ch. 11);

Conversion of N_2O(ATD)–N emissions into N_2O emissions for reporting purposes is carried out using the following equation:

$$N_2O_{(ATD)} = N_2O_{(ATD)} –N \bullet 44/28$$

Leaching and runoff of N_2O in regions where such processes occur are estimated using the equation:

Equation 11.10

N_2O emissions from leaching and runoff of nitrogen from managed soils in regions where leaching and runoff occur (Tier 1)

$$N_2O_{(L)}–N = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) \bullet Frac_{LEACH-(H)} \bullet EF_5$$

Where,

$N_2O_{(L)}$–N = annual amount of N_2O–N formed as a result of leaching and runoff of nitrogen inputs in cultivated soils in regions where leaching and runoff occur, kg N_2O–N/year;

F_{SN} = annual amount of nitrogen from synthetic fertilizers applied to soils in regions where leaching and runoff occur, kg N/year,

F_{ON} = annual amount of nitrogen in properly prepared and applied manure, compost, sewage sludge, and other organic nitrogen additions, in regions where leaching and runoff occur, kg N/year;

F_{PRP} = annual amount of nitrogen in urine and dung deposited by grazing animals in regions where leaching and runoff occur, kg N/year (from Equation 11.5, IPCC 2006, Vol. 4, Ch. 11);

F_{CR} = annual amount of nitrogen returned to soils in crop residues (above-ground and below-ground), including from nitrogen-fixing crops and from renewal/restoration of forage crops and pastures, in regions where leaching and runoff occur, kg N/year;

F_{SOM} = annual amount of nitrogen mineralized in mineral soils due to soil carbon loss from soil organic matter as a result of land-use or management change, in regions where leaching and runoff occur, kg N/year (from Equation 11.8, IPCC 2006, Vol. 4, Ch. 11);

$Frac_{LEACH-(H)}$ =fraction of all nitrogen added to cultivated soils or mineralized in cultivated soils that is lost through leaching and runoff in regions where leaching and runoff occur, kg N/kg N input (Table 11.3, IPCC 2006, Vol. 4, Ch. 11);

EF_5 = emission factor for N_2O emissions from nitrogen leaching and runoff, kg N_2O–N/kg N leached (Table 11.3, IPCC 2006, Vol. 4, Ch. 11);

Conversion of $N_2O(L)$–N emissions into N_2O emissions for reporting purposes is carried out using the following equation:

$$N_2O_{(L)} = N_2O_{(L)}–N \bullet 44/28$$

5.5.2.3 Activity Data

5.5.2.3.1 Direct N_2O emissions from managed soils 3.D.1.

For calculations, data on nitrogen fertilizer imports and exports for the period 2020–2023 were provided by the National Statistical Committee. Data for 1990–2020 were taken from the materials of the previous 1990–2020 inventory, while data on fertilizer application for 2021–2023 were taken from the National Statistical Committee.

Table 0.22. Annual amount of synthetic fertilizers in terms of kg of nitrogen (N) applied to soils with fertilizers for the period 1990–2023

Year	kg N			Year	kg N		
	Total= Import-export	Applied to rice	Other crops		Total= Import-export	Applied to rice	Other crops
1990	273,500,000	2,735,000	270,765,000	**2007**	80,300,000	803,000	79,497,000
1991	324,800,000	3,248,000	321,552,000	**2008**	94,400,000	944,000	93,456,000
1992	282,700,000	2,827,000	279,873,000	**2009**	90,600,000	906,000	89,694,000
1993	59,200,000	592,000	58,608,000	**2010**	86,300,000	863,000	85,437,000
1994	47,800,000	478,000	47,322,000	**2011**	101,900,000	1,019,000	100,881,000
1995	31,600,000	316,000	31,284,000	**2012**	96,900,000	969,000	95,931,000
1996	41,800,000	418,000	41,382,000	**2013**	94,300,000	943,000	93,357,000
1997	91,500,000	915,000	90,585,000	**2014**	113,300,000	1,133,000	112,167,000
1998	78,300,000	783,000	77,517,000	**2015**	111,000,000	1,110,000	109,890,000
1999	77,400,000	774,000	76,626,000	**2016**	111,300,000	1,113,000	110,187,000
2000	80,300,000	803,000	79,497,000	**2017**	125,000,000	1,250,000	123,750,000
2001	79,300,000	793,000	78,507,000	**2018**	115,900,000	1,159,000	114,741,000
2002	79,200,000	792,000	78,408,000	**2019**	127,659,000	1,289,483.6	126,369,516
2003	79,900,000	799,000	79,101,000	**2020**	47,682,502	2,148,480	45,534,022
2004	79,100,000	791,000	78,309,000	**2021**	64,349,077	2,243,160	62,105,917
2005	80,600,000	806,000	79,794,000	**2022**	45,738,950	2,095,920	43,643,030
2006	84,500,000	845,000	83,655,000	**2023**	78,400,453	2,123,820	76,276,633

Data on rice cultivation areas were presented earlier in Table 5.17, Section 5.4.2.

5.5.2.3.2 Indirect N_2O emissions from managed soils 3.D.2.

The same activity data are used as for subcategory “3.D.1. Direct N_2O emissions from managed soils.”

5.5.2.4 Emission Factors and Parameters

5.5.2.4.1 Direct N_2O emissions from managed soils 3.D.1.

In the absence of a national coefficient, the nitrogen application rate for rice in China – 180 kg N/ha – was used.[87].

Default emission factors from the IPCC 2006 Guidelines for estimating N_2O emissions from cultivated soils (Vol. 4, Ch. 11, Table 11.1):

- For flooded rice fields – 0.003 kg N_2O–N / kg N,
- For others – 0.01 kg N_2O–N / kg N.

Default emission factors for total nitrogen (N) losses from manure management, storage, and application systems for the systems "Dry storage" and "Poultry without litter" are presented in Table 5.23.

Table 0.23. Default emission factors for total N losses from manure management, storage, and application systems

Livestock Category	Nitrogen Loss Factor, %	Source
Dairy cattle	40%	2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.23
Non-dairy cattle	50%	
Sheep and goats	15%	
Camels	15%	
Horses	15%	
Asses	15%	
Swine	50%	
Poultry	55%	

5.5.2.4.1 Indirect N_2O emissions from managed soils (3.D.2.)

Default emission factors and parameters used are taken from the 2006 IPCC Guidelines (Volume 4, Chapter 11, Table 11.3).

Default Emission, Volatilization and Leaching Factors for Indirect N_2O Emissions from Soils

Coefficient	Default Value	Uncertainty Range
EF_4 [Volatilization and redeposition of nitrogen], kg N_2O–N / (kg volatilized NH_3–N + NO_x–N)[22]	0.010	0.002 – 0.05
EF_5 [Leaching/runoff], kg N_2O–N / (kg N leached/runoff)[23]	0.0075	0.0005 – 0.025
FracGASF [Fraction of synthetic fertilizer N volatilized], (kg NH_3–N + NO_x–N) / (kg applied N)	0.10	0.003 – 0.3
FracGASM [Fraction of all applied organic N fertilizers, as well as N excreted by grazing animals, that is volatilized], (kg NH_3–N + NO_x–N) / (kg applied or excreted N)	0.20	0.05 – 0.
FracLEACH (H) [Fraction of N lost through leaching/runoff for regions where leaching/runoff occurs in humid climates] – (≡ PE for that period) × water-holding capacity of soils, or in regions (except humid climates) where irrigation is applied], (kg N lost as leaching/runoff) / (kg of applied N, including N excreted by grazing animals)	0.30	0.1 – 0.8

The use of the previous term *FracLEACH (H)* has been modified in such a way that it is now applicable only to regions where the water-holding capacity of the soil is exceeded as a result of rainfall or irrigation (excluding drip irrigation) and leaching/runoff of water occurs. This term has been redefined as *FracLEACH (H)*. In the above definition of

[87] National Library of Medicine website https://pmc.ncbi.nlm.nih.gov/articles/PMC9318169/

FracLEACH (H), PE represents potential evapotranspiration, and the rainy season may be considered as periods when precipitation is more than 0.5 (evaporation in the evapoparameter). (Explanations of the terms "potential evapotranspiration" and "evaporation in the evapoparameter" can be found in standard literature on meteorology and agricultural sciences). For other regions, the default value of *FracLEACH (H)* is assumed to be zero.

Figure 0.14. Snapshot of Table 11.3 from the 2006 IPCC Guidelines

5.5.3. Uncertainties and Time Series Consistency

The 2006 IPCC Guidelines do not provide any numerical estimate of uncertainty for the category "Direct N_2O emissions from soils." Therefore, since the data source (import data) is similar to that of certain other categories, it was decided to apply the same approach to assess the uncertainty of activity data. Specifically, the uncertainty of activity data was evaluated by default as 10–20% for countries with limited statistical detail. The upper value of 20% was applied (2006 IPCC Guidelines, Volume 3, Sections 5.2.3.2 and 5.3.3.2).

The uncertainty assessment of emission factors is based on the 2006 IPCC Guidelines, Volume 4, Chapter 11, Table 11.1, and amounts to 200%.

The activity data, emission factors, and uncertainty estimates described above in Section 5.4.2 were applied to the complete time series for the entire period under consideration, from 1990 to 2023.

5.5.4. Quality Assurance and Quality Control

The quality control procedures for this category correspond to those presented in Table 6.1 of Chapter 6, Volume 1 of the 2006 IPCC Guidelines. The main focus was placed on verifying the data during their transfer to the calculation file.

The activity data were verified by the compiler of the Agriculture sector using data from the National Statistical Committee of the Kyrgyz Republic. The quality control procedures for this category correspond to those presented in Table 6.1 of Chapter 6, Volume 1 of the 2006 IPCC Guidelines.

5.5.5. Recalculations for the Category

A transition was made from GWP values under the IPCC Second Assessment Report (SAR) to GWP values under the IPCC Fifth Assessment Report (AR5). The recalculation was carried out for the sector as a whole. For details, see Section 5.1, Figure 5.5.

In order to obtain new import data with the required level of detail, it is necessary to conclude a standing Agreement between the National Statistical Committee and the Ministry of Natural Resources, Ecology and Technical Supervision for the provision of data for inventories (For official use only).

5.6. Category "Urea Application" (CRF 3.H.)

5.6.1. Category Description

In Kyrgyzstan, this category has been included in the GHG emissions assessment for the first time. It accounts for CO_2 emissions resulting from the application of urea to soils and its subsequent transformation/decomposition through soil processes.

The entire volume of urea used in Kyrgyzstan is imported. As noted earlier in Chapter 4, the electronic database on imports/exports in the National Statistical Committee was launched in 2006. Obtaining earlier data is challenging. Therefore, the notation key "NE" was applied for reporting CO_2 emissions from urea application in agriculture for the years 1990–2006.

CO_2 emissions from the category "Urea Application" for the period 1990–2023 are presented in Table 5.24. The trend of emissions from this category over 1990–2023 is shown in Figure 5.15.

Table 0.24. CO_2 emissions from the category "Urea Application"

Year	кт CO_2	Year	kt CO_2	Year	kt CO_2	Year	kt CO_2
1990	NE	**1999**	NE	**2008**	9.97	**2017**	20.94
1991	NE	**2000**	NE	**2009**	10.46	**2018**	14.78
1992	NE	**2001**	NE	**2010**	36.04	**2019**	19.49
1993	NE	**2002**	NE	**2011**	9.25	**2020**	12.28
1994	NE	**2003**	NE	**2012**	1.32	**2021**	16.69
1995	NE	**2004**	NE	**2013**	9.45	**2022**	7.35
1996	NE	**2005**	NE	**2014**	24.70	**2023**	14.92
1997	NE	**2006**	6.06	**2015**	10.30		
1998	NE	**2007**	24.26	**2016**	32.73		

Note: NE – not estimated, as source activity data were not provided.

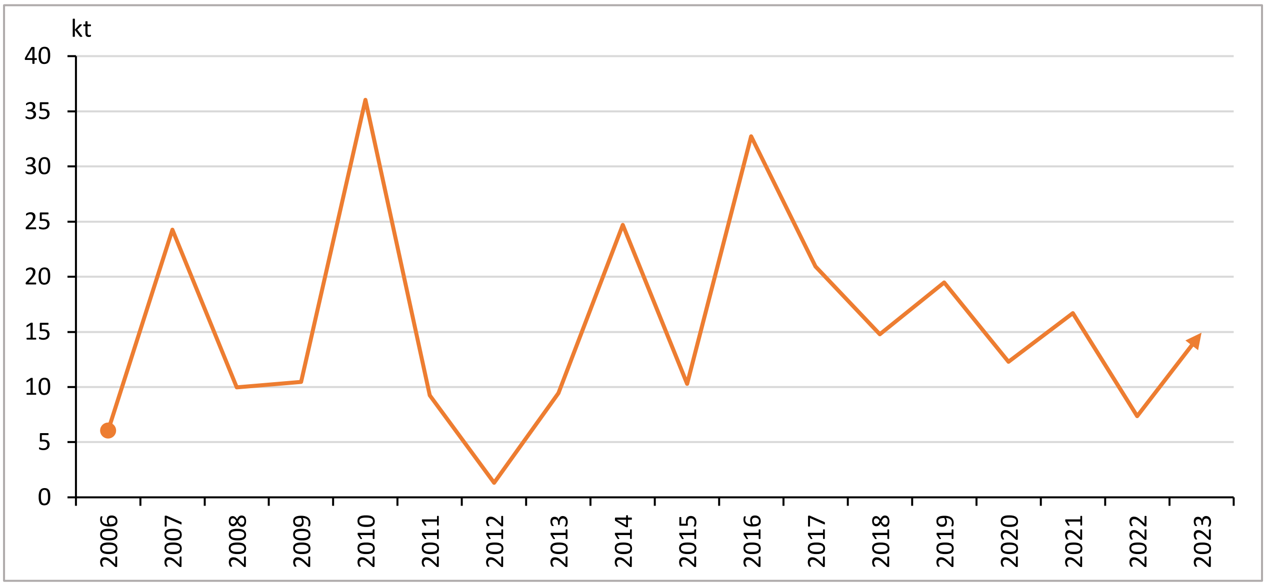

Figure 0.15. Trend of emissions from the category "Urea Application" for the period 2006–2023.

The irregularity of emissions corresponds to the uneven pattern of urea imports.

5.6.2. Methodology

The addition of urea to soils during fertilization leads to CO_2 losses that were originally captured during industrial production. Urea ($CO(NH_2)_2$), in the presence of water and urease enzymes, is hydrolyzed to ammonium (NH_4^+), hydroxyl ion (OH^-), and bicarbonate (HCO_3^-). Similar to the soil reaction following lime application, the resulting bicarbonate is converted into CO_2 and water.

CO_2 emissions from urea fertilization can be estimated using Equation 11.13 of the 2006 IPCC Guidelines, Volume 4, Chapter 11, Section 11.4.1:

Уравнение 11.13
Годовые выбросы CO_2 в результате внесения мочевины в почву

$$CO_2\text{–}C\ Выброс = M \bullet EF$$

Where:

CO_2–C Emissions = annual carbon emissions from urea application to soils, tons C/year;

M = annual amount of urea fertilizer applied, tons urea/year;

EF = emission factor, tons C/(tonne urea).

The estimated amount of carbon (CO_2–C) is then converted to CO_2 by multiplying by 44/12.

5.6.2.1 Activity Data

There are no national or sectoral statistics on the actual volumes of urea applied in agriculture. Therefore, in the assessment it is assumed that all imported urea (see Table 5.25) is used in the year of import.

Table 0.25. Urea Imports

Year	Imports, t	Year	Imports, t	Year	Imports, t	Year	Imports, t
1990	NE	**1999**	NE	**2008**	13,599.9	**2017**	28,551.5
1991	NE	**2000**	NE	**2009**	14,268.6	**2018**	20,159.1
1992	NE	**2001**	NE	**2010**	49,140.2	**2019**	26,581.1
1993	NE	**2002**	NE	**2011**	12,615.7	**2020**	16,751.7
1994	NE	**2003**	NE	**2012**	1,799.1	**2021**	22,764.5
1995	NE	**2004**	NE	**2013**	12,882.5	**2022**	10,021.9
1996	NE	**2005**	NE	**2014**	33,680.0	**2023**	20,351.3
1997	NE	**2006**	8,264.5	**2015**	14,051.7		
1998	NE	**2007**	33,075.7	**2016**	44,629.0		

Note: NE – not estimated, as source activity data were not provided.

5.6.2.2 Emission Factors

The default emission factor value from the 2006 IPCC Guidelines (Volume 4, Chapter 11, Section 11.4.2) was used, which is 0.2.

5.6.3. Uncertainties and Time Series Consistency

The 2006 IPCC Guidelines do not provide any numerical estimate of uncertainty for the category "Urea Application." Recent studies[88] in this area indicate lower emission factor values for urea use: 0.0143–0.0156 kg CO_2–C per kg of urea in the first study, and 6.17–6.31 kg CO_2–C per kg of urea, or 4.97–5.24%, in the second study. Comparison of the results of these studies with the emission factor value from the 2006 IPCC Guidelines makes it possible to estimate the uncertainty of the emission factor at no less than 100%.

[88] https://www.sciencedirect.com/science/article/abs/pii/S1164556317303278 and https://www.sciencedirect.com/science/article/abs/pii/S1352231016303740#:~:text=However%2C%20the%20assumption%20that%20all,not%20developed%20for%20arable%20soils.

Since the data source (import data) is similar to that used for certain other categories of Chapter 5 (IPPU sector), the same approach was applied to assess the uncertainty of activity data. Specifically, activity data uncertainties were evaluated by default for countries with limited statistical detail as 10–20%. The upper value of 20% was used, in accordance with the 2006 IPCC Guidelines (Volume 3, Sections 5.2.3.2 and 5.3.3.2).

The activity data, emission factors, and uncertainty estimates described in Section 5.6.2 were applied to the complete time series for the entire period under consideration, from 1990 to 2023.

5.6.4. Quality Assurance and Quality Control

The quality control procedures for this category correspond to those presented in Table 6.1 of Chapter 6, Volume 1 of the 2006 IPCC Guidelines. The main focus was placed on verifying the data during their transfer to the calculation file.

The activity data were verified under the QA/QC Plan by the compiler of the Agriculture sector, based on data from the National Statistical Committee of the Kyrgyz Republic. The quality control procedures for this category correspond to those presented in Table 6.1 of Chapter 6, Volume 1 of the 2006 IPCC Guidelines.

5.6.5. Recalculations for the Category

Since the category “Urea Application” was introduced for the first time, no recalculations were performed.

5.6.6. Planned Improvements

It is planned to obtain urea import data for the years 1990–2005.

In order to acquire new import data with the required level of detail, it is necessary to conclude a standing Agreement between the National Statistical Committee and the Ministry of Natural Resources, Ecology and Technical Supervision for the provision of data for inventories (For Official Use).

6. Land Use, Land-Use Change and Forestry (CRF 4.)

This chapter covers greenhouse gas emissions and removals in the Land Use, Land-Use Change and Forestry (LULUCF) sector, calculated in accordance with the methodologies and guidelines outlined in Volume 4 of the 2006 IPCC Guidelines.

6.1. Sector Overview

The assessment of emissions and removals in the LULUCF sector for the preparation of the NID-1 covered the following categories and subcategories:

4.A. Forest land
4.A.1. Forest land remaining forest land
4.B. Cropland
4.B.1. Cropland remaining cropland
4.C. Grassland
4.C.1. Grassland remaining grassland
4(IV). A. Forest land
4(IV). A.1. Forest land remaining forest land
4(IV). A.1.b. Forest fires

The results of the assessment of carbon stock changes are presented for:

- forests,
- perennial plantations on cropland,
- woody and shrubby vegetation in pastures.

Additionally, an assessment is provided of carbon stock changes in mineral soils and of CO_2, CH_4, N_2O and NOx emissions resulting from forest fires.

In 2023, the net removals in the sector amounted to 10,308.89 kilotons (kt) of CO_2, which is equivalent to 54% of total national greenhouse gas emissions. Overall, the sector is a net sink. The largest contribution is provided by the category “Forest land,” followed by cropland and grassland.

Values of carbon dioxide removals for the period 1990–2023 are presented in Table 6.1. The dynamics of emissions and the trend of removals are shown in Figure 6.1 below.

Table 6.1. Net CO_2 removals by category for 1990–2023

Year	4.A. Forest land	4.B. Cropland	4.C. Grassland	Total	Year	4.A. Forest land	4.B. Cropland	4.C. Grassland	Total
1990	-7,785.1	-1,305.8	-549.1	-9,640.0	**2007**	-7,983.9	-1,612.8	-492.7	-10,089.4
1991	-7,809.0	-1,364.3	-548.8	-9,722.1	**2008**	-8,049.3	-1,577.4	-512.5	-10,139.2
1992	-7,815.4	-1,372.2	-548.6	-9,736.2	**2009**	-8,021.6	-1,607.8	-504.3	-10,133.7
1993	-7,817.1	-1,412.1	-548.3	-9,777.5	**2010**	-8,039.9	-1,592.6	-503.7	-10,136.2
1994	-7,827,9	-1,433.5	-548.0	-9,809.4	**2011**	-8,011.0	-1,566.7	-504.4	-10,082.1
1995	-7,845,0	-1,424.5	-547.8	-9,817.3	**2012**	-8,048.2	-1,564.7	-506.4	-10,119.3
1996	-7,836.2	-1,418.9	-547.5	-9,802.6	**2013**	-8,069.3	-1,544.7	-502.1	-10,116.1
1997	-7,836.9	-1,396.4	-547.3	-9,780.6	**2014**	-8,075.7	-1,543.5	-526.2	-10,145.4
1998	-7,864.0	-1,072.5	-685.2	-9,621.8	**2015**	-8,109.3	-1,535.5	-506.7	-10,151.5

Year	4.A. Forest land	4.B. Cropland	4.C. Grassland	Total	Year	4.A. Forest land	4.B. Cropland	4.C. Grassland	Total
1999	-7,878.4	-1,363.8	-533.6	-9,775.7	**2016**	-8,070.1	-1,547.3	-508.2	-10,125.6
2000	-7,852.7	-1,439.1	-511.3	-9,803.1	**2017**	-8,145.4	-1,560.3	-509.7	-10,215.4
2001	-7,893.1	-1,070.9	-739.3	-9,703.3	**2018**	-8,167.2	-1,743.6	-393.4	-10,304.3
2002	-7,917.7	-1,016.4	-769.9	-9,704.0	**2019**	-8,194.6	-1,585.2	-523.6	-10,303.4
2003	-7,931.3	-1,049.6	-768.2	-9,749.0	**2020**	-8,207.4	-1,543.0	-543.8	-10,294.1
2004	-7,951.4	-1,568.6	-493.6	-10,013.6	**2021**	-8,206.1	-1,745.5	-351.3	-10,302.8
2005	-7,979.8	-1,569.8	-496.2	-10,045.8	**2022**	-8,194.1	-1,775.2	-326.0	-10,295.2
2006	-8,016.4	-1,604.8	-475.0	-10,096.2	**2023**	-8,213.7	-1,767.2	-328.4	-10,309.2*

Note: Column values may not sum due to rounding.
* the amount without reduction due to wildfire emissions.

In the LULUCF sector, in addition to removals, there are also emissions of methane (CH_4) and nitrous oxide (N_2O) generated from biomass burning, but these are insignificant and depend on the scale of forest fires (see Table 6.2).

Table 6.2. Estimated CH_4 and N_2O emissions from forest fires, 1990–2023

Emissions of methane and nitrous oxide, kt CO_2 eq.							
Year	CH_4	N_2O	Total	Year	CH_4	N_2O	Total
1990	0.000	0.000	0.000	**2007**	0.046	0.024	0.070
1991	0.022	0.011	0.033	**2008**	0.082	0.043	0.125
1992	0.000	0.000	0.000	**2009**	0.044	0.023	0.066
1993	0.154	0.080	0.234	**2010**	0.050	0.026	0.076
1994	0.039	0.021	0.060	**2011**	0.055	0.029	0.084
1995	0.005	0.002	0.007	**2012**	0.059	0.031	0.090
1996	0.000	0.000	0.000	**2013**	0.095	0.050	0.144
1997	0.057	0.030	0.086	**2014**	0.114	0.060	0.173
1998	0.049	0.026	0.075	**2015**	0.337	0.177	0.514
1999	0.025	0.013	0.039	**2016**	0.046	0.024	0.070
2000	0.012	0.006	0.018	**2017**	0.130	0.068	0.198
2001	0.032	0.017	0.048	**2018**	0.046	0.024	0.070
2002	0.084	0.044	0.129	**2019**	0.100	0.053	0.153
2003	0.063	0.033	0.095	**2020**	0.083	0.044	0.127
2004	0.017	0.009	0.027	**2021**	0.025	0.013	0.038
2005	0.078	0.041	0.119	**2022**	1.350	0.707	2.057

Note: Column values may not sum due to rounding.

6.1.1 Dynamics of Removals for 1990–2023

The main source of carbon removals in the sector is the biomass growth in forests, perennial crops, and woody vegetation on grasslands.

In 2023, net CO_2 removals increased by 669.2 thousand tons compared to 1990, or by 6.9% (see Table 6.3 and Figure 6.1). This is largely due to the expansion of forest areas and perennial plantations.

Carbon losses from logging remain insignificant. The average annual logging volume for the period 1990–2023 amounted to about 26,500 m³, with a downward trend in recent years, as mainly sanitary and maintenance logging is carried out.

Table 6.3. Net CO_2 removals in the LULUCF sector by category in 1990 and 2023

Category	Net removals (kt CO_2)		Difference (kt CO_2)	Change (%)
	1990	2023		
Forest land	-7,785.1	-8,213.7	-428.6	5.5
Cropland	-1,305.8	-1,767.2	-461.4	35.3
Grassland	-549.1	-328.4	220.7	-40.2
Total LULUCF	**-9,640.0**	**-10,309.2**	**-669.2**	**6.9**

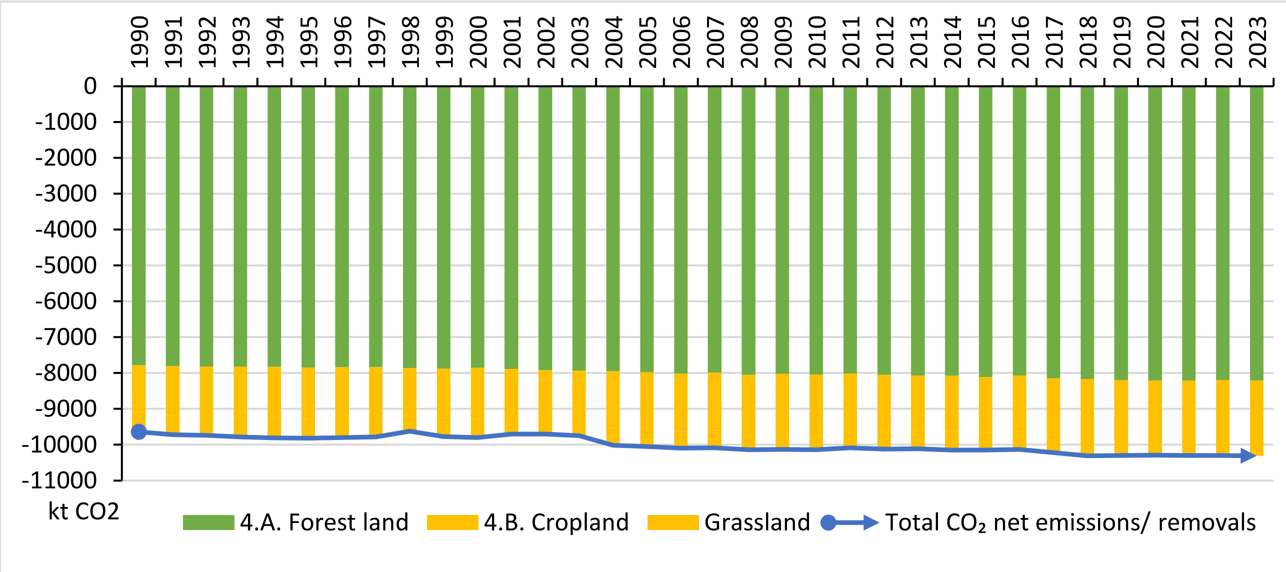

Figure 6.1. Dynamics of CO_2 removals in the LULUCF sector by carbon stock categories, 1990–2023

6.2. Land-Use Definitions and Classification Systems Used, and Their Correspondence to the IPCC Land-Use Categories, Land-Use Change and Forestry

In the current inventory, land-use categories and land types are taken into account for which the 2006 IPCC Guidelines (Volume 4) provide Tier 1 assessment methods, parameters, and default factors. As part of the NID preparation, an analysis was also conducted to align the land-use types used in the Kyrgyz Republic with the IPCC land-use categories (see Table 6.4).

Table 6.4. Correspondence between national land-use types and IPCC categories

IPCC Categories	National Land-Use Types
Forest land	Forest-covered area
Cropland	Orchards
	Mulberry plantations
	Other plantations
	Orchards and other fruit and berry perennial plantations
	Collective orchards

IPCC Categories	National Land-Use Types
	Shelterbelts
	Other protective forest plantations
Grassland	Woody-shrub vegetation

6.3. Information on Approaches Used for Representing Land Areas and on Land-Use Databases Applied in the Inventory

According to the 2006 IPCC Guidelines (Volume 4), there are three approaches to representing land areas:

- Approach 1: Total land-use area, without information on conversions between land-use categories. Only the total area for each separate land-use category and land type is determined.
- Approach 2: Total land-use area, including conversions between land-use categories. This approach tracks reallocation between land-use categories.
- Approach 3: Detailed spatial data on land-use conversions. This approach provides more accurate information by tracking land-use reallocations with geographic referencing.

At present, the land accounting system of the Kyrgyz Republic does not implement a land-use change matrix. Consequently, the national land accounting system corresponds only to the requirements of Approach 1.

Analysis of land reporting materials has shown that it is possible to identify only transitions between land-use categories, but it is not feasible to do so at the level of specific land types. It is precisely land cover change—i.e., reallocation between land types—that leads to changes in carbon stocks in reservoirs.

Therefore, the assessment of emissions and removals associated with land-use change is not conducted within the current inventory.

6.3.1. Classification of lands in the Kyrgyz Republic

According to the Land Code of the Kyrgyz Republic, the entire land fund of the country is divided into agricultural and non-agricultural lands and classified by intended purpose as follows:

- agricultural lands;
- residential areas;
- lands of industry, transport, communications, energy production, defense and other purposes;
- lands of specially protected natural areas;
- forestry fund lands;
- water fund lands;
- reserve lands.

Table 6.5 reflects the distribution of the land fund of Kyrgyzstan by area of land categories and their dynamics from 2000 to 2023.

Table 6.5. Land fund distributions as per categories and area.

№	Land category	Land area at the beginning of the year, thousand hectares

		2000	2005	2010	2015	2020	2023
1	Agricultural lands	5,788.2	5,698.4	5,684.5	6,542,6	6,751.4	6,743.1
2	Residential areas	231.7	250.0	263.2	276.3	279.6	285.2
3	Lands of industry, transport, defense communications and other purposes	227.5	221.8	223.6	228.9	232.1	236.8
4	Lands of specially protected natural sites;	349.3	447.8	707.4	823.8	1,187.5	1,187.5
5	Forestry fund lands	2 634.3	2,684.9	2,613.7	2,600.0	2,529.8	2,529.5
6	Water fund lands	767.0	767.3	767.4	767.3	767.3	767.6
7	Reserve lands	9 996.9	9,924.7	9,735.1	8,756.0	8,247.3	8,245.2
Total lands		**19,994.9**	**19,994.9**	**19,994.9**	**19,994.9**	**19,994.9**	**19,994.9**

Source: National Statistical Committee. Note: Columns may not sum due to rounding..

Agricultural land is land used for agricultural production. These include: plough land, fallow land, land under perennial plantings, hayfields and pastures.
Non-agricultural land includes household plots, collective vegetable gardens and orchards, forest lands, areas occupied by trees and shrubs, natural waters, roads, cattle drive, buildings (including structures, yards, and streets), as well as destroyed and other lands.

Data on land (except for forests) are obtained from official land reports on the availability and distribution of land by category and type. The table below shows the dynamics of perennial plantings on cultivated lands and trees and shrubs on pastures (see Table 6.6).

Table 6.6. Perennial plantings and trees and shrubs, thousand hectares

Category	Type	1990	2000	2010	2020	2023
Cultivated land remaining as cultivated land	Orchards	30,8	29,9	27,7	29,2	29,9
	Mulberries	3,4	3,0	2,6	2,6	2,5
	Other plantings	0,8	0,2	0,4	0,8	0,9
	Gardens and other fruit and berry perennial plantings	16,1	22,7	34,5	35,3	35,7
	Collective gardens	4,4	4,4	3,5	3,6	3,6
	Field shelter-belt forest	9,2	9,1	9,9	9,9	9,9
	Other shelter-belt forest	95,0	100,6	102,6	102,5	102,4
	Total perennial plantings:	159,7	169,9	181,2	183,9	184,9
Pasture lands remaining as pasture lands	Trees and shrubs plantings	358,0	353,1	351,0	350,6	350,5

Source: State Enterprise for Land Management "Kyrgyzgiprozem

The data shows the structure and dynamics of the area of perennial plantings on cultivated lands, as well as tree and shrub vegetation on pastures for the period 1990–2023. From 1990 to 2023, the total area of perennial plantings increased by 25.2 thousand hectares (+16%). The main contribution to the increase was made by orchards, protective forest plantations and shelterbelts. At the same time, a decrease in the area of mulberry trees and collective orchards was recorded.

6.3.2 Forest data

Forest areas are taken from official forest fund inventory materials of the Kyrgyz Republic. Forest fund inventory is conducted every five years. The latest inventory was conducted in 2023 and covers:

- lands of the State Forest Fund (SFF),
- Specially protected natural areas (SPNA),
- forests outside the territory of SFF and SPNA.

According to the results of the latest forest fund inventory, the forest area of Kyrgyzstan is 1,273.1 thousand hectares. The distribution of forest areas for 2008, 2013, 2018 and 2023 is presented in Table 6.7.

Table 6.7. Distribution of forest areas by accounting territories for the period 2008, 2013, 2018 and 2023.

Distribution of forests, (thousand hectares)	2008	2013	2018	2023
Total forests	1,116.6	1,135.5	1,206.7	1,273.1
Forests of SFF and SPNA	839.6	860.0	891.7	936.8
Forests not included in SFF and SPNA	277.0	275.5	315.0	336.3

Source: First National Forest Inventory (2008)[89] and Forest Fund Accounting (2013–2023) [90].

Analysis of the dynamics shows that the increase in the forested area from 2008 to 2023 was 156.5 thousand hectares (+14%).

The increase in the forested area is explained by several reasons:

i. clarification of forest boundaries and areas during forest management,
ii. inclusion of forests outside the SFF/SPNA,
iii. natural restoration and expansion of forests
iv. Transfer of older forest plantations to the forested area.

The first national forest inventory was conducted in 2008-2010, covering the entire territory of the country, including forests outside the SFF and SPNA. The total forested area of the country was 1,116.6 thousand hectares, and the area of forests not included in the SFF and SPNA was 277 thousand hectares.

Since 2011, the second cycle of forest management operations on the lands of the state forest fund and protected natural areas began. And since 2012, forest management operations have also begun in parallel on lands outside the territory of the state forest fund and protected natural areas. Henceforth, high-resolution satellite images began to be actively used in forest management, which made it possible to determine the forest area more accurately. As a result, the quantitative and qualitative characteristics of forests began to be regularly updated, and these data began to be taken into account when conducting forest fund inventories in 2013, 2018 and 2023.

Thus, the increase in the forested area is primarily due to the clarification of the boundaries and areas of forests. Additional factors also included the natural expansion of forest areas and the transfer of older forest plantations to the forested area.

[89] Government Decree of the Kyrgyz Republic No. 407 of 26 July 2011 on the Approval of the Results of the National Forest Inventory of the Kyrgyz Republic. https://cbd.minjust.gov.kg/7-14770/edition/385687/ru
90 Explanatory Note on the Accounting of the State Forest Fund (unpublished).

The gradual increase in forest area is also confirmed by remote sensing data. According to GLAD (Global Land Cover and Land Use Change)[91] in the period from 2000 to 2020, forest area increased by 35 thousand hectares. The average annual increase was 1.7 thousand hectares. Based on these data (2000, 2020), a reverse linear extrapolation of forest area for the period 1990–2022 was performed (see Table 6.8).

Table 6.8. Forest area for the period 1990–2023 as a result of extrapolation, thousand hectares.

Years	1990	1995	2000	2005	2010	2015	2020	2023*
Forest area	1,216.1	1,224.7	1,233.4	1,242.0	1,250.6	1,259.2	1,267.9	1,273.1

Note: * forest area according to forest fund inventory data for 2023.

6.3.3 Assessment of uncertainties

The uncertainty assessment was performed according to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines. Approach 1 was used, which involves separately assessing the uncertainties of activity data and emission/removal factors and then combining them.

The largest contribution to the total uncertainty of the sector comes from category 4.C.1. Pasture land remaining Pasture land - 171.1%. This is due to the high uncertainty of the default factors used to estimate carbon stock changes.

Category 4.A.1. Forest Land remaining Forest Land is also characterized by significant uncertainty - 153.1%, which is also explained by the use of default factors.

Category 4.B.1. Cultivated land has an uncertainty level of 118.0% and has a moderate impact on the total uncertainty of the sector.

Forest land fires (category 4(IV). A.1.b) result in minor emissions of CH_4 and N_2O and, accordingly, make minor contributions to the uncertainty of the overall trends.

The overall uncertainty level for the Land Use, Land-Use Change and Forestry (LULUCF) sector is 123.8%, and the uncertainty in the national emission trend is 52.6%.

The uncertainty calculation was performed using the tool of Uncertainty Analysis IPPC Inventory Software. The results of the quantitative assessment of uncertainties by greenhouse gas source and sink categories are presented in Table 6.9.

91 https://glad.umd.edu/dataset/GLCLUC2020

Table 6.9. Assessment of uncertainty for LULUCF sector

IPCC category	Gas	Emissions or absorptions		Uncertainty in activity data	Uncertainty of emission factors/estimation parameters	Unified uncertainty	Contribution to variability by category in t year (2023)	Type A sensitivity	Type B sensitivity	Uncertainty in national emissions trend introduced by uncertainty in emission factor/estimation parameter	Uncertainty in national emissions trends introduced by uncertainty in activity data	Uncertainty introduced into the trend of total national emissions
		In base year	In t year (2023)									
		kt CO_2э	kt CO_2э	%	%	%		%	%	%	%	%
4. Land												
4.A.1. Forest land remaining forest land	CO_2	-7785,062	-8213,658	43,174	146,902	153,115	14882,740	0,011	0,852	1,687	52,023	2709,277
4.B.1. Cropland remaining cropland	CO_2	-1305,812	-1767,181	14,142	117,154	118,004	409,198	0,038	0,183	4,500	3,666	33,690
4.C.1. Grassland remaining grasslands	CO_2	-549,105	-328,365	14,142	170,491	171,076	29,694	0,027	0,034	4,575	0,681	21,397
4(IV). A. Forest areas												
4(IV). A.1.b. Forest fire	CH_4	0,000261	0,207	33,400	40,400	52,419	0,00000110	0,0000214	0,0000214	0,000865	0,001012	0,00000177
4(IV). A.1.b. Forest fire	N_2O	0,000136	0,108	33,400	26,900	42,886	0,00000020	0,0000112	0,0000112	0,000301	0,000530	0,00000037
Total		-9639,978	-10308,888				15321,632					2764,364
				Percentage of uncertainty in the total inventory:			**123,781**				**Uncertainty of trend:**	**52,577**

6.3.4 Recalculations by sector

As part of the current inventory for the preparation of Biennial Transparency Report (BTR)1, a recalculation of the entire time series of estimates for the LULUCF sector categories for the period 1990–2020 was carried out. The recalculation was carried out in connection with the clarification of data on activities and land classification.

Comparison with the previous inventory (National Communication (NC) 4) has shown a slight decrease in net absorption volumes — by 3.5% average. At the same time, the recalculation did not change the overall trend: the sector continues to act as a net absorber of greenhouse gases (see Table 6.10 and Fig. 6.2).

Table 6.10. Comparison of CO_2 absorption values in NC 4 and BTR 1

Years	NC 4	BTR 1	Difference		Years	NC 4	BTR 1	Difference	
			kt CO_2	%				kt CO_2	%
1990	-10,266.1	-9,640.0	-626.1	6.1	**2006**	-10,207.4	-10,096.2	-111.2	1.1
1991	-10,287.8	-9,722.1	-565.7	5.5	**2007**	-10,308.0	-10,089.4	-218.5	2.1
1992	-10,284.3	-9,736.2	-548.2	5.3	**2008**	-10,248.1	-10,139.2	-108.9	1.1
1993	-10,290.7	-9,777.5	-513.2	5.0	**2009**	-10,301.4	-10,133.7	-167.7	1.6
1994	-10,306.6	-9,809.4	-497.2	4.8	**2010**	-10,332.8	-10,136.2	-196.6	1.9
1995	-10,321.2	-9,817.3	-503.9	4.9	**2011**	-10,294.5	-10,082.1	-212.4	2.1
1996	-10,029.5	-9,802.6	-226.9	2.3	**2012**	-10,323.2	-10,119.3	-203.9	2.0
1997	-10,301.2	-9,780.6	-520.6	5.1	**2013**	-10,215.3	-10,116.1	-99.2	1.0
1998	-10,329.2	-9,621.8	-707.5	6.8	**2014**	-10,326.8	-10,145.4	-181.4	1.8
1999	-10,336.9	-9,775.7	-561.1	5.4	**2015**	-10,335.8	-10,151.5	-184.3	1.8
2000	-10,301.6	-9,803.1	-498.5	4.8	**2016**	-10,302.0	-10,125.6	-176.3	1.7
2001	-10,219.4	-9,703.3	-516.1	5.0	**2017**	-10,366.8	-10,215.4	-151.4	1.5
2002	-10,237.5	-9,704.0	-533.5	5.2	**2018**	-10,940.8	-10,304.3	-636.5	5.8
2003	-9,912.1	-9,749.0	-163,1	1.6	**2019**	-10,954.2	-10,303.4	-650.8	5.9
2004	-10,301.1	-10,013.6	-287.5	2.8	**2020**	-10,960.1	-10,294.1	-666.0	6.1
2005	-10,204.3	-10,045.8	-158,.5	1.6			**Mean**	**-367,5**	**3,5**

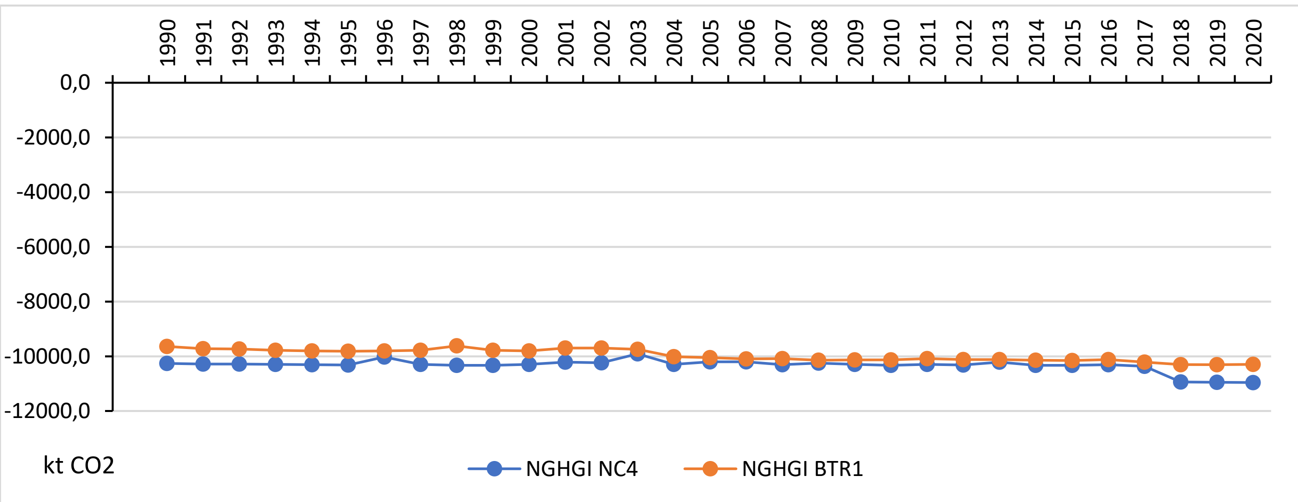

Figure 6.2. Dynamics of net CO_2 absorptions: recalculation of NC4 and BTR1 values.

6.3.4.1 Recalculation of CH_4 and N_2O emissions from forest fires

The current inventory also includes a recalculation of methane (CH_4) and nitrous oxide (N_2O) emissions from biomass combustion during forest fires. The recalculation was made to switch from the Global Warming Potential (GWP) values for Greenhouse Gases (GHG) used in the Second Assessment Report of the IPCC (AR 2) to the more current values from the Fifth Assessment Report (AR 5).

The calculation methodology and input data (by fire area) remained the same, but the change in GWP resulted in an 11.8% increase in total emissions in CO_2 equivalent (see Table 6.11 and Fig. 6.3).

Table 6.11. Recalculation of CH_4 and N_2O emissions from forest fires, thousand tones of CO_2-eq.

Year	AR 2	AR 5	Difference, %	Year	AR 2	AR 5	Difference, %
1990	0.000	0.000	11.8	**2007**	0.062	0.070	11.8
1991	0.030	0.033	11.8	**2008**	0.112	0.125	11.8
1992	0.000	0.000	11.8	**2009**	0.059	0.066	11.8
1993	0.209	0.234	11.8	**2010**	0.068	0.076	11.8
1994	0.054	0.060	11.8	**2011**	0.075	0.084	11.8
1995	0.006	0.007	11.8	**2012**	0.081	0.090	11.8
1996	0.000	0.000	0.0	**2013**	0.129	0.144	11.8
1997	0.077	0.086	11.8	**2014**	0.155	0.173	11.8
1998	0.067	0.075	11.8	**2015**	0.459	0.514	11.8
1999	0.034	0.039	11.8	**2016**	0.062	0.070	11.8
2000	0.016	0.018	11.8	**2017**	0.177	0.198	11.8
2001	0.043	0.048	11.8	**2018**	0.063	0.070	11.8
2002	0.115	0.129	11.8	**2019**	0.137	0.153	11.8
2003	0.085	0.095	11.8	**2020**	0.114	0.127	11.8
2004	0.024	0.027	11.8	**2021**	0.034	0.038	11.8
2005	0.106	0.119	11.8	**2022**	1.839	2.057	11.8
2006	0.038	0.042	11.8	**2023**	0.282	0.315	118

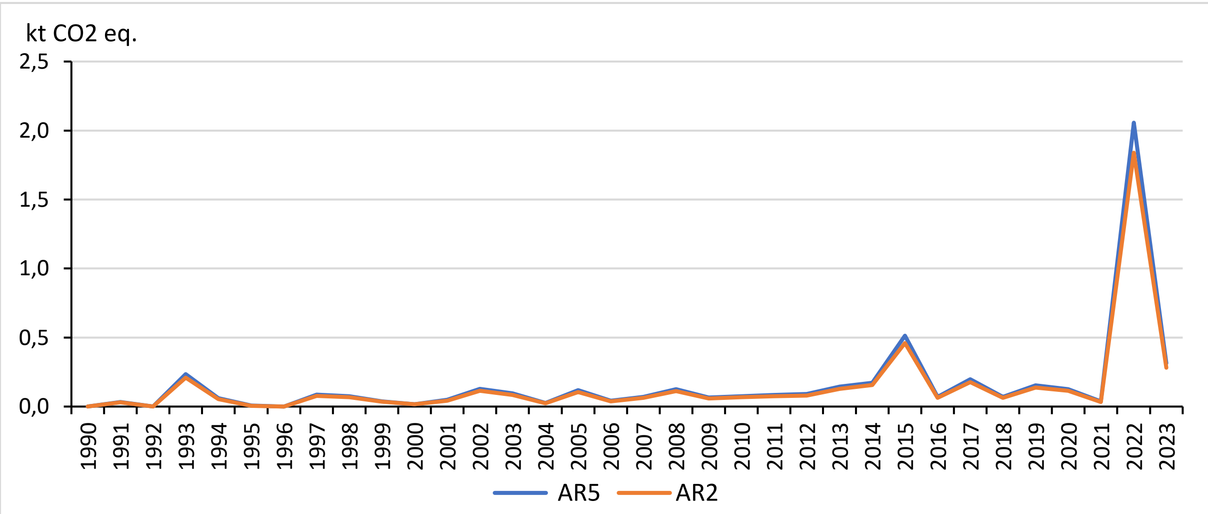

Figure 6.3. Results of CH_4 and N_2O emission recalculation according to GWP value of AR 2 and AR 5

6.4. Forest Land Category (4.A.)

6.4.1. Category Description

According to the 2006 IPCC Guidelines, forest land includes all land with woody vegetation that meets the threshold criteria used to define forests in a national greenhouse gas inventory, and also includes systems with a vegetation structure that does not currently exceed, but has the potential in situ to reach, the threshold criteria used by the country to define the forest land category.

National thresholds for defining forests are:

- Minimum area of 0.2 hectares
- Minimum crown cover of 10%
- Minimum stand height of 1.9 meters
- Minimum width of 25 meters

Shelterbelts and other protective plantations are included in the category "Cropland" in accordance with the provisions of the IPCC Guidelines.

To assess changes in carbon reserves in living biomass, forests were stratified by the following characteristics:

- forest types (juniper, fir, hardwood);
- climatic zones;
- ecological zones (see Fig. 6.4.1).

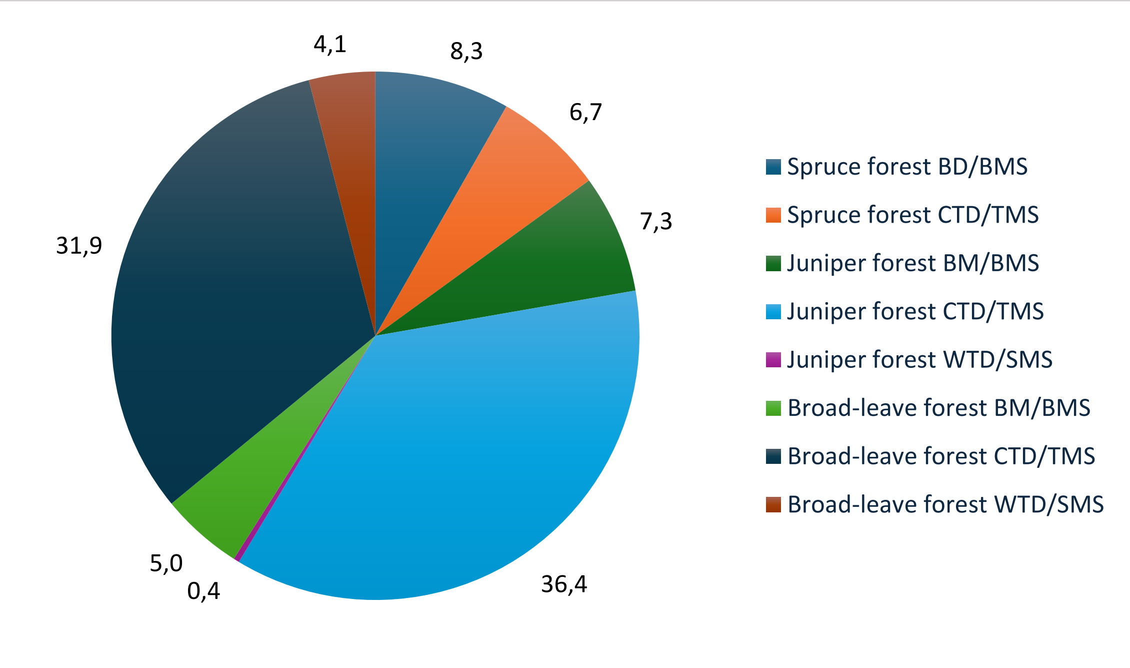

Figure 6.4. Distribution of forests by climatic and ecological zones (%)

As shown in Figure 6.4, the country's forests are distributed into three main types and located in different climatic and ecological zones:

- warm temperate dry (WTD)
- cool temperate dry (CTD)
- boreal moist (BM) and boreal dry (BD).

• subtropical mountain systems (SMS)
• temperate mountain systems (TMS)
• boreal mountain systems (BMS).

The classification of forests and their distribution into these zones was developed based on the results of a land use assessment conducted in 2019 within the framework of the Food and Agriculture Organization of the United Nations (FAO) project. As a result, forest lands were grouped into eight classes based on forest type and their geographical location in climatic and ecological zones, allowing the application of the most appropriate default factors from the 2006 IPCC Guidelines.

In 2023, the net CO_2 absorption by forests was 8,213.7 kt CO_2, an increase of 428.6 kt CO_2 (or 5.5%) compared to the 1990 level (see Table 6.12).

Table 6.12. Changes in forest area and net CO_2 absorption

Category	Area, thousand hectares		Change of area		Net absorption (kt CO2)		Change in absorption	
	1990	2023	Thousand ha	%	1990	2023	kt CO_2	%
Forest lands remaining forest lands	1,216.1	1,273.1	57.0	4.7	-7,785.1	-8,213.7	-428.6	5.5

The category **"Forest land"** is the key category for the LULUCF sector. In 2023, it accounted for about 80% of the total net removals in the sector. Detailed information on forest areas is presented in Table 6.14. Figure 6.12 shows net removals by forests for the period 1990–2023.

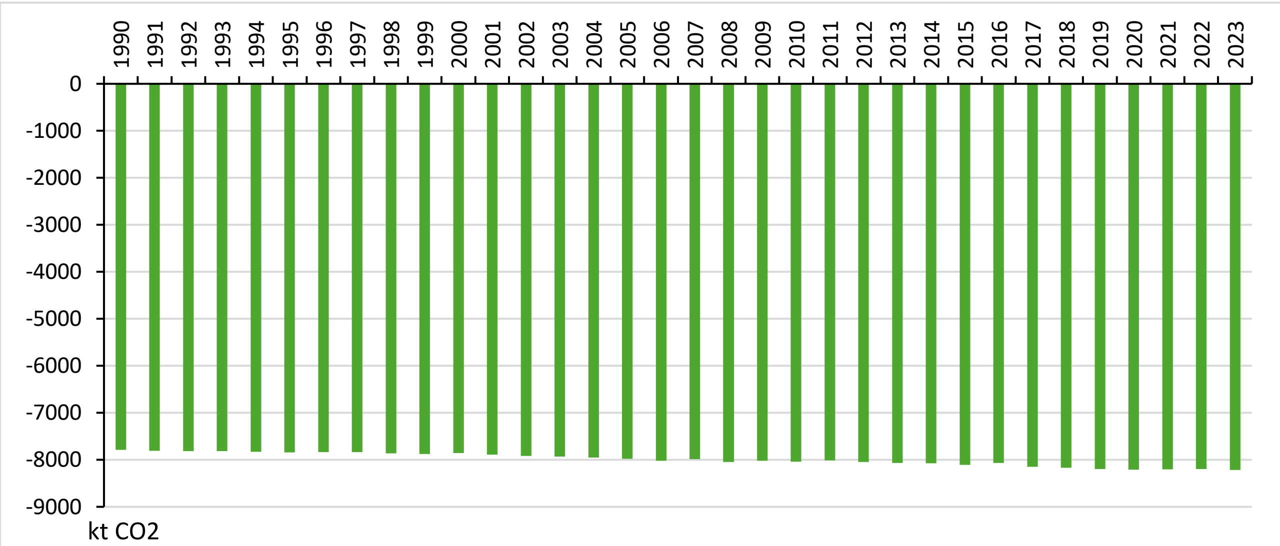

Figure 6.5. Net CO_2 absorption by forests, 1990–2023.

6.4.2. Methodological issues

The category "Forest land remaining forest land" is a key category according to the key category analysis. However, the transition to the second level of the IPCC methodology has not yet been implemented due to the lack of data on land conversion, as well as the lack of national greenhouse gas emission and removal factors for the LULUCF sector in the Kyrgyz Republic.

In this regard, the logic-1 level 1 methodology was applied, based on the default values and factors recommended in IPCC 2006. This allowed for a quantitative assessment of changes in carbon stocks in living biomass and mineral soils, as well as emissions of gases other than CO_2 during forest fires.

6.4.2.1 Forest land remaining forest land (4.A.1)

According to the Guidelines, the following carbon pools and non-CO_2 gases should be estimated for the category Forest land remaining forest land at logic-1 level 1:

- Living biomass – aboveground and belowground;
- Soil carbon;
- Non-CO_2 gases – methane (CH_4) and nitrous oxide (N_2O) from biomass burning.

For dead organic matter (dead wood and litter), the Guidelines do not provide default methods and parameters at logic-1 level 1. In such cases, carbon stock changes are assumed to be absent or in equilibrium, and emissions and removals are therefore assumed to be zero.

Below is a table (Table 6.13) containing a list of carbon pools and non-CO_2 gases subject to assessment at logic-1 level 1, with an indication of the relevant methodological sections of the 2006 IPCC Guidelines.

Table 6.13. Carbon pools and non-CO_2 gases subject to assessment at logic-1 level 1 and the relevant sections of the 2006 IPCC Guidelines.

Land utilization category	Subcategory	Carbon pools and non-CO2 gases	Section on methods	Method, Chapter 2.	Method, Level 1.
Forest lands	Forest land remaining forest land (FF)	Aboveground biomass	4.2.1	2.3.1.1	⨁
		Underground biomass	4.2.1	2.3.1.1	⨁
		Dead organic matter	4.2.2	2.3.2.1	0
		Soil carbon	4.2.3	2.3.3.1	⨁[1]
		Non-CO2 gases from biomass combustion	4.2.4	2.4.1	⨁

Notes for the Level 1 Method column:
⨁- evaluation methods and default parameters are provided in the Guidelines.
0 - no methods or parameters are provided in the IPCC Guidelines, emissions are assumed to be zero or at equilibrium;
⨁[1]- in the guidelines the default parameters are only available for organic soils.

6.4.2.2. Activity data

Table 6.14 presents forest areas from 1990 to 2023. A detailed description of the data sources and the method for assessing the dynamics of change can be found in Section 6.3.

Table 6.14. Data on forest areas from 1990–2023, thousand hectares

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Area	1,216.1	1,217.8	1,219.5	1,221.3	1,223.0	1,224.7	1,226.4	1,228.2	1,229.9

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
Area	1,231.6	1,233.4	1,235.1	1,236.8	1,238.5	1,240.3	1,242.0	1,243.7	1,245.4
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
Area	1,247.2	1,248.9	1,250.6	1,252.3	1,254.1	1,255.8	1,257.5	1,259.2	1,261.0
Year	2017	2018	2019	2020	2021	2022	2023		
Area	1,262.7	1,264.4	1,266.1	1,267.9	1,269.6	1,271.3	1,273.1		

Table 6.15 presents the felling volume from 1990 to 2023. Information on felling volume was obtained from the database of the previous inventory and from the forest fund accounting materials for 2023.

Table 6.15. Data on felling volumes, thousand m3

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Volume	35,0	31,0	32,3	35,0	35,0	33,1	39,0	42,0	37,1
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
Volume	36,0	47,0	38,0	33,9	33,0	30,1	24,8	17,0	30,0
Год	2008	2009	2010	2011	2012	2013	2014	2015	2016
Volume	13,5	25,1	22,8	34,8	26,8	23,7	25,0	18,1	33,2
Год	2017	2018	2019	2020	2021	2022	2023		
Volume	13,7	10,3	5,3	4,6	8,3	15,2	12,5		

6.4.2.2.1 Living Biomass

Method Selection

Emissions and absorption of greenhouse gases from biomass were estimated using the biomass gain–loss method recommended in the 2006 IPCC Guidelines. According to this method, the change in carbon stocks in living biomass is defined as the difference between carbon inputs to biomass and its losses.

- Gains include the average annual increase in biomass, both aboveground and belowground.
- Losses include annual wood removals due to sanitary felling.

This method provides a quantitative estimate of changes in carbon stocks in living biomass using the default parameters and factors provided for logic-1 level 1.

Selection of Emission Factors and Parameters

The gain-loss method requires the use of a number of parameters that allow quantitative assessment of changes in carbon stocks in living biomass. In particular, data on the average annual growth of above-ground biomass, conversion and expansion factors (BCEF), growth of below-ground biomass, as well as parameters related to biomass losses, including those due to felling, are used.

- **Average annual growth of aboveground biomass (GW):** The values of the coefficient were selected based on Table 4.9 of the 2006 IPCC Guidelines. The selection took into account the characteristics of forest species, climatic and ecological zones, in accordance with the stratification applied in this inventory.
- **Ratios of belowground to aboveground biomass (R):** The calculations are based on the coefficient of the ratio of belowground to aboveground biomass (R), the values of which are

taken from Table 4.4. The coefficient R was taken into account both the ecological zones and the volumes of aboveground biomass in the corresponding forest classes.

- **Carbon fraction in dry matter (CF):** The default value of 0.47, recommended as the default value for Tier 1, was used to calculate the carbon content of biomass.
- **Conversion and expansion factors (BCEF):** Biomass conversion and expansion factors (BCEF), which reflect the ratio of aboveground biomass to the volume of wood removed, were used to calculate the biomass losses associated with annual felling volumes. The values of the factors were selected from Table 4.5, taking into account the volumes of the forest stand and the taxation characteristics of each forest class.

6.4.2.2.2 Soil organic carbon

Method Selection

To estimate soil carbon in forests, the Guidelines provide separate guidance for two types of soils:

- mineral soils
- organic soils

According to the international classification, the soils of the Kyrgyz Republic are classified as mineral soils. As shown in Table 6.4.2, at Level 1, default parameters (including stock change factors) are provided exclusively for organic soils. Due to the lack of sufficient scientific justification and a high degree of uncertainty, for mineral forest soils, Level 1 assumes no change in carbon stocks due to management activities. Thus, the change in soil carbon for forest land remaining in the same category is assumed to be zero.

However, when using Approach 1 for reporting land use data, in which specific conversions between land uses are not tracked, the Guidelines prescribe the stock difference method to estimate changes in soil carbon stocks. In this case, the calculation is made by comparing the stocks of organic carbon in soils at the end of the reporting period (e.g. 2023) and the base year (e.g. 1990), and the difference between them reflects the change in organic carbon stocks as a result of an increase or decrease in forest area.

Selection of coefficients and parameters

To apply the specified method at level 1, the reference value of the stock of organic carbon in mineral soils (SOCref) is used, expressed in tons of carbon per hectare. The SOC values are determined according to Table 2.3 and depend on the climatic region. When choosing the corresponding values, the climatic zones characteristic of the forests of the Kyrgyz Republic were taken into account.

6.4.2.2.3 Non-CO_2 gases from biomass combustion (4(IV). A.1.b.)

This category is not a key one in the national inventory, since the areas of forest fires in the Kyrgyz Republic remain relatively insignificant (see Fig. 6.6). However, in accordance with IPCC 2006, when calculating the category “Forest land remaining forest land”, emissions of greenhouse gases other than CO_2, in particular methane (CH_4) and nitrous oxide (N_2O), arising from the combustion of biomass during forest fires, must be taken into account.

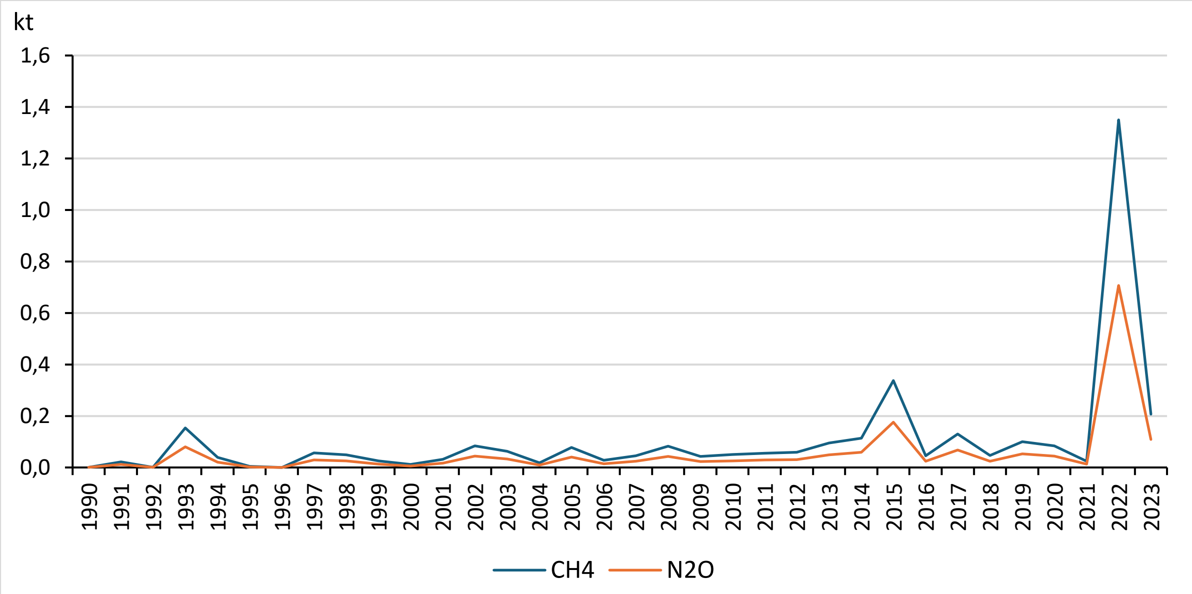

Figure 6.6. CH_4 and N_2O emissions in CO_2 eq. (according to GWP AR 5)

CO_2 emissions from biomass burning on managed forest lands are not taken into account under the assumption of vegetation restoration. The emission trend is highly variable due to unpredictable forest fire frequency and intensity, which depend on both the climatic conditions of a given year and behavioral factors.

6.4.2.2.4 Activity data

The data on forest fire area was obtained from the Ministry of Emergency Situations of the Kyrgyz Republic. The data are provided without disaggregation by fire type or intensity, which meets the requirements of Tier 1 (see Table 6.16 and Fig. 6.7).

Table 6.16. Forest land affected by wild fires, ha.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Area	0.1	8.4	0.1	59.0	15.1	1.8	0.0	21.7	18.9
Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Area	9.7	4.5	12.2	32.4	24.0	6.7	29.9	10.6	17.6
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Area	31.5	16.7	19.1	21.2	22.7	36.3	43.7	129.4	17.6
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**		
Area	49.8	17.7	38.5	32.0	9.5	518.1	79.3		

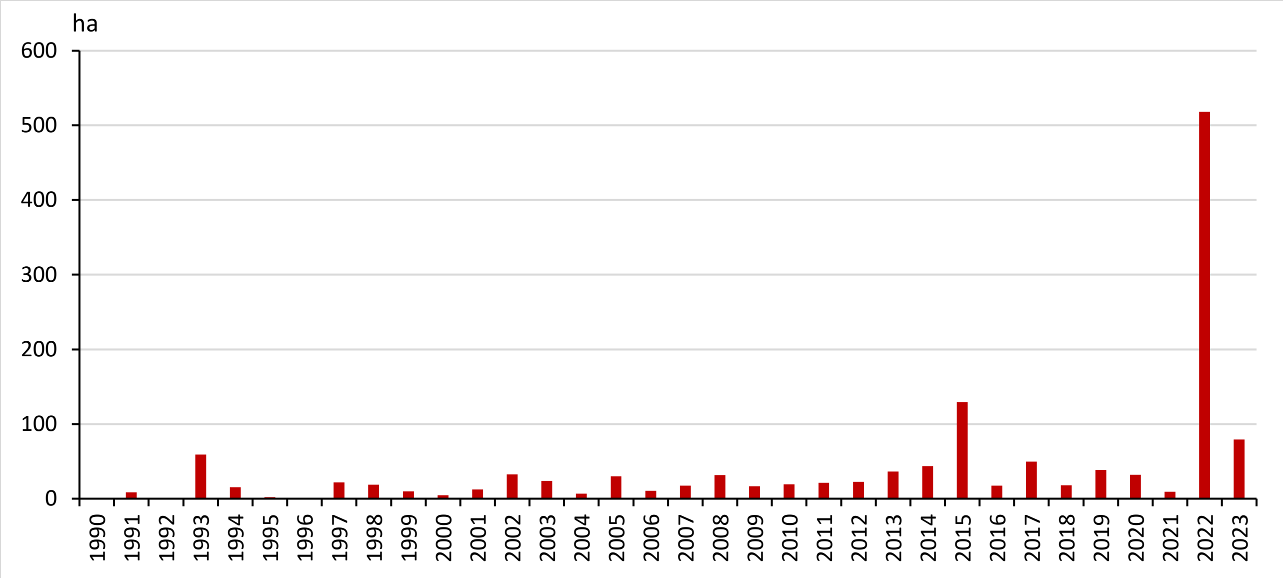

Figure 6.7. Dynamics of forest fires area in the period 1990-2023

6.4.2.2.5 Choice of factors and parameters

Emissions were estimated using Equation 2.27 adapted for Level 1, using the default values from Table 2.4. The following parameters were used in the calculations:

- Biomass fuel consumption
- Combustion factor
- CH4 emission factor
- CO emission factor
- N2O emission factor
- NOx emission factor

The use of default values and aggregated fire data ensures compliance with the IPCC Level 1 assessment requirements in the absence of national factors and detailed fire information.

6.4.3. Uncertainties and time series consistency

6.4.3.1 Assessment of uncertainty

The assessment of uncertainty in category 4.A.1. was performed in accordance with the 2006 IPCC methodology. Table 6.17 presents the uncertainties in the activity data and factors.

The uncertainty of the activity data was determined by considering the differences between various estimates of the total forest area, which are higher and lower than the official data. The uncertainties of the factors are based on the 2006 IPCC Guidelines, as default factors and parameters were used in the calculations.

Table 6.17. Uncertainty assessment results by category

Component	Activity data uncertainty, %	Uncertainty of coefficients, %	Total uncertainty, %
Annual increase in carbon stock in biomass (including above-ground and below-ground biomass)	30	96	100.6

Component	Activity data uncertainty, %	Uncertainty of coefficients, %	Total uncertainty, %
Carbon losses due to timber removal	8	65.3	65.8
Changes in carbon stocks in mineral soils	30	90	94.9

The overall uncertainty of forest fire emissions is 82.7%, of which the uncertainty of activity data is 33.4% and the uncertainty of coefficients is 75.7%.

6.4.3.2 Time series consistency

To ensure time series consistency, activity data were harmonized in response to recommendations received during national consultations. For this purpose, back extrapolation methods were applied for forest areas. The calculation results and coefficients used were discussed at working meetings and technical consultations.

Also, the same set of coefficients and parameters for the entire time series was used for all calculations.

6.4.4. Quality Assurance and Quality Control

In preparing the Category 4A section, the general QC procedures in accordance with IPCC 2006 (Table 6.1, Chapter 6, Volume 1) were followed. Particular attention was paid to the following procedures:

- transfer of activity data between primary sources and the files used in inventory preparation;
- correctness of the choice of default values for biomass increment factors, below-ground to above-ground biomass ratio (R), biomass conversion and expansion (BCEF), and dry matter carbon fraction (CF);
- calculation of absorption and rescaled values from time series.

6.4.5. Recalculations for specific categories

6.4.5.1 Category "Forest land remaining forest land" (4.A.1)

As part of the current inventory, the time series of estimates for the category "Forest land remaining forest land" for the period 1990–2020 was recalculated. The recalculation was carried out in accordance with the principles of ensuring the consistency of time series.

The reason for the recalculation was the update of the forest area data based on the forest fund inventory for 2023, which showed an increase compared to the previously presented values. To assess the trend, remote sensing data were analyzed, based on which the dynamics of the increase in forest area were determined.

As noted in the previous sections, forest expansion occurs mainly due to natural regeneration, which means that this process is usually gradual. Taking this into account, it was decided to perform a reverse extrapolation, that is, to extend the identified trend to the entire period since 1990.

After recalculation, the volumes of net acquisitions turned out to be comparatively larger, in 1990 - by 14%, in 2020 - by 5% compared to the previous inventory (see Table 6.18).

Table 6.18. Comparison of the absorption volumes of National Greenhouse Gas Inventory (NGHGI) in NC 4 and Biennial Transparency Report (BTR)

Year	Net absorption kt CO_2		Change	
	NC 4	BTR 1	kt CO_2	NC 4
1990	-6,827.8	-7,785.1	-957.3	14.0
2020	-7,490.5	-7,870.9	-380.4	5.1

6.4.5.2 Non-CO_2 gases from biomass combustion (4(IV). A.1.b.)

As part of the current inventory, methane (CH_4) and nitrous oxide (N_2O) emissions from wildfires in Forest Land Remaining Forest Land have been recalculated. The recalculation was undertaken due to the change from the Global Warming Potential (GWP) values used in the IPCC Second Assessment Report (AR2) to the more current values from the IPCC Fifth Assessment Report (AR5).

Although the calculation method and the underlying data on wildfire area remained the same, the recalculation resulted in higher emissions in CO_2-equivalent terms. Table 6.19 shows the changes for individual years.

Table 6.19. Comparison of National Greenhouse Gas Inventory (NGHGI) emissions in NC-4 and BTR1

Year	AR 2, kt CO_2э	AR 5, kt CO_2э	Difference, kt CO_2э	Change (%)
1990	0,000355	0,000397	0,000042	+11,8
2020	0,113604	0,127037	0,013432	+11,8

This is explained by the fact that the GWP for CH_4 in OD 5 is higher (28 instead of 21), and for N_2O it is lower (265 instead of 310). However, the share of CH_4 in the emission structure predominates, so the overall increase is 11.8% over the entire time series (see Fig. 6.8). The values for AR5 are shown in blue, and those for AR2 are shown in red.

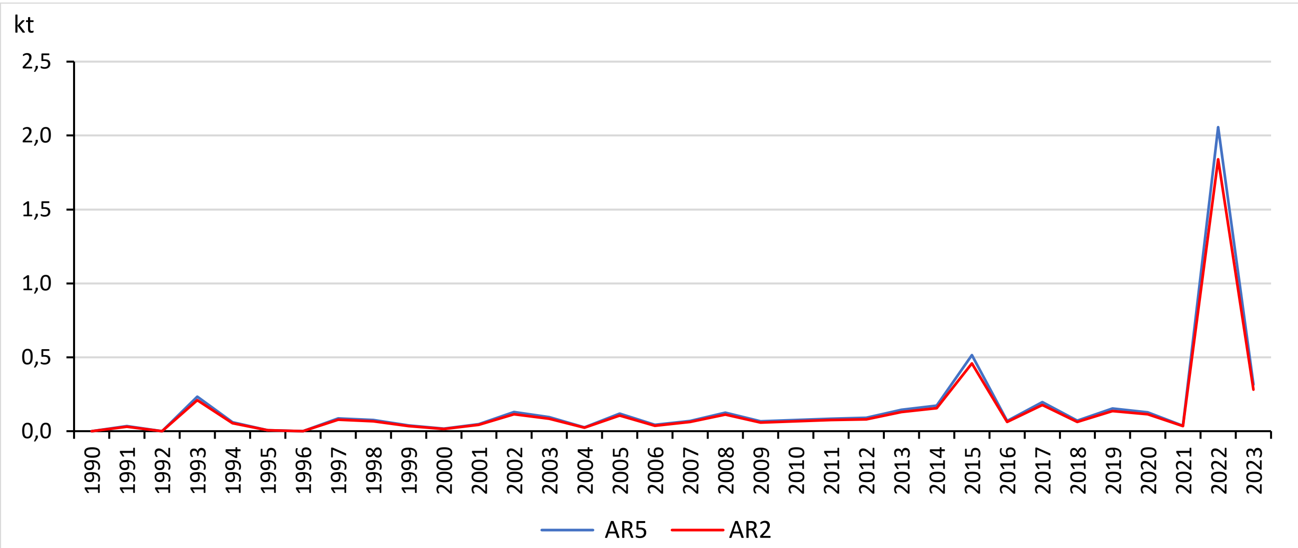

Figure 6.8. Comparison of CH_4 and N_2O emissions from biomass combustion based on GWP values of AR 2 and AR 5

6.4.6. Planned improvements by specific categories

The current inventory of Forest Land Remaining Forest Land has seen some important improvements to improve the accuracy of estimates and reduce uncertainties.

- Remote sensing data were analyzed and forest areas were back-extrapolated to the base year based on the results. This made the time series more consistent and reflected the gradual nature of the increase in forest areas.
- Changes in soil organic carbon stocks were estimated using the stock difference method as provided in the IPCC Guidelines for Approach 1 in land presentation.

No improvements are planned for this category. However, to further improve accuracy and completeness, and to move towards higher IPCC methodology levels, the following improvements are recommended for the Forest Land Remaining Forest Land category:

Improvements in activity data:

- Clarification of forest areas and determination of change dynamics: Use of remote sensing data with high temporal and spatial resolution to more accurately map forest areas and track their changes.
- Maintenance of continuous forest inventory: Ensure that forest inventory is maintained on an annual basis and that forest inventory materials are continuously updated based on new forest management results.
- Implementation of land-use change matrix: Develop and implement a land-use change matrix as a tool for tracking land conversion, which will allow for more accurate differentiation between land-use categories and their transformations.
- Development and implementation of a detailed forest classification: Incorporation of a detailed classification of forests by climatic and ecological zones into the national forest inventory system.
- Fuelwood removal records: Maintain detailed fuelwood hauling/removal statistics consistent with the 2006 IPCC Guidelines to better estimate carbon losses.
- Improve forest fire records: Improve forest fire records, including collecting more detailed data on fire area, type and intensity, to accurately estimate associated emissions.

Improvements related to assessment methods (factors and methodologies):

- Development of national emission and removal factors: Organization and implementation of research and development work to obtain national emission and removal factors specific to the conditions of Kyrgyzstan, which will allow the transition to the use of higher-level methods.
- Determination of reference stocks and national soil carbon change factors: Determination of reference stocks of organic carbon in forest soils, as well as development of national soil carbon stock change factors for different forest types and management types.

6.5. Cropland Category (4.B.)

6.5.1. Description

Cropland includes arable and cropland, rice paddies and agroforestry systems where the vegetation structure is below the threshold criteria used for the Forest Land category and it is expected that these thresholds will not be exceeded in the future.

This category includes land under temporary and permanent crops, as well as land temporarily fallow. Temporary crops include cereals, oilseeds, vegetables, root crops and forage crops. Permanent crops include tree and shrub plantations, including orchards, vineyards, shelterbelts and other agroforestry systems, except those that meet the criteria for Forest Land.

In 2023, the net absorption of greenhouse gases by perennial crops on Cultivated lands amounted to -1,767.2 kt of CO_2 eq., which is 461.4 thousand tons of CO_2 (or 35.3%) more than the 1990 level (see Table 6.20 and Fig. 6.9).

Table 6.20. Change in net absorption volumes

Category	Area, thousand hectares		Change of area		Net absorption (kt CO2)		Change in absorption	
	1990	2023	Thousand ha	%	1990	2023	kt CO_2	%
Cropland remaining cropland	159.7	184.9	25.3	15.8	-1,305.8	-1,767.2	-461.4	35.3

Over the entire period, the area of perennial plantings increased by 25.3 thousand hectares (15.8%). Detailed information on the area of perennial plantings is presented in Figures 6.9–6.11 and Table 6.20. Significant fluctuations in 1998–2003 may be due to revision of statistical approaches or changes in accounting methodology.

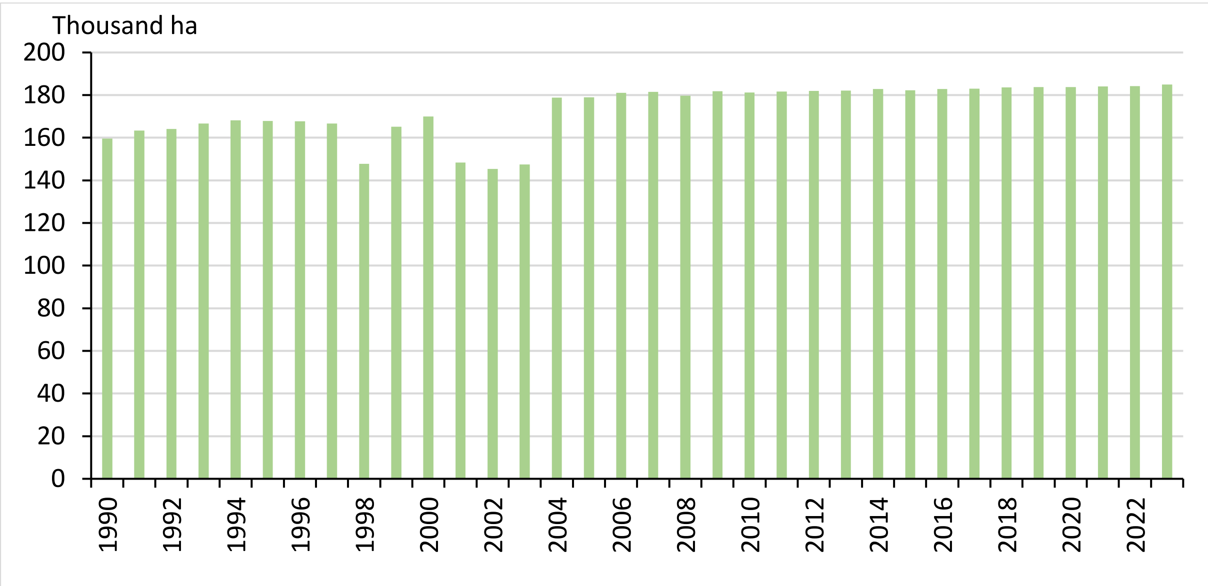

Figure 6.9. Perennial plantations area

The category "Cropland remaining Cropland" accounts for about 17% of the total absorption of the LULUCF sector. Figure 6.10 shows the net absorption of perennial plantings from 1990 to 2023.

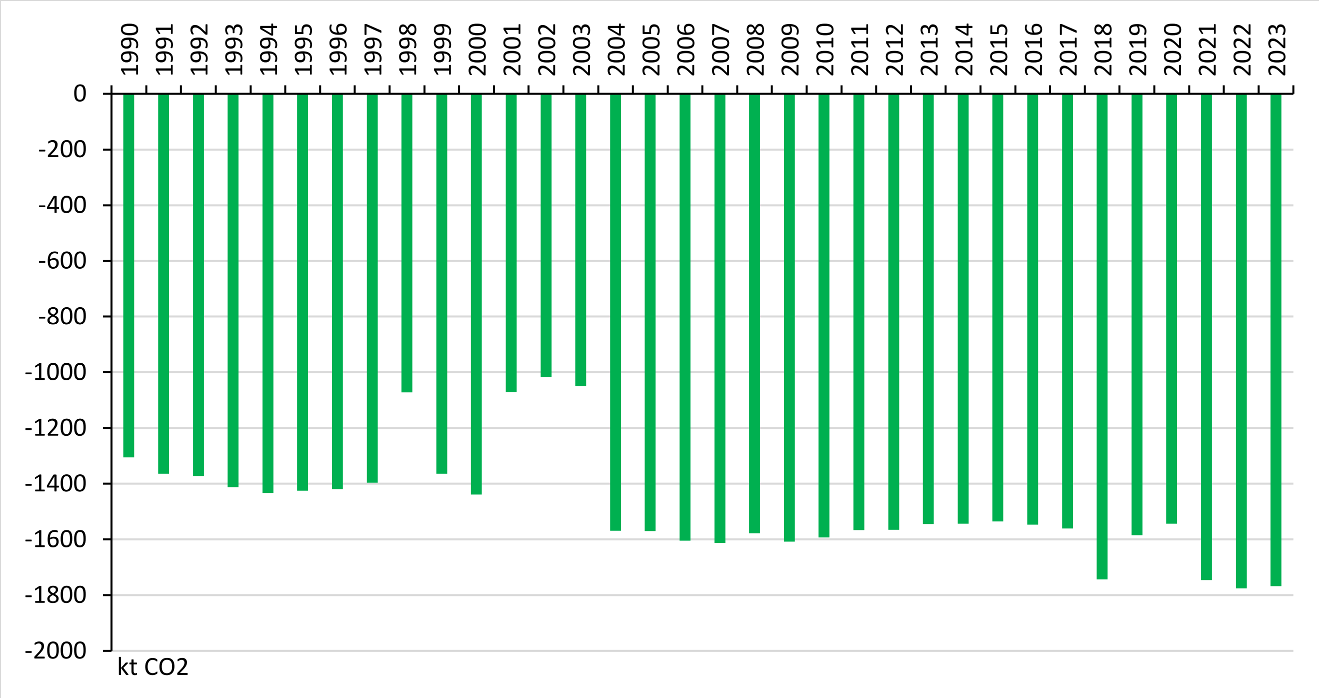

Figure 6.10. Net absorption by perennial plantings from 1990 to 2023

As shown in Figure 6.11, perennial plantings on cultivated land include: orchards, mulberry trees, forest shelterbelts, fruit and berry and other protective plantings. Figure 6.11 shows changes in the areas of different types of perennial plantings for the period 1990 to 2023. In general, there is a moderate increase in the area of orchards and protective forest plantings.

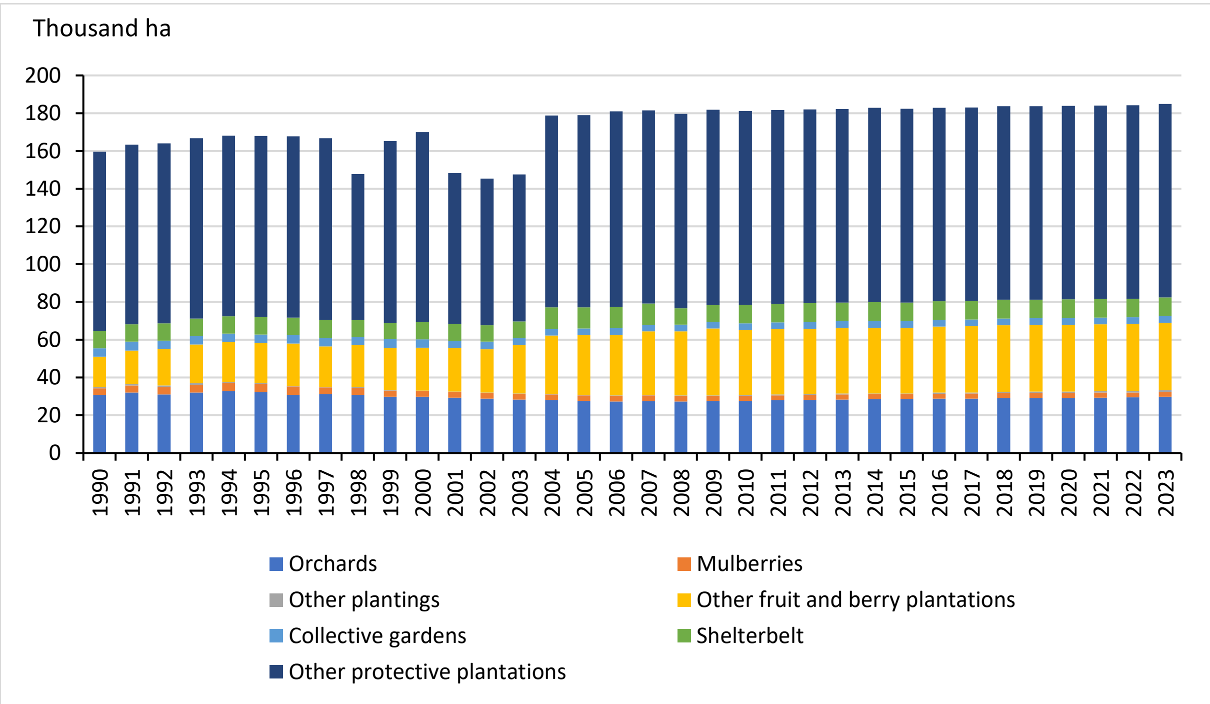

Figure 6.11. Structure of perennial plantings

The largest share is occupied by protective plantings in the structure of perennial plantings. The fluctuations recorded in 1998 and 2001–2003 are probably associated not with actual changes, but with a revision of the land accounting methodology.

6.5.2. Methodological issues

The category "Cropland Remaining Cropland" is also a key category. However, the transition to higher methodological levels is not possible due to the lack of national emission and removal factors, so the Level 1 method in accordance with the 2006 IPCC Guidelines was applied in this inventory. The calculations are based on default values recommended by the IPCC, including the biomass stock change factor and reference soil organic carbon stocks.

6.5.2.1 Category "Cultivated land remaining cultivated land" (4.B.1.)

According to the 2006 IPCC Guidelines, the following carbon pools and non-CO_2 gases should be estimated under Level 1 for the category Cultivated land Remaining Cultivated land:

- Biomass - aboveground and belowground.
- Soil carbon.
- Non-CO_2 gases.
- CH4 emissions from rice cultivation.

For dead organic matter, the Level 1 method assumes that dead wood and litter carbon stocks are either absent from Cultivated land or in equilibrium. Thus, there is no need to estimate carbon stock changes for these pools.

Methane (CH4) emissions from rice cultivation are estimated in the Agriculture sector.

Below is a table listing the carbon pools and non-CO_2 gases to be assessed at Level 1, according to the 2006 IPCC Guidelines.

Table 6.21. Land-use categories, carbon pools and non-CO2 gases to be assessed at Level 1 and relevant sections of the 2006 IPCC Guidelines.

Land use category	Subcategory	Carbon pools and non-CO2 gases	Section on methods	Method, Chapter 2.	Method, Level 2.
Cultivated land	Cultivated land remaining Cultivated land (CC)	Aboveground biomass	4.2.1	2.3.1.1	⊕
		Dead organic matter	4.2.2	2.3.2.1	0
		Soil carbon	4.2.3	2.3.3.1	⊕
		Non-CO2 gases from biomass combustion	4.2.4	2.4.1	⊕
		CH4 emissions from rice cultivation;	5.5	-	⊕

Notes for the Level 1 Method column:
⊕ - evaluation methods and default parameters are provided in the Guidelines.
0 - no methods or parameters are provided in the Guidelines, emissions are assumed to be zero or at equilibrium.

6.5.2.2 Activity data

Description and trends of perennial planting areas are presented in Section 6.1. Table 6.22 presents perennial planting areas from 1990 to 2023.

Table 6.22. Areas occupied by various perennial crops, thousand hectares

Years	Orchards	Mulberries	Other plantings	Orchards and other fruit and berry plantations	Collective orchards	Shelterbelt	Other protective plantations	Total
1990	30.8	3.4	0.8	16.1	4.4	9.2	95.0	159.7
1991	32.0	3.8	0.8	17.6	4.8	9.2	95.2	163.4
1992	31.1	3.9	0.8	19.3	4.4	9.2	95.3	164.1
1993	32.0	4.1	0.8	20.6	4.4	9.3	95.5	166.7
1994	32.7	4.3	0.7	21.1	4.4	9.3	95.7	168.2
1995	32.2	4.5	0.2	21.4	4.4	9.3	95.8	167.9
1996	30.9	4.3	0.4	22.4	4.4	9.4	96.0	167.8
1997	31.2	3.5	0.3	21.5	4.6	9.4	96.2	166.7
1998	30.9	3.5	0.6	22.1	4.5	8.8	77.3	147.7
1999	29.8	3.2	0.2	22.5	4.6	8.6	96.3	165.2
2000	29.9	3.0	0.2	22.7	4.4	9.1	100.6	169.9
2001	29.3	3.1	0.2	23.0	3.8	9.0	79.9	148.3
2002	28.9	3.0	0.2	22.9	4.0	8.6	77.7	145.3
2003	28.3	3.0	0.2	25.7	3.8	8.7	77.8	147.5
2004	28.1	3.0	0.3	30.9	3.4	11.4	101.7	178.8
2005	27.7	2.9	0.2	31.6	3.6	11.1	101.8	178.9
2006	27.3	3.0	0.2	32.0	3.6	11.3	103.6	181.0
2007	27.5	3.0	0.2	33.8	3.4	11.3	102.3	181.5
2008	27.3	3.0	0.2	34.0	3.5	8.7	103.0	179.7
2009	27.6	2.7	0.3	35.3	3.6	8.8	103.5	181.8
2010	27.7	2.6	0.4	34.5	3.5	9.9	102.6	181.2
2011	28.0	2.6	0.4	34.6	3.6	9.9	102.6	181.7
2012	28.2	2.6	0.5	34.6	3.6	9.9	102.6	181.9
2013	28.4	2.7	0.4	34.8	3.6	9.9	102.4	182.2
2014	28.5	2.6	0.4	34.7	3.6	9.9	103.0	182.9
2015	28.6	2.5	0.4	34.8	3.6	9.9	102.5	182.3
2016	28.8	2.6	0.6	34.9	3.6	9.9	102.5	182.9
2017	28.8	2.6	0.6	35.1	3.6	9.9	102.5	183.1
2018	29.1	2.6	0.7	35.2	3.6	9.9	102.5	183.6
2019	29.1	2.6	0.8	35.3	3.6	9.9	102.5	183.8
2020	29.2	2.6	0.8	35.3	3.6	9.9	102.5	183.8
2021	29.4	2.6	0.8	35.3	3.6	9.9	102.5	184.1
2022	29.5	2.6	0.8	35.4	3.6	9.9	102.5	184.2
2023	29.9	2.5	0.9	35.7	3.6	9.9	102.4	184.9

Note: Rows may not sum due to rounding.

6.5.2.3 Living Biomass

Choice of Method

Carbon can accumulate in the biomass of Cultivated land that contains perennial woody vegetation. Changes in biomass are estimated only for perennial woody crops. For annual crops, the increase in

biomass stocks in one year is assumed to be equal to the loss of biomass from harvesting and mortality in the same year. Thus, there is no net accumulation of carbon stocks in the biomass of annual crops.
The default assumption is that there is no change in the below-ground biomass of perennial trees grown in agricultural systems. Default values for below-ground biomass in agricultural systems are not available.

Biomass-related greenhouse gas emissions and removals, as well as forest emissions, were estimated using the biomass gain and loss method recommended by the 2006 IPCC Guidelines. According to this method, the change in carbon stocks in living biomass is defined as the difference between carbon inputs to biomass and its losses.

Selection of absorption factors and parameters

The gain and loss method requires the use of a number of parameters that allow quantitative assessment of carbon stock changes in aboveground biomass. In particular, data on biomass accumulation rates, harvest cycles, reference soil organic carbon stocks, and relative stock change factors are used.

- **Biomass accumulation rates (G) and harvest cycle:**

The coefficient values were selected based on Table 5.1 of the 2006 IPCC Guidelines. The coefficient corresponding to the moderate dry climate region was chosen, since the majority of perennial crops grow in this climate region.

The same coefficients and parameters were used for the entire time series.

6.5.2.4 Soil organic carbon

Choice of method

As with forest land, when using Approach 1 for reporting land-use data, where specific conversions between land uses are not monitored, the IPCC Guidelines recommend using the stock difference method to estimate changes in soil organic carbon under perennial cropland.

In this case, the calculation is made by comparing the total organic carbon stocks of soils under perennial cropland. The default time period for determining stock change (D) is 20 years, which is in line with the IPCC Guidelines recommendations for equilibrium or significant change.

The resulting difference between these values represents the net change in total organic carbon stocks due to changes in perennial cropland area during the period under analysis.

Selection of coefficients and parameters

• Soil organic carbon reference stocks

For the application of this method, the reference value for the mineral soil organic carbon stock (SOCref) is used at Level 1, expressed in tons of carbon per hectare. The SOC values are determined according to Table 2.3 and depend on the climate region. The climate regions were taken into account when selecting the appropriate values.

• Land use factor (FLU), management factor (FMG) and carbon input rates (FI):

The default coefficient values provided by the 2006 IPCC Guidelines were used for the calculations. The same coefficients and parameters were used for the entire time series.

6.5.2.5 Non-CO_2 gases from biomass combustion 4(IV).B.1.b.

According to the 2006 IPCC Guidelines, emissions of methane (CH_4) and nitrous oxide (N_2O) from the burning of crop residues should be included in the Cultivated land category, where data are available. Such an assessment at Level 1 requires information on the presence and characteristics of the burning of residues, as well as on crop types, residue mass, combustion parameters and associated emission factors.

Therefore, non-CO_2 emissions from the burning of crop residues have not been estimated in the current inventory, as the necessary activity data and parameters are not available. If such information becomes available, an estimate may be included in the future.

6.5.3. Uncertainties and consistency of time series

6.5.3.1 Uncertainty assessment

The uncertainty assessment in category 4.B.1 is based on the IPCC 2006 methodology. Table 6.23 provides the uncertainty values for the activity data and factors.

According to the Level 1 methodology, the uncertainty in the area of cropland is considered low, below 10%, since such data are collected annually using reliable methods. In the Kyrgyz Republic, data on the area of perennial plantings are also collected annually as part of official land reports. Given the availability of official annual statistics and the lack of direct uncertainty estimates, an area uncertainty of ±10% was adopted for the calculations, as recommended in the IPCC 2006 for Level 1. The uncertainties in the coefficients were taken from the 2006 IPCC Guidelines, since default coefficients and parameters were used in the calculations.

Table 6.23. Uncertainty assessment results

Component	Activity data uncertainty, %	Uncertainty of coefficients, %	General uncertainty
Annual increase in carbon stock in biomass	10	75	75.7
Changes in carbon stocks in mineral soils	10	90	90.6

6.5.3.2 Time Series Consistency

To ensure time series consistency, the same set of emission factors and parameters were used for the entire time series for all calculations.

6.5.4. Quality Assurance and Quality Control

In preparing the section on category 4.B., general quality control procedures were applied according to the recommendations of the 2006 IPCC (Table 6.1, Chapter 6, Volume 1).

In the process of working on section 4B, special attention was paid to the following aspects:

- Correctness of the transfer of data on areas of permanent crops from primary sources to the inventory files.
- Correctness of the choice of values of factors and parameters taking into account the relevant climatic zones.

- Reasonableness of the adopted assumptions and the applied default values from the 2006 IPCC Guidelines.
- Accuracy of the calculations of absorptions and recalculated values in the time series.

All data, assumptions and factors used were discussed within the framework of national and technical consultations.

6.5.5. Category-specific recalculations

6.5.5.1. Category "Cultivated land remaining cultivated land" (4.B.1)

The basis for the recalculation was the decision by national consultations on 8 April 2025 on the need to clarify the methodology for classifying land within the category[92]. The main reason was the revision of the approach to accounting for tree and shrub plantations, which were previously included in perennial crops.

The analysis adopted the methodological assumption that:

- tree and shrub plantations are mainly located near pasture lands,
- shrubs predominate in their vegetation composition.

To avoid possible double-counting and in accordance with IPCC guidelines, the mentioned areas were classified as pasture land.

Additionally, the new software version (v2.97) introduced the ability to estimate emissions and removals from shrub vegetation (vegetation type - shrubland), which was not available in the previous version (v2.54).

As a result of these changes, the area of perennial plantings in the category "Cropland" has been significantly reduced compared to the previous inventory (see Table 6.24).

Table 6.24. Area of perennial plantings in the category "Cropland" in NC 4 and BTR 1, thousand hectares

Year	Area of perennial plantings, thousand hectares		Difference	
	NC 4	BTR 1	thousand ha	%
1990	492.8	159.7	–333.1	-67.6
2000	502.7	169.9	–332.8	-66.2
2010	499.7	181.2	–318.5	-63.7
2020	500.7	183.8	–316.9	-63.3

A comparison of net removals by perennial crops in National Greenhouse Gas Inventories of NC 4 and BTR 1 is presented in Table 6.25 and Figure 6.12.

Table 6.25. Results of recalculation by areas

Year	Net absorption kt CO_2		Change	
	NC 4	BTR 1	kt CO_2	%
1990	3,415.3	1,305.8	-2,109.5	-61,8
2020	3,469.7	1,543.0	-1,926.7	-55,5

[92] Protocol of the National Consultations of 8 April 2025 (unpublished).

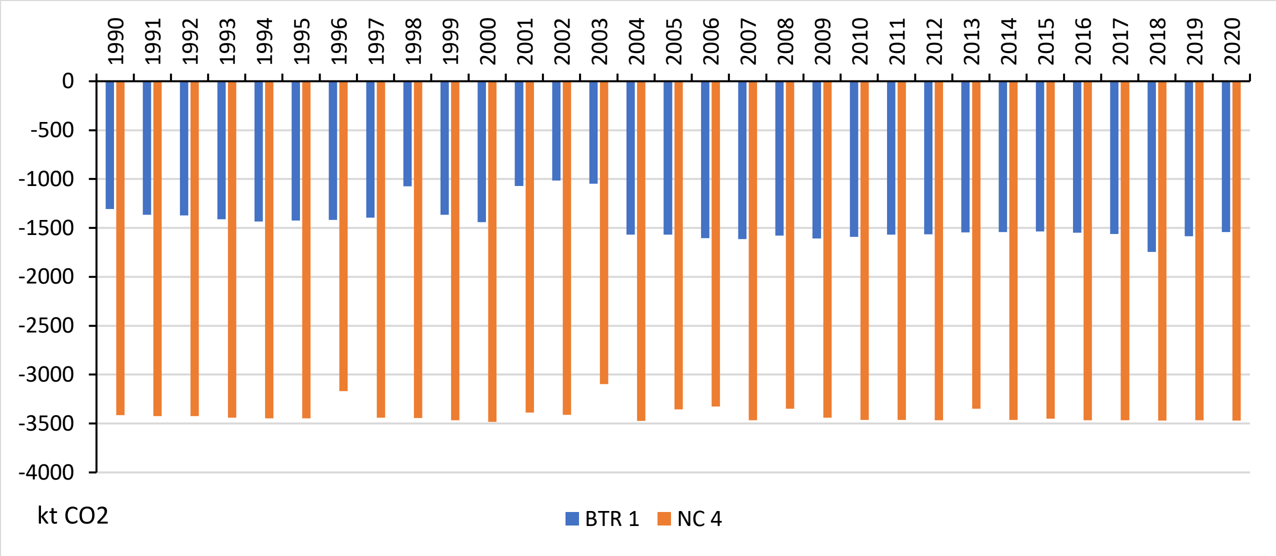

Figure 6.12 Comparison of absorption estimates in BTR 1 and NC 4

6.5.6. Planned improvements for specific categories

As part of the current inventory, important improvements have been made to the category "Cultivated land Remaining Cultivated land" to improve the accuracy of the estimates. These improvements include:

- Recalculation of the time series of estimates, which has resulted in a more precise land classification methodology. In particular, tree and shrub plantations have been reclassified as grassland to avoid double-counting.
- Estimation of changes in soil organic carbon stocks under perennial plantations using the stock difference method as provided in the IPCC Guidance for Approach 1 to Land Use Reporting.

No improvements are planned for this category. However, to further improve accuracy and completeness, and to move towards higher levels of IPCC methodology, the following improvements are recommended for the Cultivated land Remaining Cultivated land category:

Improvements related to activity data:

- **Clarification and validation of perennial plantings:** There is a need to refine and validate perennial plantings using remote sensing data.
- **Development and implementation of a land-use change matrix:** Development of a comprehensive land-use change matrix for the transition to higher approaches and methodological levels.
- **Detailing the classification of perennial plantings:** Development and implementation of a more detailed national classification of perennial plantings, taking into account their climatic, ecological and economic characteristics.
- **Collection of data on crop residue burning:** Organization of a systematic collection of detailed data on crop residue burning activities for subsequent estimation of non-CO_2 gases.

Improvements in estimation methods (factors and methodologies):

- Development of national emission and removal factors: Organization of research and development work to obtain national emission and removal factors specific to the conditions of Kyrgyzstan, which will allow the transition to higher-level methods.
- Establishing national parameters for soil organic carbon: Research to establish national soil organic carbon reference stocks (SOCrefs) and national stock change factors for mineral soils under different perennial plantings types and management practices.

6.6. Category "Grassland (4.C.)"

6.6.1. Description

The pasture lands of the Kyrgyz Republic are vast territories characterized by the dominance of herbaceous vegetation, as well as a significant presence of trees and shrubs in various climatic and altitude zones. They are the basis of the country's livestock industry and play a key role in providing the forage base.

According to the 2006 IPCC Guidelines, many shrub-covered areas with a high proportion of perennial woody biomass can be considered a type of pasture, and countries can classify all or part of these areas as pastures.

In previous national inventories, greenhouse gas emissions and absorptions associated with pastures were not taken into account. However, within the framework of the fifth cycle of the National Inventory, calculations for this category were performed for the first time. This became possible due to the revision of the methodology for accounting and reclassification of tree and shrub vegetation, previously accounted for as part of perennial plantings on cultivated lands. In 2023, the net absorption of CO_2 by tree and shrub vegetation on pastures amounted to -328.4 kt CO_2, which is 220.7 kt CO_2 (or 40.2%) less than in 1990 (see Table 6.26).

Table 6.26. Change in net absorption volumes

Category	Area, thousand hectares		Area change		Net absorption (kt CO_2)		Absorption change	
	1990	2023	Thou. ha	%	1990	2023	kt CO_2	%
Grassland remaining grassland	358.0	350.5	-7.5	-2.1	-549.1	-328.4	-220.7	-40.2

The observed reduction in the area of trees and shrubs by 7.5 thousand hectares (2.1%) over the period under review has an impact on the reduction in CO_2 absorption volumes.

The fluctuations recorded in 1998 and 2001–2003 may be due to revision of statistical approaches or changes in the accounting methodology. Details on the dynamics of the area of trees and shrubs on pastures for the period 1990–2023 are presented in Figure 6.13.

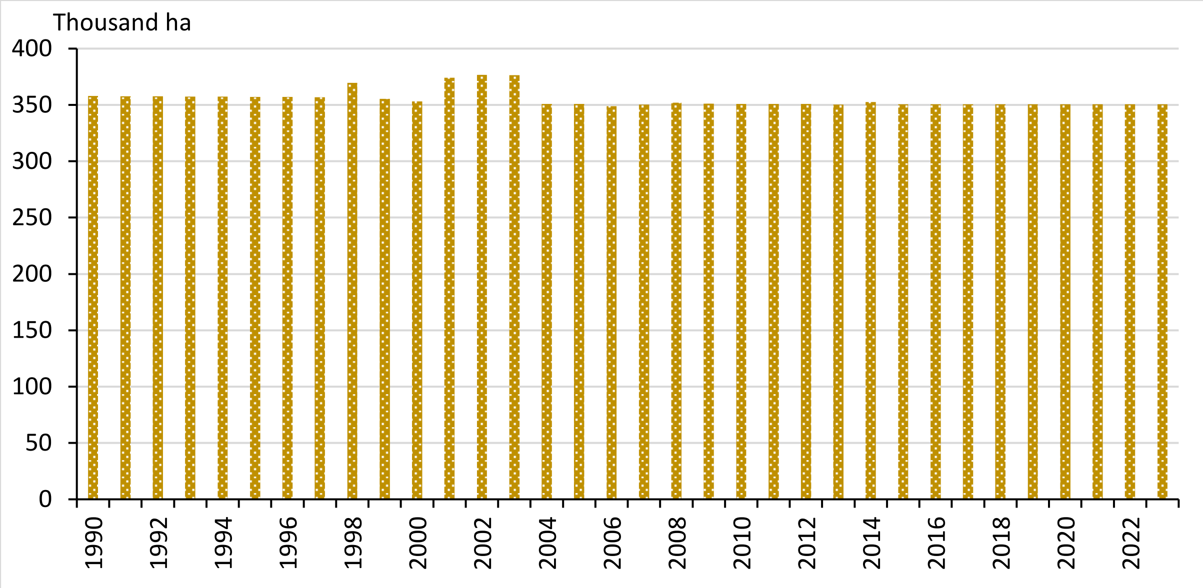

Figure 6.13. Areas of tree and shrub vegetation in the period 1990-2023

The contribution of the subcategory "Grassland Remaining Grassland to the total absorption of the LULUCF sector in 2023 is about 3%. The dynamics of net CO_2 absorption of the category is presented in Figure 6.14.

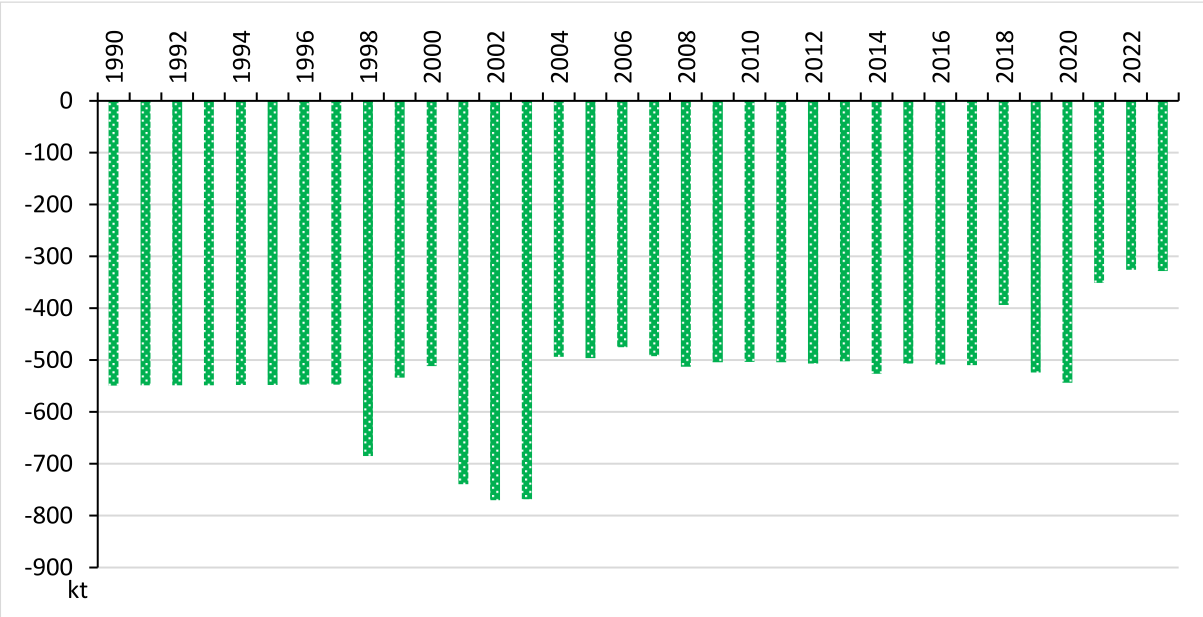

Figure 6.14. Net removals of trees and shrubs from pastures in the period 1990-2023.

6.6.2. Methodological issues

6.6.2.1. Category "Grassland Remaining Grassland" (4.C.1).

According to the 2006 IPCC Guidelines, the following carbon pools and non-CO_2 gases should be estimated for the category "Pastures Remaining Pastures" at Level 1:

- Soil carbon;
- Non-CO_2 gases - methane (CH_4) and nitrous oxide (N_2O) from biomass burning.

For living biomass and dead organic matter (dead wood and litter), the Guidelines do not provide default methods and parameters at Level 1. In such cases, changes in carbon stocks are assumed to be absent or in equilibrium, and emissions and removals are therefore assumed to be zero.

Below is Table 6.27, which lists the carbon pools and non-CO_2 gases to be assessed at Level 1, with the corresponding sections of the 2006 IPCC Guidelines.

Table 6.27. Carbon pools and non-CO_2 gases to be assessed at Level 1 and the corresponding sections of the 2006 IPCC Guidelines.

Land use category	Subcategory	Carbon pools and non-CO2 gases	Section on methods	Method, Chapter 2.	Level 1 Method
Pastures	Pastures remaining pastures	Living biomass	6.2.1	2.3.1.1	0
		Dead organic matter	6.2.2	2.3.2.1	0
		Soil carbon	6.2.3	2.3.3.1	⊕
		Non-CO2 gases from biomass combustion	6.2.4	2.4.	⊕
Notes for the Level 1 Method column: ⊕- Estimation methods and default parameters are provided in the Guidelines. 0 - The Level 1 approach assumes no change in pasture biomass. 0 - The Level 1 method assumes that dead wood and litter stocks are in equilibrium and thus there is no need to estimate carbon stock changes for these pools.					

The category "Grassland remaining grasslansx" (4.C.1) is not a key category according to the key category analysis. However, despite the fact that at Level 1 the IPCC Guidelines assume no change in carbon stocks in living biomass, it was decided to include an assessment of this category. The basis for this approach was the significant distribution of tree and shrub vegetation on the pastures of the Kyrgyz Republic.

To assess the change in carbon stocks, a national parameter based on the average wood increment according to the forest fund inventory of the Kyrgyz Republic was used in combination with the default wood density factor from the 2006 IPCC Guidelines (Table 4.14, Chapter 4, Volume 4).

6.6.2.2 Activity data

Table 6.28 presents the areas of tree and shrub vegetation from 1990 to 2023. A detailed description of the data sources is given in Section 6.3.

Table 6.28. Data on the areas of tree and shrub vegetation from 1990–2023, thousand hectares

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Area	358.0	357.8	357.7	357.5	357.3	357.2	357.0	356.8	369.5
Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Area	3553	353.1	374.1	376.8	376.5	350.9	351.0	348.9	350.4
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Area	352.10	351.20	351.00	350.92	350.98	350.44	352.53	350.59	350.59
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**		
Area	350.6	350.6	350.6	350.6	350.6	350.5	350.5		

6.6.2.3 Living Biomass

Method Selection

Emissions and removals of greenhouse gases associated with biomass were estimated using the biomass gain–loss method recommended by the 2006 IPCC Guidelines. According to this method, the change in carbon stocks in living biomass is defined as the difference between carbon inputs to biomass and its losses. However, the losses were not estimated due to the lack of data on wood removals from these areas.

The use of this method provides a quantitative estimate of changes in carbon stocks in living biomass using national default parameters and factors.

Emission Factors and Parameters

Choice of Factors and Parameters

The gain–loss method requires the use of a number of parameters and factors that allow the change in carbon stocks in living biomass to be quantified. In particular, the average annual rate of accumulation of aboveground perennial biomass (G), the ratio of belowground to aboveground biomass (R), and the fraction of carbon in dry matter (CF) are used.

- **Average annual rate of accumulation of aboveground perennial biomass (G):**

To determine the average annual rate of accumulation of perennial biomass, a national parameter based on the average wood increment from the forest inventory of the Kyrgyz Republic was used in combination with the default wood density factor from the 2006 IPCC Guidelines (Table 4.14, Chapter 4, Volume 4).

- **Belowground to aboveground biomass ratios (R):**

Calculations are based on the ratio of belowground to aboveground biomass (R), the values of which are taken from Table 6.1. The choice of R factor was made taking into account the vegetation type.

- **Carbon fraction in dry matter (CF):**

The standard value of 0.47, recommended as the default value for Tier 1, was used to calculate the carbon content of biomass.

6.6.2.4 Soil organic carbon

Choice of method

As with other land-use categories, when using Approach 1 for reporting land-use data, where specific conversions between land-use types are not monitored, the 2006 IPCC Guidelines recommend using the stock difference method to estimate changes in soil organic carbon in pastures.

In this case, the calculation is made by comparing the total organic carbon stocks of the soils under pastures. In this case, a default time period of 20 years is used to determine the stock change (D), which is consistent with the IPCC Guidelines recommendations for equilibrium or significant change.

The resulting difference between these values reflects the net change in total organic carbon stock associated with the change in the area of grassland covered by trees and shrubs during the analysis period.

Selection of stock change factors and parameters

- **Soil organic carbon reference stocks**

For the application of this method, the reference value for the mineral soil organic carbon stock (SOCref) is used at Tier 1, expressed in tons of carbon per hectare. The SOC values are determined according to Table 2.3 and depend on the climate region. The climate regions were taken into account when selecting the appropriate values.

- **Land use factor (FLU), management factor (FMG) and carbon input rates (FI):**

The default coefficient values provided by the 2006 IPCC Guidelines were used for the calculations. The same coefficients and parameters were used for the entire time series.

6.6.2.5 Non-CO_2 gases from biomass burning 4(IV).C.1.b.

Grassland fires may involve both herbaceous and woody vegetation. According to IPCC 2006:

- CO_2 emissions from biomass burning in Grassland remaining grassland are not reported because they are largely offset by CO_2 that is incorporated back into the biomass through photosynthesis within weeks to years after burning.;
- Non-CO2 emissions (particularly CO, CH_4, N_2O and NOx) from incomplete combustion of biomass in managed grassland should be reported regardless of origin (natural or anthropogenic fires).

At Level 1, emissions are estimated using data from Table 2.4, which lists biomass fuel consumption by vegetation type. However, this requires stratification of fire data by vegetation type, which is not possible due to a lack of information. Therefore, non-CO_2 emissions from grassland fires have not been estimated. As the necessary data become available, an estimate may be included in future inventories.

6.6.3. Uncertainties and consistency of time series

6.6.3.1 Uncertainty assessment

The uncertainty assessment for category 4.C.1. “Grassland remaining grassland” was carried out in accordance with the 2006 IPCC methodology. Table 6.29 presents the uncertainty values for the activity data and coefficients.

A direct assessment of the uncertainty of the activity data and the national parameter calculated on the basis of the total average increment according to the forest fund inventory data of the Kyrgyz Republic, as well as the wood density value from Table 4.14 (Chapter 4, Volume 4) of the 2006 IPCC Guidelines, was not possible due to the lack of sufficient information.

In this regard, the following assumptions were made:

- The uncertainty of the average annual rate of accumulation of aboveground perennial biomass is estimated at approximately 15%.
- Activity data uncertainty within 10%.

Uncertainties for the remaining factors were taken from IPCC 2006, as default values were used in the calculations.

Table 6.29. Uncertainty assessment results

Component	Activity data uncertainty, %	Emission factors uncertainty, %	Total uncertainty
Annual increase of carbon stock in biomass	10	144.8	145.1
Change in carbon stocks in mineral soils	10	90	90.6

6.6.3.2 Time series consistency

To ensure time series consistency, the same set of coefficients and parameters was used for the entire time series.

6.6.4. Quality Assurance and Quality Control

The section was prepared using general quality control procedures as recommended in the 2006 IPCC Guidelines (Table 6.1, Chapter 6, Volume 1).

In the course of work on this category, special attention was paid to the following aspects:

- the correctness of the transfer of data on the area of woody and shrubby vegetation from pastures from primary sources to the calculation tables;
- the validity of the choice of the national parameter based on the total average increment according to forest inventory data;
- the correctness of the application of the wood density coefficient and other default parameters given in the 2006 IPCC Guidelines;
- compliance with uniform approaches in calculating the indicators for the entire time series.

All data, parameters, assumptions and calculation approaches used were discussed within the framework of national and technical consultations.

6.6.5. Category-specific recalculations

No recalculations were made for category 4.C. “Pastures Remaining Pastures” because emissions and removals for this category were not estimated in previous national inventories.

6.6.6. Planned improvements for specific categories

As part of the current inventory for the category "Pasture Remaining Pasture", the CO2 absorption by trees and shrubs was estimated for the first time.

No improvements are planned for this category; however, the following improvements are recommended to improve the accuracy of calculations and possible transition to a higher level of the IPCC methodology:

Improvements related to activity data:

- Clarification of areas of trees and shrubs: it is recommended to refine and validate these areas using remote sensing data.
- Implementation of a land-use change matrix: creation of a land-use change matrix for the transition to higher approaches and methodological levels.

- Stratification of fires in grasslands: stratification of fire areas by vegetation types is necessary to estimate GHG emissions.

Improvements related to estimation methods (factors and methodologies):

- Development of national emission and removal factors: research should be conducted to establish and refine national factors for shrub vegetation. This will provide a more accurate estimate of carbon flows.
- Definition of parameters for soil carbon: It is necessary to study reference stocks of soil organic carbon in grasslands, as well as the corresponding change factors under different conditions and management types.

6.7. Wetlands Category (4.D.)

Wetlands include any land that is covered or saturated with water for all or part of the year and that does not fall under the categories of forest land, cultivated land or pasture. Managed wetlands include only wetlands in which the groundwater level is artificially modified (e.g. drained or rewetted) or that are created by human activity (e.g. damming a river).

The wetlands category includes 2 subcategories:

- Peatlands
- Floodplains.

Table 6.30 below contains a list of Greenhouse Gases (GHGs) to be assessed at Level 1, with an indication of the relevant methodological sections of the 2006 IPCC Guidelines.

Table 6.30. Greenhouse gases that are subject to assessment at Level 1 and relevant sections of IPCC 2006.

Land use category	Subcategory	Gases	Section on methods	Method, Chapter 2.	Level 1 Method
Wetlands	Peatlands remaining peatlands	CO2 emissions	7.2.1.1	-	⊕
		Emissions of gases other than CO2	7.2.1.2	-	⊕
	Floodplains remaining floodplains	CO2 emissions	NG	-	0
		Emissions of gases other than CO2	Addition 3	-	⊕

Notes for the Level 1 Method column:
⊕- Estimation methods and default parameters are provided in the Guidelines.
0 – floodplains remaining floodplains, no methodologies are provided.
NG – no indication in the Guidelines

Due to the lack of necessary data on peatlands, including information on areas (managed and unmanaged), location in climate zones, nutrient classification and volumes of peat extracted, greenhouse gas emissions were not estimated in the current inventory. The notation key "NE" (not estimated) was applied for this category.

Greenhouse gas emissions from floodplains were also not estimated due to the lack of necessary data for calculations. In particular:

- seasonal flooded areas,
- ice-free period,
- and data on average daily emissions.

Due to the lack of this information, the notation key "NE" (not estimated) was also applied for this category.

6.8. Category “Settlements” (4.E.)

Settlements include all developed lands, including residential, transport, retail and production (commercial, industrial) infrastructure of any size, unless they are included in other land-use categories.

Below is Table 6.31, which contains a list of carbon pools to be assessed at Level 1, with an indication of the relevant methodological sections of the 2006 IPCC Guidelines.

Table 6.31. Carbon pools to be assessed the relevant sections of the 2006 IPCC Guidelines

Land use category	Subcategory	Carbon pool	Section on methods	Method, Chapter 2.	Level 1 Method
Settlements	Settlements remaining settlements (SS)	Aboveground biomass	8.2.1	2.3.1.1	0
		Dead organic matter	8.2.2	2.3.2.1	0
		Soil carbon	8.2.3	2.3.3.1	⊕[1]

Notes for the Level 1 Method column:
0 - no methods or parameters are provided in the Guidelines; emissions are assumed to be zero or at equilibrium.
⊕[1]- in the guidelines the default parameters are only available for organic soils..

As shown in Table 6.31, no methods or parameters are provided in IPCC 2006 for estimating carbon changes in aboveground biomass and dead organic matter at Level 1. It is assumed that emissions and absorptions are in equilibrium. For soil carbon, IPCC 2006 provides default parameters only for organic soils. The necessary activity data and national parameters and factors are not available for estimation using methods of a higher level. Therefore, no estimation of greenhouse gas emissions and removals from settlements has been made in the current inventory and, therefore, the notation key "NE" (not estimated) has been applied.

6.9. Category "Other Land" (4.F.)

Other Land includes areas without vegetation, rock, glaciers, and all land areas that are not included in any of the other five land-use categories. These lands are often unmanaged, in which case changes in carbon stocks and emissions of gases other than CO2 are not estimated. The 2006 IPCC Guidelines only guide land converted to "Other Land". This is because the conversion involves changes in carbon stocks.

Due to the lack of sufficient data on land conversions to "Other Land", emissions and removals were not estimated in the current inventory and the notation key "NE" (not estimated) was used.

6.10. Category "Harvested wood" (4.G.)

In consideration of the small volumes of annual timber harvesting, it is assumed that the contribution of this category to the total absorption may be quite low. Due to this and the lack of reliable data on timber use, emissions and removals for this category have not been estimated. The notation key "NE" (not estimated) has been applied.

7. Waste (CRT 5)

7.1. Sector overview

The Waste sector covers greenhouse gas emissions arising from the processing, disposal and use of various types of waste. In 2023, the volume of total greenhouse gas emissions in the Kyrgyz Republic from the Waste sector was about 5%, the most comes from CH4 emissions from domestic wastewater and waste landfill deposit and a small part from N2O. Emissions in the Waste sector were estimated in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for the following categories and subcategories:

- 5.A. Solid Waste Disposal
    - 5.A.2. Unmanaged Solid Waste Landfills
- 5.B. Biological Treatment of Solid Waste
    - Composting
- 5.C. Incineration and Open Burning
    - 5.C.2. Open Burning of Waste
- 5.D. Wastewater Treatment and Discharge
    - 5.D.1. Domestic Wastewater Treatment and Discharge
    - 5.D.2. Industrial Wastewater Treatment and Discharge.

The Level 1 method and default emission factors (see Table 7.1) were used to estimate greenhouse gas (GHG) emissions for all categories in the Waste sector. The main provider of information is the National Statistical Committee of the Kyrgyz Republic.

An important part of the analysis of GHG inventory results is the assessment of uncertainty. The total uncertainty for each category is the sum of the uncertainty of the collected data and the uncertainty of the applied method for estimating GHG emissions. For the applied assessment method (level), this is the greatest uncertainty of the emission factors used. Given that the emission factors (EF) recommended by the 2006 Methodology by default were used to estimate GHG emissions, the main contribution to the uncertainties of the "Waste" sector is made by the uncertainties of the activity data. The uncertainty calculation for all the considered categories of the "Waste" sector was performed in accordance with the 2006 Guidelines, Volume 1, Chapter 3.

Table 7.1. Methods, emission factors and indicators of key categories in the Waste sector in 2023.

Category	CO2			CH4			N2O		
	Method	EF	Key category	Метод	Method	EF	Key category	КВ	Method
5.A. Solid waste disposal	NA	NA	NA	T1	D	L, T	NA	NA	NA
5.B. Biological treatment of solid waste	NA	NA	NA	T1	D	-	T1	D	-
5.C. Incineration and open burning	T1	D	-	T1	D	-	T1	D	-
5.D. Wastewater treatment and disposal	NA	NA	NA	T1	D	L, T	T1	D	+

NA – not applicable; T1 – IPCC Guidelines Level1; D – IPCC Guidelines default emission factor. L – key category by level; T – key category by trend.

In 2023, emissions from the Waste sector amounted to 959.80 kt CO_2 eq. The largest contribution to the sector's GHG emissions in 2023 was made by category "5.D. Wastewater discharge and treatment" - 562.92 kt CO_2 eq., of which 433.21 kt CO_2 eq. came from subcategory "5D1. Domestic wastewater discharge and treatment" and 21.0 kt CO_2 eq. from subcategory "5.D2. Industrial wastewater discharge and treatment". Wastewater treatment in the Kyrgyz Republic is mainly carried out by aerobic methods, which is accompanied by CH_4 emissions. The contribution of the wastewater category was 58.6% of total sectoral emissions.

Category "5.A.2. Solid waste disposal" accounts for 381.91 kt CO_2 eq. (39.8%). This category is the second largest GHG emission category in the Waste sector, accounting for 39.8% of total sectoral emissions. Greenhouse gas emissions from waste disposal in landfills are CH4. According to the inventory of waste disposal sites in the Kyrgyz Republic conducted in 2018, there were 406 landfills, of which only 107 (26%) were authorized. Many landfill sites (almost 96%), even those that are authorized and have the appropriate title documents, have not been transformed into the appropriate land category required for the placement of landfills, that is, into the category of industrial, transport, communications, energy, defense and other lands. This creates legal barriers to regulation and control over waste disposal sites. [93]

GHG emissions from subcategory "5.C.2. Open burning of waste" amounted to 13.21 kt CO_2 eq. Open burning made up a small part of all emissions in the sector and amounted to 1.4%. There are no operating waste incineration plants in the Kyrgyz Republic, but there is a practice of waste burning by the population. The National Statistical Committee does not keep a "direct" record of burned waste, including by its composition, but it does keep records of the population getting rid of waste by burying it. Since 2016, fewer people have resorted to waste burning, it is explained by the introduction of stricter restrictions on this method of disposal.

Emissions from category "5.B. Biological treatment of solid waste" (composting) amounted to 1.8 kt CO_2 eq. For the Kyrgyz Republic, composting is a developing area in waste management and is practiced mainly by small municipal sites and pilot projects with the support of international organizations; "direct" accounting of composted waste is not conducted. However, the National Statistical Committee of the Kyrgyz Republic keeps records of the population that disposes of garbage by burying. Emissions from this category account for 0.2% of emissions from the "Waste" sector. The dynamics of GHG emissions by the "Waste" sector for the period 1990-2023 by source categories is presented in Fig. 7.1.

93 Analytical Report on the Inventory of Waste Disposal Sites in the Kyrgyz Republic http://eco-expertise.org/wp-content/uploads/2022/03/Analytical_report_on_the_inventory_of_waste_disposal_sites_.pdf

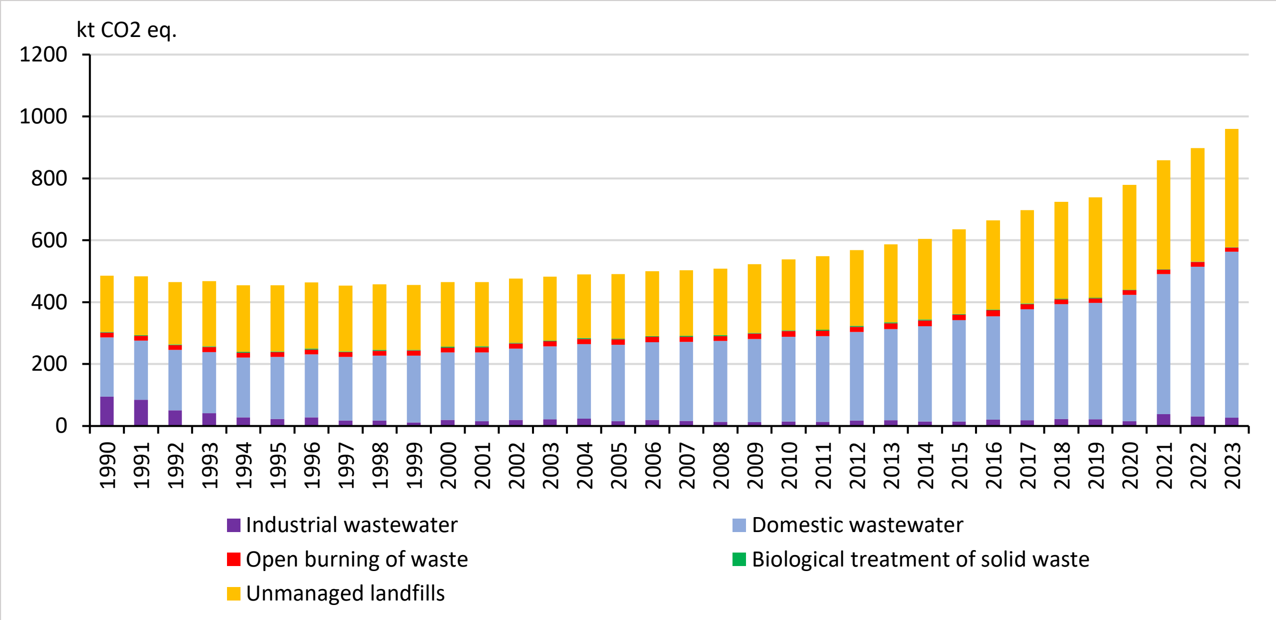

Figure 7.1. GHG emissions trends in the Waste sector for the period 1990–2023.

From 1990 to 2023, GHG emissions in the Waste sector increased by 473.76 kt CO_2 eq. (97.5%), in category 5.A, GHG emissions by 2023 increased by 275.49 kt CO_2 eq. (96.5%), in category 5.B emissions by 2023 decreased by 0.40 kt CO_2 eq. (19%), in category 5.C emissions by 2023 decreased by 2.2 kt CO_2 eq. (14.38%), and in category 5.D they increased by 276.5 kt CO_2 eq. (96.5%) compared to 1990 levels. Table 7.2 presents greenhouse gas emissions by categories in the Waste sector for the periods 1990 and 2023 in kt CO_2 eq.

Table 7.2. Greenhouse gas emissions in the Waste sector for the period 1990-2023 according to the IPCC category coding.

Year	5.A.	5.B.	5.C.	5.D.	Total	Year	5.A.	5.B.	5.C.	5.D.	Total
1990	182.01	2.17	15.43	286.42	486.04	**2007**	211.60	2.90	16.54	271.96	503.00
1991	190.12	2.22	15.58	275.55	483.47	**2008**	214.43	2.96	16.05	274.73	508.17
1992	201.43	2.27	15.76	245.76	465.29	**2009**	222.00	2.87	17.44	280.89	523.20
1993	210.97	2.29	15.76	239.16	468.19	**2010**	229.38	2.57	17.91	288.50	538.35
1994	215.73	2.29	15.59	221.43	455.04	**2011**	236.85	3.22	17.34	290.86	548.27
1995	214.12	2.31	15.57	222.79	454.79	**2012**	244.44	3.59	16.69	303.53	568.26
1996	214.12	2.36	15.72	231.55	463.69	**2013**	251.79	2.88	18.34	313.57	586.59
1997	212.62	2.41	15.85	222.89	453.76	**2014**	261.24	2.74	18.07	322.91	604.90
1998	212.16	2.45	16.00	227.14	457.75	**2015**	273.03	2.40	17.96	341.81	635.20
1999	209.95	2.50	16.10	227.37	455.92	**2016**	287.54	2.26	19.55	354.63	664.0
2000	208.76	2.55	16.29	237.17	464.77	**2017**	301.55	1.88	17.36	376.75	697.55
2001	207.76	2.59	16.35	238.10	464.80	**2018**	312.98	1.76	15.87	393.19	723.80
2002	207.19	2.63	16.40	249.81	476.03	**2019**	324.51	1.60	15.21	397.47	738.70
2003	206.74	2.67	16.46	257.00	482.86	**2020**	338.59	1.53	15.69	423.20	779.00
2004	206.2	2.71	16.55	264.66	490.15	**2021**	352.41	1.38	14.93	490.30	859.02
2005	208.79	2.76	16.66	262.96	491.17	**2022**	366.76	1.59	15.34	514.51	898.20
2006	209.70	2.80	16.73	271.21	500.43	**2023**	381.91	1.76	13.21	562.92	959.80

Over the period from 1990 to 2023, there has been an increase in emissions of methane (CH_4) by 454.56 kt CO_2 eq. (106.4%) and nitrous oxide (N_2O) by 19.2 kt CO_2 eq. (32.7%) (see Fig. 7.2).

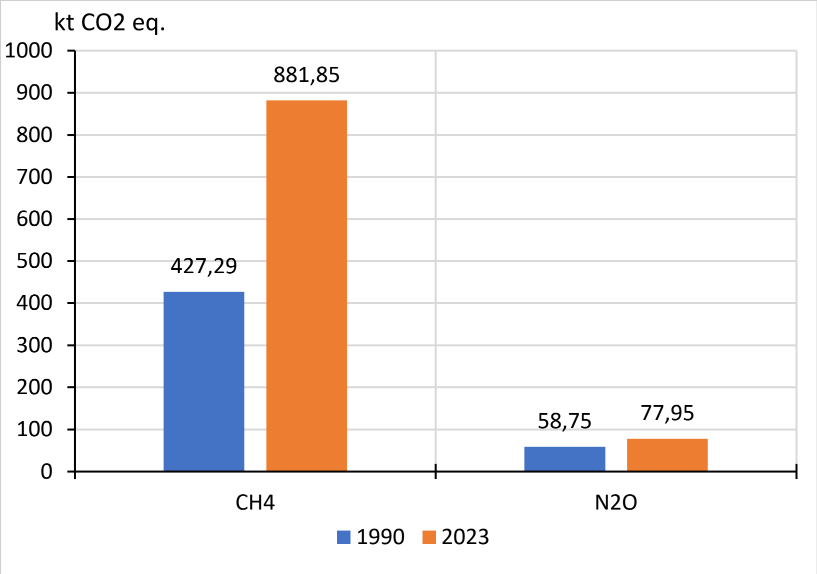

Figure 7.2. Comparison of GHG emissions by gas types in the Waste sector in 1990 and 2023

Table 7.3. shows GHG emissions in kt of CO2 equivalent in the Waste sector by year for the period 1990-2023.

Table 7.3. GHG emissions in the Waste sector for the period 1990-2023.

Year	CH_4	N_2O	Total	Year	CH_4	N_2O	Total
1990	427.3	58.8	486.0	**2007**	448.7	54.3	503.0
1991	430.0	53.5	483.5	**2008**	451.8	56.4	508.2
1992	412.3	53.0	465.3	**2009**	464.4	58.8	523.2
1993	414.8	53.3	468.2	**2010**	479.1	59.3	538.4
1994	407.1	48.0	455.0	**2011**	489.1	59.2	548.3
1995	403.2	51.6	454.8	**2012**	509.3	59.0	568.3
1996	413.4	50.3	463.7	**2013**	525.1	61.4	586.6
1997	407.5	46.2	453.8	**2014**	541.7	63.3	605.0
1998	409.5	48.2	457.7	**2015**	572.5	62.7	635.2
1999	407.1	48.8	455.9	**2016**	597.4	66.6	664.0
2000	417.1	47.7	464.8	**2017**	633.8	63.8	697.5
2001	416.5	48.3	464.8	**2018**	657.6	66.2	723.8
2002	424.5	51.6	476.0	**2019**	669.8	69.0	738.8
2003	429.9	52.9	482.9	**2020**	707.1	71.9	779.0
2004	436.3	53.9	490.1	**2021**	786.1	72.9	859.0
2005	435.8	55.4	491.2	**2022**	823.3	74.8	898.2
2006	445.4	55.0	500.4	**2023**	881.9	78.0	959.8

The diagram in Fig. 7.3 shows the dynamics of methane (CH_4) and nitrous oxide (N_2O) emissions in kt CO_2 eq. for the period 1990 - 2023.

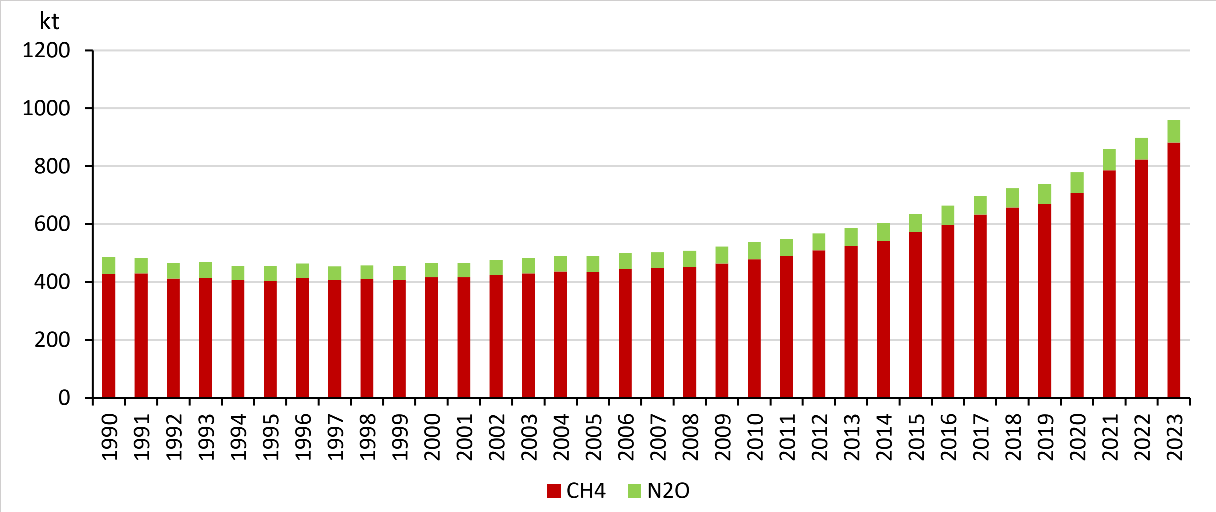

Figure 7.3. Dynamics of GHG emissions by gas types in the Waste sector for the period 1990–2023.

7.2. Category "5.A. Solid Waste Disposal"

7.2.1. Subcategory "5.A.2. Unmanaged landfillst"

In 2018, within the framework of the United Nations Environment Programme (UNEP) project "Strengthening the Kyrgyz Republic's capacity to manage waste throughout the life cycle"[94] an inventory of consumer waste disposal sites in the Kyrgyz Republic was conducted, according to which 406 landfills were counted. The operational capacity of many landfills in large cities was calculated for 15-20 years (1970), but this period stretched out for more than 30 years.

According to the inventory, many landfills were created and operate without compliance with technical, sanitary and environmental safety standards. Most solid waste landfills are located on agricultural lands and do not meet sanitary and environmental requirements for waste disposal, are not fenced and no records are kept of waste receipt. There are no exact data on accumulated waste, due to the lack of accounting for the amount of waste placed and the lack of organization of waste removal.[95.]

The environmental requirements for waste placement facilities stipulated by law are not always observed, concerning the implementation of environmental monitoring, keeping records of the amount and characteristics of the placed waste indicating the origin, date of delivery, identification of the producer or waste collector, and in the presence of hazardous waste - the exact location of their placement, conducting dosimetry monitoring of each batch of waste to prevent radioactive substances from entering the landfill.

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94 Comprehensive Analysis of the Existing State of the Municipal Solid Waste (MSW) Management System

http://eco-expertise.org/sovershenstvovanie-ekologicheskoj-pol/stranovye/

95 Analytical Report on the Inventory of Waste Disposal Sites in the Kyrgyz Republic

http://eco-expertise.org/wp-content/uploads/2022/03/Analytical_report_on_the_inventory_of_waste_disposal_sites_.pdf

According to the data of the National Statistical Committee, the amount of waste disposed to landfills in the Kyrgyz Republic in 2023 totaled **1,505.38 thousand tons**. The amount of waste disposed by region of the country is presented in Figure 7.7 (in thousand tons).

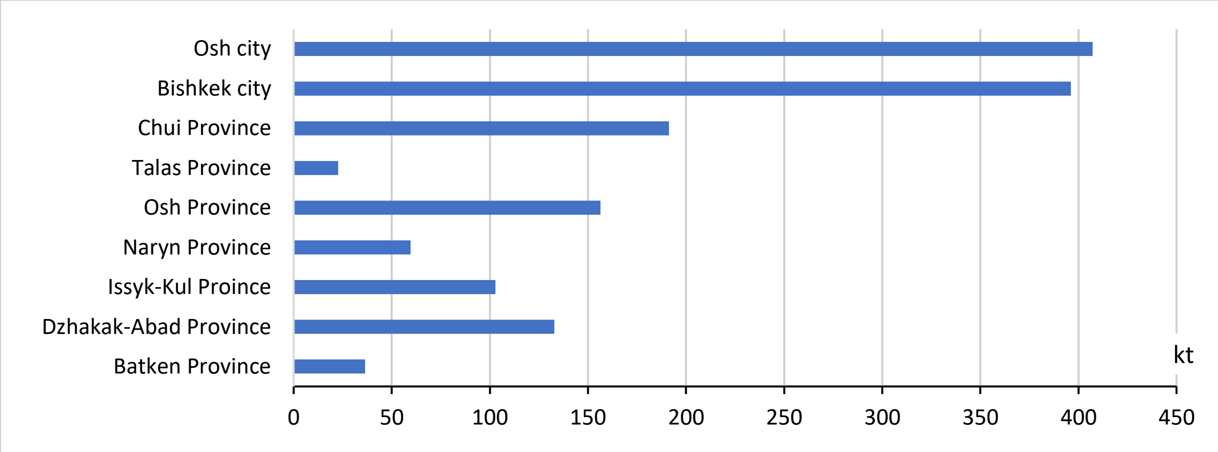

Figure 7.4. Regional distribution of waste disposal in 2023

As shown in Figure 7.4, the largest volumes of municipal solid waste (MSW) disposed in 2023 were recorded in Osh (440 thousand tons) and Bishkek (430 thousand tons). However, it should be noted that low figures for other regions do not indicate the absence of waste, but rather reflect problems in data collection and reporting.[96, 97].

At present, the waste management system in the Kyrgyz Republic is based primarily on the collection and disposal of mixed municipal solid waste (MSW). The prevailing practice of household waste treatment consists of disposal at sanitary landfills and unorganized dumps. The situation is further aggravated by the absence of separate collection of household waste: expired medicines, broken fluorescent lamps and thermometers containing mercury, containers with residues of pesticides, paints, varnishes, and other hazardous substances are discarded into common containers together with paper, plastics, glass, metal packaging, and food waste. All of this is transported to landfills, which are most often arranged in abandoned quarries, ravines, wetlands, and frequently near residential areas.[98] Thus, the absence of separate collection and centralized treatment of hazardous household waste increases the risks of environmental pollution and complicates the reliable inventory of greenhouse gas emissions.

In certain waste disposal sites, partial sorting of plastic bottles, cardboard, and glass containers is carried out; however, in most landfills, sorting is absent. Informal waste collectors select part of the

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96 Analytical Report on the Inventory of Waste Disposal Sites in the Kyrgyz Republic

https://eco-expertise.org/wp-content/uploads/2022/03/Analytical_report_on_the_inventory_of_waste_disposal_sites_.pdf

97 Waste management and recycling in the former Soviet Union: The City of Bishkek, Kyrgyz Republic (Kyrgyzstan) https://www.researchgate.net/publication/258200465_Waste_management_and_recycling_in_the_former_Soviet_Union_The_City_of_Bishkek_Kyrgyz_Republic_Kyrgyzstan

98 National Report on the State of the Environment of the Kyrgyz Republic, 2015–2018. Bishkek, 2020. https://aarhus.kg/wp-content/uploads/2021/05/NSOER_rus.pdf

valuable waste fractions at waste collection sites. Official statistics on the amount of sorted and recycled municipal solid waste[99] (MSW) are not maintained.

Public access to municipal solid waste (MSW) collection and disposal services is provided mainly in large cities of the country, while for small towns and rural areas (especially remote rural settlements) the problem is either the absence of such services or their insufficient level. Methods of waste disposal directly depend on access to the services provided by municipal utilities.

Industrial Waste. According to the information provided in response to the request, the NSC does not have data on the amount of industrial waste generated and disposed of in sanitary landfills, such as: food waste, waste from the tobacco industry, pulp and paper, textiles, construction and demolition waste, and waste from the woodworking industry. According to the National Report on the State of the Environment for 2010–2014,[100] a significant share of production waste is disposed of on enterprise premises (122 waste disposal sites). On average, about one percent of the waste generated annually is transferred to other enterprises, mainly for use or disposal. Waste is transferred or transported mainly to municipal landfills. Since 2013, there has been a trend of increasing waste utilization within enterprises themselves. Thus, enterprises began to use newly generated production and consumption waste at a rate of 38% in 2013 and 48% in 2014, attributing this to the availability of financial resources for these purposes.

Medical Waste. According to the information provided in response to the request, the NSC does not have data on the amount of medical waste generated and disposed of in sanitary landfills. According to the Analytical Report presented by the NGO "Profmeditsina," medical waste is disposed of in landfills together with municipal solid waste (MSW), part of it is subject to open burning, and it constitutes a share of MSW.

In healthcare organizations, general non-hazardous waste is collected separately in containers placed on special sites, which are then removed either by the organization itself or, under contract with municipal services, to the nearest landfill. In some healthcare organizations, the practice of open burning of general non-hazardous waste (feldsher-midwife stations, FAPs) persists. Autoclaved plastic and metal waste is then transferred to private companies for recycling. Other sterilized waste is discharged into the general flow of non-hazardous waste. In 2015, the Republican Center for Infection Control under the NGO "Prophylactic Medicine" conducted a study to assess the volume and classes of medical waste generated in feldsher-midwife stations (FAPs), which amounted to 0.85 thousand tons per year. According to NSC data, the volume of waste removed in the Kyrgyz Republic amounted to 1,113.3 thousand tons. Hence, the share of medical waste generated in FAPs of the total volume of waste removed is estimated at 0.1%. The study noted that the presented data are the results of fragmented research and do not reflect the situation either as a whole or by classes of waste generated.

According to the response to the request on the amount of waste disposed of at the sanitary landfill of Bishkek, only municipal solid waste (MSW) is accepted for disposal at the landfill site. Industrial, medical, and hazardous waste are not accepted.[101.]

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[99] Analytical report on the inventory of consumer waste disposal sites on the territory of the Kyrgyz Republic. https://eco-expertise.org/wp-content/uploads/2022/03/Analytical_report_on_the_inventory_of_waste_disposal_sites_.pdf

100 Approved by Order of the Government of the Kyrgyz Republic dated 19 December 2016, No. 549-r.p. https://aarhus.kg/ru/natsionalnyj-doklad-o-sostoyanii-okruzhayushhej-sredy-2011-2014-goda

101 Response to Request No. 12-01-6/1646 dated 26 February 2025.

Due to the absence of national statistical data on the volumes of industrial and medical waste generation and disposal, methane (CH_4) emissions in the current inventory were estimated only for municipal solid waste (MSW). Sludge generation was not taken into account, as its recording is carried out on a fragmented basis. In accordance with the 2006 IPCC Guidelines, Volume 5, Chapter 6, the default value for sludge removal is equal to zero. When reliable information on other waste categories (in particular, industrial and medical waste) becomes available, the corresponding emissions will be recalculated within future inventories.

Figure 7.5 presents the trend of methane (CH_4) emissions in category "5.A.2. Unmanaged Disposal Sites" for the period 1990–2023.

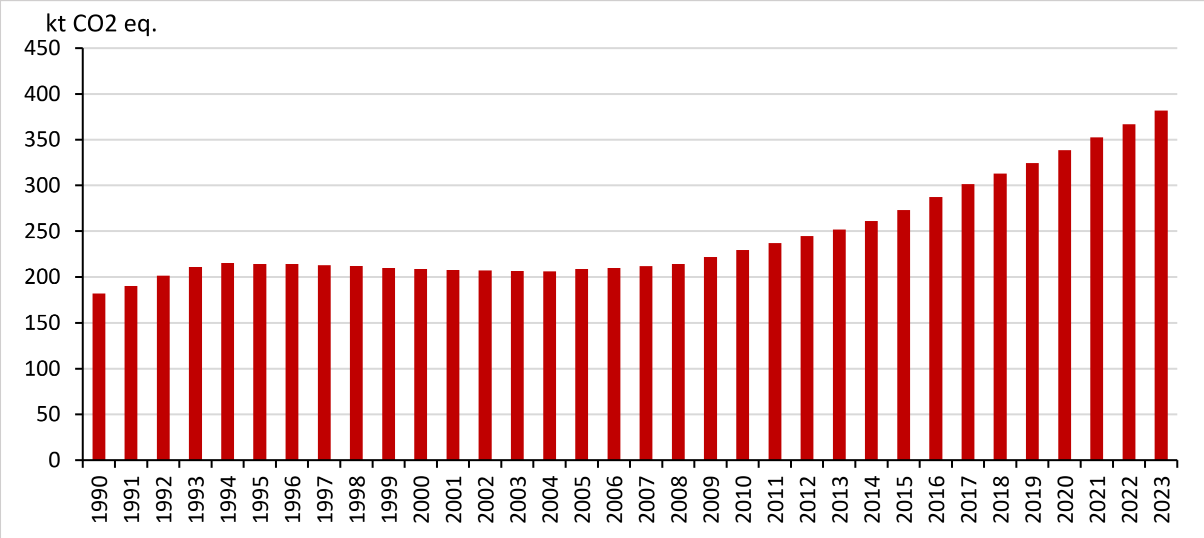

Figure 7.5. Trend of CH_4 Emissions in Category "5.A.2. Unmanaged Disposal Sites"

The period from 1994 to 2009 is characterized by a gradual decrease in the volumes of MSW disposal: after a peak in 1994 (215.73 kt CO_2 eq.), there was a steady decline until 2004 (206.22 kt CO_2 eq.). This reduction was associated with multiple factors such as the economic downturn following the collapse of the USSR, a decrease in GDP per capita, failures in public utility systems, a decline in the level of urbanization and waste collection/disposal from households, a sharp increase in the number of uncontrolled dumpsites in the city and suburban areas,[102] and new structural changes in the statistical system.[103] After 2009, methane (CH_4) emissions began to rise, driven simultaneously by improvements in MSW collection and reporting, as well as by growth in GDP and population.

7.2.2.1 Methodological Issues

Method Selection

The IPCC methodology for estimating CH_4 emissions from landfills is based on the First-Order Decay (FOD) method. This method assumes that degradable organic components (Degradable Organic Carbon, DOC) in waste decompose slowly over several decades, during which methane (CH_4) is generated. If conditions remain constant, the level of CH_4 generation depends solely on the amount of carbon that continues to remain in the waste.

[102] Environmental Protection in the Kyrgyz Republic 2000–2006: Statistical Yearbook. http://www.stat.kg/media/publicationarchive/66c8df8d-8314-4a1d-abab-a71c6c1f628b.pdf

[103] NSC. https://stat.gov.kg/ru/about/istoriya-statistiki/

Given that no studies have been conducted in the Kyrgyz Republic on the share of CH_4 in landfill gas, the oxidation factor, the half-life period, and other parameters necessary for estimating CH_4 emissions, Tier 1 has been applied using default coefficients in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Annual CH_4 emissions from solid waste disposal can be estimated using Equation 3.1 of Chapter 3: Solid Waste Disposal.[104.]

Equation for Estimating CH_4 Emissions from Solid Waste Disposal Sites.

$$CH_4\ Emissions = \left[\sum_x CH_4generated_{\ xT} - R_T\right] \times (1 - OX_T)$$

Where:
CH_4 emissions – CH_4 generated in year T, Gg
T – inventory year considered
x – waste category or waste type/material
R^T – CH_4 recovered in year T, Gg
OX^T – oxidation factor in year T

CH_4 recovery must be calculated from the volume of CH_4 generated. Only the fraction of CH_4 that has not been recovered is subject to oxidation in the upper layer of landfills.

The following are the main parameters and input data required for the estimation of annual (and cumulative) CH_4 emissions from unmanaged disposal sites.

1. Data on the Amount of Waste Collected and Disposed

To obtain sufficiently accurate results under the First-Order Decay (FOD) method, it is necessary to prepare and assess historical data on waste disposal covering a period of three to five “half-lives.” Thus, effective practice is to use waste disposal data for a period of at least 50 years. The estimation of CH_4 emissions was based on municipal solid waste (MSW) data, which cover a significant time interval and are presented in different accounting formats. For the purpose of analysis and subsequent interpretation, the entire period under consideration has been conditionally divided into three key stages, which will be further reviewed:

Historical period 1969–1989. Data for this period were collected from archival sources and used as the initial basis for the estimation of CH_4 emissions in accordance with the requirements of the 2006 IPCC Guidelines.

According to the response to the request, the National Statistical Committee (NSC) of the Kyrgyz Republic does not have data on the amount of MSW collected and disposed of for the period 1969–1990. Due to the absence of official statistical data on waste disposal volumes for 1969–1989, the calculated values were obtained through normalization based on available demographic and methodological assumptions.

To estimate the volumes of waste collected and disposed of during the given period, an indirect method was applied, including the following assumptions: the annual population figures were taken from the official retrospective statistics of the Kyrgyz Republic; the waste generation rate was

104 IPCC. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste. Chapter 3: Solid Waste Disposal https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf assumed at the level of 290 kg/person/year[105], reflecting the approximate per capita MSW generation rate under Soviet-era conditions; the share of waste subject to collection and disposal was set at 0.6 of generated waste, in line with the recommendations of the 2006 IPCC Guidelines [106]applicable under conditions of limited information on the waste collection system and population coverage by MSW services.

Period 1990–2009, during which the statistical accounting of waste volumes was carried out in cubic meters (m^3).

According to the data provided by the national statistical authorities, from 1990 to 2009 inclusive, the volumes of collected waste were recorded in cubic meters (m^3). Starting from 2010, statistical reporting on this indicator has been maintained in metric tons. To ensure the consistency of the time series and the possibility of accurate calculation of GHG emissions in accordance with the IPCC methodology, data for 1990–2009 were converted from m^3 to tons. Since no data on the density of solid waste were available for the period 1990–2009, the conversion was carried out using recalculation coefficients based on the average density of municipal solid waste (MSW): 262 kg/m^{3}[3] [107] or 1990, 300 kg/m^3 for 2003[108], and 0.3 t/m^3 for 2008.[109] Adjustment of density values for the period 1990–2010 was performed using interpolation, applying a method of restoring dependencies from small samples with unknown structure, through a nonparametric regression recovery algorithm.[110].

During the period 1990–2008, the accounting of waste volumes by the National Statistical Committee (NSC) included an aggregate indicator "Snow and Other Waste Removed." According to expert judgment, approximately 50% of this volume corresponded to municipal solid waste (MSW). Therefore, half of the values under this indicator were included in the calculations as the volume of MSW collected. Starting from 2008, this indicator was excluded from statistical reporting.

The modern stage (2010–2023) is characterized by the transition to waste accounting in tons.

An analysis of the data on the volumes of municipal solid waste (MSW) collected during the period 2010–2023 by region revealed sharp deviations in certain years: Bishkek city (2008–2015), Osh city (2012–2014), Jalal-Abad oblast (2008–2010), Issyk-Kul oblast (2009–2012), and Chui oblast (2010–2012). These spikes coincided with the transition from accounting for waste volumes in m^3 to

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105 Indicative Standards for the Accumulation of Solid Waste from Stand-Alone Public Facilities, Trade and Cultural-Service Institutions in the Cities of the RSFSR (for Consolidated Calculations and Planning). Moscow, 2 March 1982. Table 2. http://www.libussr.ru/doc_ussr/usr_11080.htm

106 IPCC. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 2: Waste Generation, Composition and Management Data (Table 2A.1, p. 2.18).

107 Indicative Standards for the Accumulation of Solid Waste from Stand-Alone Public Facilities, Trade and Cultural-Service Institutions in the Cities of the RSFSR (for Consolidated Calculations and Planning).

Moscow, 2 March 1982. Table 2. http://www.libussr.ru/doc_ussr/usr_11080.htm

108 State Institution "Scientific Research Center for Resource Conservation and Waste Management" (SIRC-RCWR), Moscow, 2003. Methodological guidelines for estimating the volumes of waste generation by production and consumption, p. 90.

109 Ibid.

110 Ilyasov, Sh.A. Automated Processing of Spectrometry Results and the Study of Technological Processes by Nonparametric Methods.

PhD thesis (Candidate of Technical Sciences). http://www.dslib.net/upravlenie-socsystem/avtomatizirovannaja-obrabotka-rezultatov-spektrometrii-i-issledovanie.html accounting in tons. In this regard, recalculations of the indicators were carried out to eliminate incomparability and distortions associated with the change in measurement units. This made it possible to smooth out uncharacteristic peak values and ensure a correct trend for the subsequent estimation of CH_4 emissions for the respective period.

The methodology and assumptions applied for the normalization of data used in the estimation of CH_4 emissions were discussed at a working session with members of the working group and documented to ensure transparency and traceability of calculations. More detailed information is presented in Section 7.2.5 “Recalculations,” while the amount of waste collected for the period 1969–2023 is presented in Table 7.4.

Classification of Landfills and Methane Correction Factors (MCF)
One of the key tasks in estimating CH_4 emissions from solid waste disposal sites is the accurate determination of landfill types, since the method of waste placement and the depth of deposited waste directly affect the rate and intensity of anaerobic decomposition of organic matter, and consequently, the volume of methane generated.

In accordance with the IPCC methodology (under CRT), landfills are classified as follows:

- 5.A.1. Managed Landfills. Anaerobic controlled solid waste disposal sites – waste is placed in specially prepared cells and (1) is covered with soil or other material, (2) is mechanically compacted, or (3) is covered in layers.
- 5.A.2. Unmanaged Landfills. All landfills that do not meet the criteria for managed solid waste disposal sites. These are divided into:
  - Unmanaged deep landfills – depth of waste disposal greater than or equal to 5 meters;
  - Unmanaged shallow landfills – depth of waste disposal less than 5 meters.
- 5.A.3. Unclassified Landfills. Landfills that do not fall under the conditions of 5.A.1 or 5.A.2.

In the Kyrgyz Republic, there are no direct data on the actual depth of landfills, since they are often formed spontaneously and tend to expand “horizontally” rather than “vertically.” [111]. This creates uncertainty when attempting to directly apply the formal criteria presented in the 2006 IPCC Guidelines, which are primarily oriented toward landfills with a known depth of waste accumulation. According to the information provided in the Waste Disposal Site Inventory, all landfills in the Kyrgyz Republic are classified as unmanaged deep or shallow.

Taking the above into account and based on the principles of Tier 1, the classification of unmanaged landfills was carried out depending on the total volume of disposed waste (thousand tons), rather than by the number of meters of subsurface deposition. Based on the volume of disposed waste attributable to the landfills of Bishkek and Osh, it was decided to classify them as deep, while all other landfills were classified as shallow. Figure 7.6 presents the percentage shares of disposed waste by regions and the cities of Bishkek and Osh.

111 Analytical Report on the Inventory of Waste Disposal Sites in the Kyrgyz Republic: http://eco-expertise.org/wp-content/uploads/2022/03/Analytical_report_on_the_inventory_of_waste_disposal_sites_.pdf

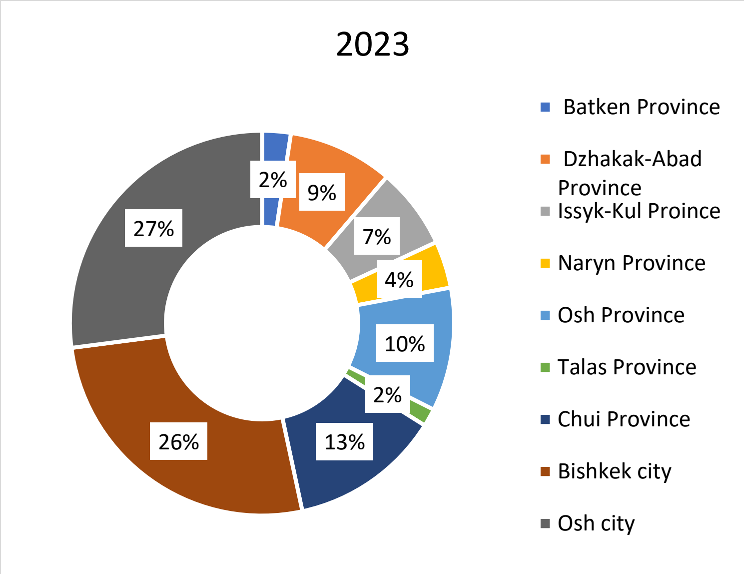

Figure 7.6. Structure of the total volume of disposed waste by regions and the cities of Bishkek and Osh.

According to the 2006 IPCC Guidelines, the methane correction factor (MCF) for deep unmanaged landfills (greater than 5 m) is 0.8, and for shallow unmanaged landfills (less than 5 m) is 0.4.

Table 7.4 presents the amount of solid waste disposed in landfills, divided into deep and shallow, for the period 1969–2023, with percentage distribution by landfill type.

Table 7.4. Amount of solid waste disposed in landfills, divided into deep and shallow, for the period 1969–2023.

Year	Volume of disposed waste, thousand tons	Deep landfills, %	Shallow landfills, %	Year	Volume of disposed waste, thousand tons	Deep landfills, %	Shallow landfills, %
1969	497.6	25.0	75.0	**1997**	442.2	41.3	58.7
1970	510.0	30.0	70.0	**1998**	352.2	44.7	55.3
1971	520.1	34.8	65.2	**1999**	389.8	45.4	54.6
1972	531.7	35.1	64.9	**2000**	388.0	47.9	52.1
1973	542.9	35.2	64.8	**2001**	412.6	44.6	55.4
1974	554.6	35.4	64.6	**2002**	383.9	56.7	43.3
1975	567.3	35.7	64.3	**2003**	374.0	59.0	41.0
1976	578.4	36.0	64.0	**2004**	480.7	64.4	35.6
1977	590.4	36.2	63.8	**2005**	415.8	66.2	33.8
1978	601.1	36.5	63.5	**2006**	462.5	63.5	36.5
1979	612.4	36.8	63.2	**2007**	497.0	65.2	34.8
1980	623.7	36.9	63.1	**2008**	689.0	64.5	35.5
1981	635.2	37.2	62.8	**2009**	701.3	63.2	36.8
1982	647.5	37.4	62.6	**2010**	686.0	71.0	29.0
1983	660.8	37.7	62.3	**2011**	693.9	73.4	26.6
1984	675.0	38.0	62.0	**2012**	667.7	81.4	18.6
1985	687.9	38.3	61.7	**2013**	761.0	79.8	20.2
1986	700.7	41.2	58.8	**2014**	875.9	76.7	23.3
1987	714.5	41.4	58.6	**2015**	1,007.3	74.6	25.4

Year	Volume of disposed waste, thousand tons	Deep landfills, %	Shallow landfills, %	Year	Volume of disposed waste, thousand tons	Deep landfills, %	Shallow landfills, %
1988	727.8	41.5	58.5	**2016**	995.7	78.0	22.0
1989	740.2	41.7	58.3	**2017**	981.5	68.0	32.0
1990	772.7	40.8	59.2	**2018**	1,047.8	61.4	38.6
1991	916.1	43.9	56.1	**2019**	1,147.6	64.7	35.3
1992	864.6	43.3	56.7	**2020**	1,175.9	63.0	37.0
1993	706.1	36.1	63.9	**2021**	1,229.6	62.1	37.9
1994	416.1	36.0	64.0	**2022**	1,339.6	55.9	44.1
1995	471.1	39.6	60.4	**2023**	1,505.4	53.4	46.6
1996	383.3	48.3	51.7				

Morphological composition

The morphological composition of municipal solid waste (MSW) plays a key role in assessing CH_4 emissions. The main factor is the share of degradable organic carbon (DOC), since it is this fraction that generates CH_4 during anaerobic decomposition. Organic components include food waste, paper and cardboard, wood, and garden/park waste. The higher the organic content in waste, the greater the potential volume of CH_4 emissions.

Regular monitoring of the morphological composition is not carried out either at the national level or at the level of regions and large settlements. Only fragmentary research data are available, obtained within the framework of waste management projects conducted in the cities of Bishkek and Osh. During the Waste Disposal Site Inventory, the approximate morphological composition of disposed waste was determined (by visual method). At the landfills of major settlements in the Kyrgyz Republic, the morphological composition of waste includes: plastic – 21%, glass – 10%, construction waste – 14%, food waste – 20%, organic waste – 12%, ash – 11%, metal – 0.5%, paper and cardboard – 1%, textiles – 0.5%, electronic and electrical waste, and other waste (medical, biological) – 10%.[112].

Across the Kyrgyz Republic, the morphological composition of waste is not uniform and varies depending on the welfare level of the settlement. In rural areas, the morphological composition of waste disposed at landfills mainly includes construction waste, animal carcasses, agricultural waste, etc. It should be noted that a visual assessment of the morphological composition does not allow for the precise determination of the share of the biodegradable fraction, which entails a high degree of uncertainty in calculating CH_4 emissions.

- This morphological composition represents primary information, which served as the basis for the indicators used in the following national documents:
- Analytical note on the inventory of consumer waste disposal sites;
- Green Economy Development Programme of the Kyrgyz Republic for 2019–2023;
- Concept for the introduction of the Extended Producer Responsibility (EPR) system for goods and packaging;
- Justification notes for the draft resolution on the moratorium on thin polymer films.

112 Analytical Report on the Inventory of Waste Disposal Sites in the Kyrgyz Republic: https://eco-expertise.org/wp-content/uploads/2022/03/Analytical_report_on_the_inventory_of_waste_disposal_sites_.pdf

Dues to the absence of regular monitoring of the morphological composition, the above-mentioned composition is applied for the assessment of CH_4 emissions from landfills, subsequently adjusted in line with the requirements of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Since the morphological composition obtained under the project "Inventory of Consumer Waste Disposal Sites in the Kyrgyz Republic" did not specify the components included in organic waste, a conditional division of organic waste into wood and garden/park waste was made. According to the IPCC methodology, organic waste includes both food waste and garden (yard) and park waste. Garden/park waste, in turn, includes such components as dry leaves, grass, and woody residues.

The following assumptions were made regarding this morphological composition: In the conditional division of organic waste, 6% was attributed to wood and 6% to garden/park waste; This morphological composition will be used for the estimation of methane (CH_4) emissions from landfills in the Kyrgyz Republic for the entire time series 1969–2023, given the absence of national data on the morphological composition for the historical period.

If new, more accurate data on the morphological composition of MSW become available, all estimated emission indicators will be recalculated, taking into account the updated fraction structure. This will allow for the revision of results and adjustment of CH_4 emissions according to the updated shares of food, garden/park, paper, and other MSW components.

Table 7.5. Morphological composition of waste used for the estimation of CH_4 emissions from the disposal of solid waste in unmanaged landfills.

Waste type	%
Plastics	21
Glass	10
Construction waste	14
Food waste	20
Organic waste, including:	12
– Wood	6
– Garden/park waste	6
Ash	11
Metal	0.5
Paper and cardboard	1
Textiles	0.5
Other	10
Total, %	100

4. Coefficients and parameters

Under Tier 1, for the estimation of CH_4 emissions from waste disposal sites, default values of coefficients and parameters presented in the 2006 IPCC Guidelines are applied. Table 7.6 presents the main coefficients and parameters used in the calculation of CH_4 emissions from solid waste disposal at landfills under Tier 1 according to the 2006 IPCC Guidelines.

Table 7.6. Main factors and parameters used in the calculation of CH_4 emissions from solid waste disposal at landfills.

Parameter	Symbol	Default value	2006 IPCC Guidelines reference
Fraction of degradable organic carbon in waste (DOC)	DOC	Food waste – 0.15 Garden and park waste – 0.20 Paper/cardboard – 0.40 Textiles – 0.24 Wood – 0.43	Vol. 5, Ch. 2, Table 2.4
Fraction of DOC that decomposes	DOC_f	0.5	Vol. 5, Ch. 3, p. 3.15
Fraction of methane in landfill gas	F	0.5	Vol. 5, Ch. 3, p. 3.30
Methane correction factor	MCF	0.4 (unmanaged, shallow landfill) 0.8 (unmanaged, deep landfill)	Vol. 5, Ch. 3, Table 2.4
Molar ratio of CH_4-C to CH_4	-	16/12	Vol. 5, Ch. 3, p. 3.41
Methane recovery factor	R	0 (in the absence of recovery)	Vol. 5, Ch. 3, p. 3.21
Oxidation factor	OX	0 (for unmanaged landfills)	Vol. 5, Ch. 3, p. 3.17

7.2.2.2 Uncertainties and time series consistency

In the calculation of CH_4 emissions from unmanaged landfills under Tier 1 of the 2006 IPCC Guidelines, default values are used for a number of key parameters and activity data. In situations where national or regional data are either unavailable or of low reliability, these default values form the basis for estimating emission volumes. Table 3.5 of the 2006 IPCC Guidelines[113] provides uncertainty ranges for the parameters used in the calculations for category 4A2. Approach 1 and Equations 3.1 were applied for combining uncertainties.[114.]

For each of these parameters, the 2006 IPCC Guidelines recommend a “default uncertainty range,” which reflects the variability of possible values in the absence of local measurements. Considering that the amount of disposed waste for the period 1969–1989 was obtained through estimation, and the morphological composition was determined visually, the uncertainty for these parameters was set at 60%, respectively. For statistical data on disposed waste that do not have sufficient accuracy, uncertainty was set at 30%. The overall uncertainty for activity data amounted to 90%, derived from the following uncertainties:

- Total municipal solid waste (MSWT) – ±60%
- Fraction of MSWT disposed at landfills (MSWF) – ±30%
- Overall uncertainty of waste composition – ±60%

113 IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 5: Waste, Chapter 3: Solid Waste Disposal, Table 3.5.:https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

114 IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 1: General Guidance and Reporting, Chapter 3: Uncertainty.:https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/1_Volume1/V1_3_Ch3_Uncertainties.pdf

Given that no studies have been conducted in the Kyrgyz Republic to determine the parameters of CH_4 generation from municipal solid waste (MSW) landfills, the use of national values for all coefficients required for measurement-based calculations is not possible. Therefore, the uncertainty assessment was carried out using the data provided in Table 3.5, Chapter 3, Volume 5 of the 2006 IPCC Guidelines. The overall uncertainty for coefficients and parameters was estimated at ±88.03%, derived from the following uncertainties:

- Degradable organic carbon (DOC) – ±20%
- Fraction of DOC that actually decomposes (DOCf) – ±20%
- Methane correction factor (MCF): 0.8 – ±20%; 0.4 – ±30%
- Fraction of CH_4 in landfill gas (F = 0.5) – ±5%
- Half-life period – ±75%

Thus, when applying the default values to category 4.A2, the estimated methane emissions should be considered indicative and accompanied by a significant range of uncertainty. In the future, as local field studies become available (waste composition analysis, landfill gas flux measurements, monitoring of recovery and oxidation), these ranges may be narrowed: more accurate values will be obtained for each parameter, and the generalized default values will be replaced by empirical data specific to national conditions.

7.2.2.3. Quality assurance and quality control (QA/QC)

QA/QC procedures were carried out in accordance with the QA/QC Plan. In preparing this section, cross-checking was conducted for the initial activity data used in the calculation of coefficients and emission estimates, as well as for data on the morphological composition of waste and the amount of waste disposed at landfills. The initial data, approaches to reconstructing missing data, and coefficients were discussed at inter-agency working group meetings.

7.2.2.4. Recalculations

In this cycle of NGHGI 1990-2023, recalculations of CH_4 emissions from landfills were carried out due to adjustments in the data on disposed waste.

During the analysis of waste disposal data, “spikes” were identified in Jalal-Abad region for 2008–2010, in Issyk-Kul region for 2009–2012, and in Chui region for 2010–2012. These spikes coincide with the transition from the system of accounting in cubic meters (m^3) to the system of accounting in tons.

It was assumed that during the transition from accounting of municipal solid waste disposal by volume (m^3) to mass (tons), the original time series displayed “spikes” that did not reflect the actual increase in waste mass but only the difference in the conversion method. To eliminate these spikes and obtain a consistent trend, the indicator value for the transition year was replaced with the arithmetic mean of the previous and subsequent years for the above-mentioned regions. Thus, the trend reflects real changes in waste disposal without distorting peak values caused by the change of measurement units and prevents overestimation of methane (CH_4) emissions for the specified period.

Spikes were also identified in the data on disposed waste for Bishkek and Osh. The largest spike in the data “Municipal solid waste disposed (tons) by territory” occurred in Bishkek during 2008–2015. The highest waste disposal volumes were recorded in 2009 – 822.9 thousand tons and in 2013 – 933.2 thousand tons. To determine the cause of the spike, information was requested on the amount of waste disposed at the Bishkek sanitary landfill for this period, the accounting method used (volume in m^3 or mass in tons), and the density conversion applied from m^3 to tons.

Given the response received that no archival data were available for this period and that systematic quantitative accounting of waste by volume (m^3) and mass (tons) was not carried out, a decision was made to recalculate the amount of disposed waste for 2008–2015 based on the accumulation rate and the actual population size. This decision was taken to avoid overestimation of methane (CH_4) emissions from waste disposed at the Bishkek sanitary landfill. Assumption: the recalculation of waste disposal volumes for 2008–2015 was based on the accumulation rate provided by Bishkek City Hall, which amounted to 453 kg per capita per year.

A sharp decrease in waste disposal was observed in Osh, from 133.63 thousand tons in 2012 to 87.2 thousand tons in 2013, followed by a sharp increase to 242.747 thousand tons in 2014. Assumption: this anomaly is related to accounting and reporting practices, and the waste disposal volume for 2013 was recalculated by replacing it with the average of adjacent years (smoothing of a single drop).

After recalculation, all data on waste disposal by regions and the cities of Bishkek and Osh were consolidated in a table and subsequently summed to obtain national-level data.

- Division of landfills into deep and shallow. Landfills were classified as deep or shallow depending on the total volume of disposed waste (thousand tons).
- Change in morphological composition. In the Fourth National GHG Inventory, available data on morphological composition were used: USSR (1989), Bishkek (2008, 2017), Osh (2008). In this inventory, the morphological composition obtained under the UNEP project "Strengthening the Capacity of the Kyrgyz Republic in Waste Management Throughout the Life Cycle" was applied. Assumption: this morphological composition was applied uniformly to the entire time series.
- Change in population size for 2010–2023.

7.2.2.5. Planned improvements

- To improve the quality of the GHG inventory for category 5.A. Solid waste disposal on land, the following measures need to be implemented:
- Study of the morphological composition of waste, differentiated by urban/rural areas and by winter/summer seasons.
- Study of the density of municipal solid waste in containers and during transportation, with and without compaction.
- Conducting an inventory of waste disposal sites with consideration of landfill depth, in order to use the obtained data in line with the landfill classification under the 2006 IPCC Guidelines.

7.3. Category "5.B. Composting"

7.3.1. Category description

Category 5.B. Composting covers the biological (aerobic) treatment of the organic fraction of municipal solid waste, agricultural waste, and certain types of industrial waste. During composting, organic matter decomposes by microorganisms in the presence of oxygen, releasing heat, biogenic carbon dioxide (not accounted for in the national GHG balance), as well as relatively small amounts of CH_4 and N_2O, which must be reported in the inventory in accordance with the 2006 IPCC Guidelines.

In the Kyrgyz Republic, composting is an emerging area of waste management, practiced mainly at small municipal sites and through pilot projects supported by international organizations. The share of composted waste in the total waste stream remains small, and systematic accounting of composted waste is not conducted. For example, according to the response to an official request, the municipal enterprise “Osh Maintenance and Greenery Enterprise” operates a composting site for leaves collected within the city of Osh. Composting produces biohumus and fertilizers used for soil improvement and greening, but no records are kept of the amount of leaves composted. Information was also received on an organized composting site for fallen leaves collected from municipal park and garden areas, located at Greenhouse Facility No. 2 of the municipal enterprise “Bishkekzelenstroy”. The site produces approximately 5.0–5.2 tons of biohumus per year.

The National Statistical Committee (NSC) does not maintain “direct” accounting of composted waste, but it does record data on households that dispose of waste by burying.[115] The dataset “Waste disposal by territory and place of residence through burying” is provided by the NSC at the national level, without disaggregation by waste components.

The available data will be used for the estimation of CH_4 and N_2O emissions, with the following assumptions:1) Data on waste disposal by burying are considered as waste subjected to biological treatment; 2) For the estimation of emissions from biological treatment, garden and park waste are applied.

Table 7.7. Share of households disposing of waste by burying, population, and volume of waste subjected to biological treatment (thousand tons).

Table 7.7. Share of households disposing of waste by burying, population, and volume of waste subjected to biological treatment

Year	Share of households disposing of waste by burying	Number of people living in households	Volume of waste subjected to biological treatment (composting), thousand tons/year	Year	Share of households disposing of waste by burying	Number of people living in households	Volume of waste subjected to biological treatment (composting), thousand tons/year
1990	0.18	4,340,169.6	11.4	**2007**	0.20	5,230,807.7	15.1
1991	0.18	4,407,200.4	116	**2008**	0.20	5,272,803.5	15.4
1992	0.18	4,484,390.4	11.8	**2009**	0.19	5,332,255.1	15.0
1993	0.18	4,510,286.4	12.0	**2010**	0.17	5,414,738.9	13.4
1994	0.18	4,487,079.6	12.0	**2011**	0.21	5,486,576.7	16.8
1995	0.18	4,506,900.0	12.1	**2012**	0.23	5,573,329.7	18.7
1996	0.19	4,577,516.4	12.3	**2013**	0.18	5,696,957.7	15.0
1997	0.19	4,642,356.0	12.6	**2014**	0.17	5,822,679.4	14.3
1998	0.19	4,712,972.4	12.8	**2015**	0.15	5,953,585.5	12.5
1999	0.19	4,786,875.6	13.0	**2016**	0.13	6,090,274.2	11.8
2000	0.19	4,855,688.7	13.3	**2017**	0.11	6,223,373.7	9.8
2001	0.19	4,903,296.4	13.5	**2018**	0.10	6,352,186.1	9.2

115 Response to Request of the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic (MNRETS), No. 12-01-6/1646 of 26 February 2025.

2002	0.19	4,949,718.0	13.7	**2019**	0.09	6,497,249.6	8.4
2003	0.19	4,995,252.1	13.9	**2020**	0.08	6,643,609.2	8.0
2004	0.19	5,055,543.5	14.1	**2021**	0.07	6,769,231.2	7.2
2005	0.19	5,118,637.3	14.4	**2022**	0.08	6,892,161.3	8.3
2006	0.19	5,172,075.6	14.6	**2023**	0.09	7,016,487.2	9.2

Figure 7.7. presents the results of emission estimates for category *5.B. Biological treatment (Composting)* for the period 1990–2023. As shown by the assessment results. a sharp decrease in emissions from category 5.B. is observed from 2013 to 2021. which may be associated with improvements in the quality of waste collection services.

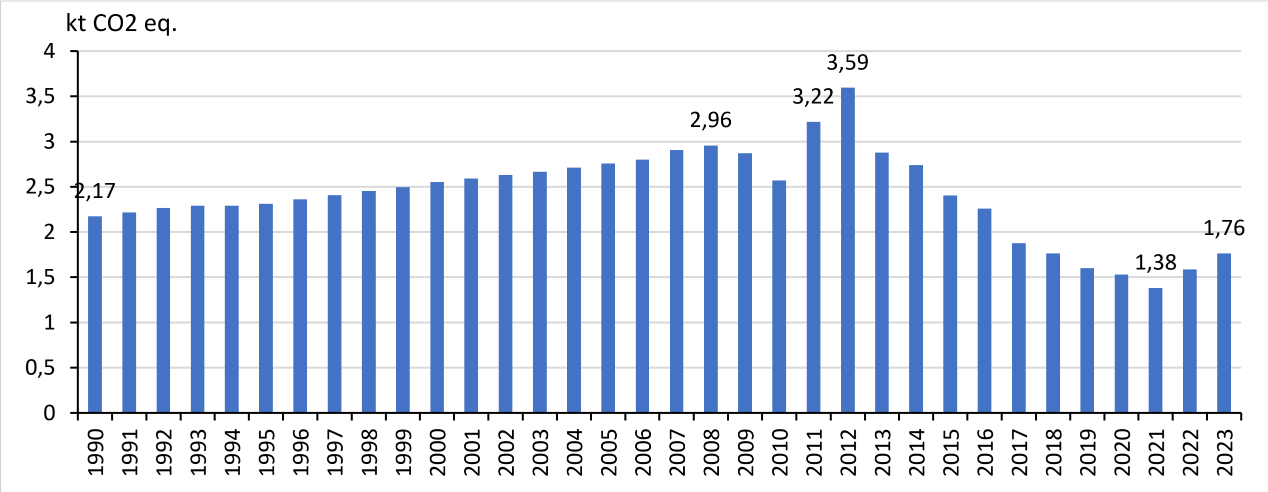

Figure 7.7. Emissions from category “5.B. Biological treatment (Composting)” for the period 1990–2023

7.3.2. Methodological issues

In the present Inventory, emissions under category 5.B. Biological treatment are estimated using the Tier 1 method presented in the 2006 IPCC Guidelines: activity is determined by the mass of organic waste directed to composting, and CH_4 and N_2O emissions are estimated, based on default emission factors. As national data on the quantity of composted waste and technological parameters (temperature regime, aeration, moisture and nitrogen content) become available, a transition to the Tier 2 method will be considered, which would increase the accuracy of estimates and provide a better reflection of actual composting conditions in the Kyrgyz Republic.

To ensure a continuous time series for the indicator “Households disposing of waste by burying” for the period 1990–2023, a combined methodology was applied, based on actual statistical data and mathematical extrapolation.

For the estimation of CH_4 and N_2O emissions from the biological treatment of solid waste, data are required on the amount and type of solid waste subjected to biological treatment. Given that in the Kyrgyz Republic no accounting of composted solid waste is carried out, the calculation of this parameter was based on the share of households disposing of waste by burying, according to the Integrated Household Budget and Labor Force Survey. and Equation 5.7 (Chapter 5 of the 2006 IPCC Guidelines) was applied to estimate the total amount of solid waste, with the value of Bfrac replaced by the share of composted waste in relation to the total amount of treated waste.

Equation 5.7

$$MSWB = P \times P_{frac} \times MSWP \times B_{frac} \times 365 \times 10^{-6}$$

Where:

MSWB – total municipal solid waste composted. Gg/year;
P – population (number of persons in households);
Pfrac – fraction of population composting waste;
MSWP – per capita waste generation. kg waste/person/day (per capita waste generation is assumed at the average rate of 290 kg per capita per year[116]);
Bfrac – fraction of composted waste in relation to the total amount of treated waste;
365 – number of days in a year;
10^{-6} – conversion factor from kilograms to Gg.

Estimation of CH_4 and N_2O emissions from biological treatment was carried out using the default method specified in Equations 4.1 and 4.2 of the 2006 IPCC Guidelines, Volume 5. Chapter 4.

Equation 4.1. CH_4 emissions from biological treatment

$$CH_4 = \sum_i (M_i \times EF_i) \times 10^{-3} - R$$

Where:
CH_4 emissions – total CH_4 emissions in the inventory year. kt CH_4;
Mi – mass of organic waste treated by biological treatment type i. kt;
EF – emission factor for treatment i. g CH_4/kg waste treated;
i – composting or anaerobic digestion;
R – total amount of CH_4 recovered in the inventory year. kt CH_4.

Equation 4.2. N_2O emissions from biological treatment

$$N_2O = \sum_i (M_i \times EF_i) \times 10^{-3}$$

Where:
N_2O emissions – total N_2O emissions in the inventory year. kt N_2O;
Mi – mass of organic waste treated by biological treatment type i. Gg;
EF – emission factor for treatment i. g N_2O/kg waste treated;
i – composting or anaerobic digestion.

Table 7.8. Default emission factors for CH_4 and N_2O emissions from biological treatment (Tier 1 method) according to the 2006 IPCC Guidelines. Volume 5.

Table 7.8. Default emission factors for CH_4 and N_2O from biological treatment (Tier 1 method).

Parameter	Value	Source
Emission factor for treatment *i*. g CH_4/kg waste treated	4 (wet weight basis)	Chapter 4. Table 4.1. p. 4.7
Emission factor for treatment *i*. g N_2O/kg waste treated	0.3 (wet weight basis)	Chapter 4. Table 4.1. p. 4.7
Total CH_4 recovered in the inventory year. Gg CH_4	0	Chapter 4. p. 4.4

[116] Building Regulations of the Kyrgyz Republic “Urban Planning and Development of Cities and Urban-Type Settlements” Approved and enacted by the Order of the State Agency for Architecture, Construction and Housing and Communal Services under the Government of the Kyrgyz Republic dated 24 March 2020, No. 39-NPA.

Parameter	Value	Source
Fraction of composted waste	0.05	Chapter 2. Table 2.A1. p. 2.18

7.3.3. Uncertainties and time series consistency

Uncertainties in the activity data for category *4B. Biological treatment of solid waste* will depend on the method of data collection. Estimated values of uncertainties for waste generation and the share of waste subjected to biological treatment can be assessed in the same way as for MSW disposed at landfills (see Table 3.5). Approach 1 and Equations 3.1 (p. 3.34) were applied for combining uncertainties.[117]

The following uncertainties were identified:

- The uncertainty of activity data depends on the quality of the data used for GHG emission estimation (e.g., ±30% for satisfactory quality, ±60% for low quality). Given the absence of "direct" data on the amount of composted waste, the uncertainty of activity data is assumed at ±60%. Data on population are ±5% (Volume 5. Chapter 6. Table 6.7), data on total municipal solid waste are ±60%.
- CH_4 emission factor: ±50%. according to the U.S. Greenhouse Gas Inventory: 1990–2022 (EPA. 2024), which confirms that by default an uncertainty of ±50% is applied to the CH_4[118], emission factor; this value was also applied to N_2O. In this case, the uncertainty is as follows:
    - Activity data – ±85%
    - Emission factors – ±70.71%

Thus, the overall uncertainty for activity data is ±85%. and for emission factors – ±70.71%.

The estimation of emissions from composting may have a very high level of uncertainty due to the lack of information from "direct" data on the amount of composted waste.

7.3.4. Quality assurance and quality control (QA/QC)

QA/QC procedures were carried out in accordance with the QA/QC Plan. In preparing this section, cross-checking was conducted for the initial activity data used in the calculation of coefficients and emission estimates for the amount of waste subjected to composting. The initial data, approaches to reconstructing missing data, and emission factors were discussed at inter-agency working group meetings.

7.3.5. Recalculations

Recalculations for category 5.B. Biological treatment (Composting) were carried out in connection with:

117 IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 1: General Guidance and Reporting, Chapter 3: Uncertainty.: https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/1_Volume1/V1_3_Ch3_Uncertainties.pdf

118 Waste 7-1 https://www.epa.gov/system/files/documents/2024-04/us-ghg-inventory-2024-chapter-7-waste_04-17-2024.pdf?utm_source=chatgpt.com p. 7-63

- Changes in population size for the period 2010–2020;
- Changes in the approach to estimating the share of households disposing of waste by burying. Statistical data on “Households disposing of waste by burying” were available for the period 2007–2023. Based on this part of the time series, a linear model was developed in Microsoft Excel to reflect the trend over time. For projecting values for earlier years (1990–2006), the linear forecast function was applied;
- Application of CH_4 (g CH_4/kg of waste treated) and N_2O (g N_2O/kg of waste treated) emission factors on a wet weight basis. For the estimation of CH_4 and N_2O emissions, wet weight emission factors were applied, whereas in the previous inventory dry weight factors had been used.

7.3.6. Planned improvements

To improve the quality of the GHG inventory for category *5.B. Biological treatment (Composting)*. the following measures need to be implemented:

- Introduce mandatory quarterly data collection from each rural and urban HCS (Housing and Communal Services) on the amount of organic waste disposed of/transferred for composting. disaggregated into garden/park and food waste;
- Standardize the reporting form across all regions (Excel template with mandatory fields: year. region. waste type. mass “wet” (tons). moisture content (%). composting site).

7.4. Category “5.C.2. Open burning”

7.4.1. Category description

According to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, open burning of waste refers to the burning of unwanted combustible materials such as paper, wood, plastics, textiles, rubber, waste oils, and other wastes in the open air, where emissions are released directly into the atmosphere without passing through a stack or chimney. Open burning also includes burning facilities where air supply to the combustion chamber is not controlled to maintain the required temperature. and the retention time is insufficient for complete combustion.

At present. one of the most pressing environmental issues in the Kyrgyz Republic remains the disposal of municipal solid waste (MSW). Although the official system of waste collection and disposal is gradually expanding. sites of illegal dumping and. more importantly. open burning of MSW are still found in almost all regions of the country. According to NSC data. in 2023. 19.3% of households disposed of waste by burning.

A specific category among burned materials is garden and woody waste (leaves. branches. tree trimmings). Garden and park waste is generated both in urban areas (cleaning of parks. lawns. squares) and in rural areas (households. orchards. and dacha plots). In the absence of proper composting or recycling sites. the population often collects this waste in piles in yards or along roadsides. followed by open burning. It should be noted that the number of households disposing of waste in this way has significantly decreased: in 2017. the share of such households was 32.9%.

In the Kyrgyz Republic. waste burning is prohibited by the Law "On Production and Consumption Waste."[119] According to Article 16. burning of waste on the territory of enterprises. institutions. organizations. and settlements is prohibited. Fines are imposed for burning garbage. household waste. leaves. and plant residues in unauthorized locations. Liability is provided for both individuals and legal entities in accordance with Article 253 of the Code of Offenses.

Incomplete combustion of organic matter generates significant CH_4 and N_2O emissions. which have a higher global warming potential than CO_2. Since garden and park waste in many cases is of organic origin. in the absence of proper control. CH_4 and N_2O emissions are considerably higher than under centralized composting or landfill disposal. The volume of waste subjected to open burning and the resulting GHG emissions are presented in Table 7.9.

Table 7.9. Volume of Waste Subjected to Open Burning and GHG Emissions from Open Burning

Year	Share of households disposing of waste by burning	Population (persons)	Volume of waste subjected to open burning. thousand tons/year	Year	Share of households disposing of waste by burning	Population (persons)	Volume of waste subjected to open burning. thousand tons/year
1990	0.36	4,340,169.6	78.0	2007	0.32	5,230,807.7	83.6
1991	0.36	4,407,200.4	78.7	2008	0.31	5,272,803.5	81.1
1992	0.36	4,484,390.4	79.7	2009	0.33	5,332,255.1	88.1
1993	0.36	4,510,286.4	79.7	2010	0.34	5,414,738.9	90.5
1994	0.36	4,487,079.6	78.8	2011	0.32	5,486,576.7	87.6
1995	0.35	4,506,900.0	78.7	2012	0.31	5,573,329.7	84.4
1996	0.35	4,577,516.4	79.4	2013	0.33	5,696,957.7	92.7
1997	0.35	4,642,356.0	80.1	2014	0.32	5,822,679.4	91.3
1998	0.35	4,712,972.4	80.8	2015	0.31	5,953,585.5	90.7
1999	0.35	4,786,875.6	81.4	2016	0.33	6,090,274.2	98.8
2000	0.34	4,855,688.7	82.3	2017	0.29	6,223,373.7	87.7
2001	0.34	4,903,296.4	82.6	2018	0.26	6,352,186.1	80.2
2002	0.34	4,949,718.0	82.9	2019	0.24	6,497,249.6	76.9
2003	0.34	4,995,252.1	83.1	2020	0.24	6,643,609.2	79.3
2004	0.34	5,055,543.5	83.6	2021	0.23	6,769,231.2	75.4
2005	0.33	5,118,637.3	84.2	2022	0.23	6,892,161.3	77.5
2006	0.33	5,172,075.6	84.5	2023	0.19	7,016,487.2	66.8

Figure 7.8 presents dynamics of emissions from category "5.C.2. Open burning of waste" for the period 1990–2023.

[119] https://cbd.minjust.gov.kg/112668/edition/1273980/ru

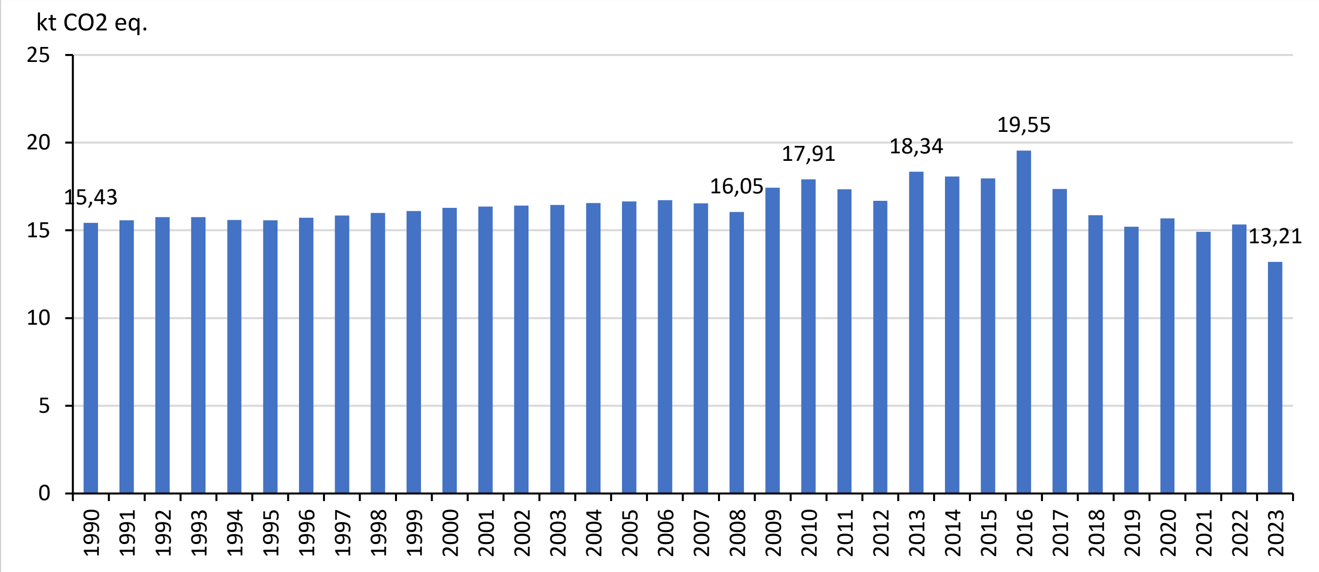

Figure 7.8. Dynamics of emissions from category “5.C.2. Open burning of waste” for the period 1990–2023

As shown in the diagram. from the early 1990s to 2009 there was a gradual increase in emissions. with a peak in 2016 (18 kt CO_2 eq). followed by a steady decline to approximately 13.21 kt CO_2 eq by 2023. Despite the fact that. according to Article 16 of the Law of the Kyrgyz Republic “On Production and Consumption Waste” and Article 253 of the Code of Offenses of the Kyrgyz Republic. open burning of waste at enterprises. in settlements. and in other territories is prohibited. with fines provided for both individuals and legal entities. actual emissions indicate that the practice of open burning continues to some extent.

The decline in emissions after the 2016 peak reflects the development of waste collection and disposal systems. improved monitoring and enforcement of the ban. as well as increased public awareness. Nevertheless. residual emissions indicate the need for further strengthening of practical measures. including the expansion of composting and organic recycling infrastructure. inspections in remote areas. awareness-raising campaigns. and the digitalization of MSW accounting in order to achieve the complete elimination of open burning of waste.

7.4.2. Methodological issues

For the estimation of emissions from open burning. the Tier 1 method is applied. which is used when CO_2 emissions from open burning of waste are not considered a key category. In this case. data on the amount of waste subjected to open burning are required.

Given that in the Kyrgyz Republic no accounting is carried out for the amount of solid waste subjected to open burning. the calculation of this parameter was based on the share of households disposing of waste by burning. according to the Integrated Household Budget and Labor Force Survey. as well as Equation 5.7 (Chapter 5. IPCC Guidelines) to estimate the total amount of solid waste subjected to open burning. The data were provided by the NSC both at the national and regional levels. Since direct data on solid waste burning are not available. and no data exist on the components of burned waste. it was assumed that the waste burned by households is garden and park waste.

To ensure a continuous time series for the indicator “Share of waste disposed of by burning. %” for the period 1990–2023. a combined methodology was applied. based on actual statistical data and mathematical extrapolation.

For the estimation of CH_4. N_2O. and CO_2 emissions from open burning of solid waste. data are required on the quantity and type of solid waste subjected to open burning. Given that in the Kyrgyz Republic no accounting is conducted for the amount of solid waste subjected to open burning. the calculation of this parameter was based on the share of households disposing of waste by burning. according to the Integrated Household Budget and Labor Force Survey. and Equation 5.7 (Chapter 5 of the 2006 IPCC Guidelines).

Equation 5.7

$$MSWB = P \times P_{frac} \times MSWP \times B_{frac} \times 365 \times 10^{-6}$$

Where:
MSWB – total municipal solid waste subjected to open burning. kt/year;
P – population (number of persons in households);
Pfrac – fraction of population burning waste;
MSWP – per capita waste generation. kg waste/person/day (per capita waste generation is assumed at the average rate of 290 kg per capita per year[120]);
Bfrac – fraction of waste burned in relation to the total amount of treated waste;
365 – number of days in a year;
10^{-6} – conversion factor from kilograms to kt.

The estimation of CH_4. CO_2. and N_2O emissions is based on the amount of waste burned in stoves or in the open. as well as on default emission factors provided in the 2006 IPCC Guidelines. Volume 5. Chapter 5. Section 5.2.

Table 7.10. Default emission factors for CH_4. N_2O. and CO_2 emissions from open burning (Tier 1 method).

Parameter	Value	2006 IPCC Guidelines reference
Dry matter content of waste (on wet weight basis). fraction	0.4	Vol. 5. Table 2.4
Carbon fraction of dry matter (total carbon content). fraction	0.49	Vol. 5. Table 2.4
Fraction of fossil carbon in total carbon (FCF)	0	Vol. 2
Oxidation factor	0.58	Vol. 5. p. 5.21
Conversion factor to CO_2	44	Vol. 5
N_2O emission factor (kg N_2O/Gg of waste)	150	Vol. 5. p. 5.25
Composite CH_4 emission factor (kg CH_4/Gg of waste)	6.500	Vol. 5. p. 5.23

7.4.3. Uncertainties and time series consistency

The estimate of the amount of waste subjected to open burning has an uncertainty of ±60% under low data quality conditions. The uncertainty of emission factors is: CO_2 ±40%. When default values for N_2O and CH_4 emission factors are used. the level of uncertainty may reach ±100% or even higher.

[120] Urban Planning and Development of Cities and Urban-Type Settlements
Approved and enacted by Order No. 39-NPA of 24 March 2020 of the State Agency for Architecture, Construction, and Housing and Communal Services under the Government of the Kyrgyz Republic. (Annex K).
https://cbd.minjust.gov.kg/200523/edition/2380/ru

Thus. CH_4 ±100% and N_2O ±100% or more when default values are applied.[121] For combining uncertainties. Approach 1 and Equations 3.1 (p. 3.34) were used.[122]. Applied uncertainties:

- The uncertainty of activity data depends on the quality of the data used for GHG emission estimation (e.g., ±30% for satisfactory quality. ±60% for low quality). Given the absence of "direct" data on the amount of waste subjected to open burning. the uncertainty of activity data is assumed at ±60%. Data on population: ±5% (Vol. 5. Chapter 6. Table 6.7); data on total municipal solid waste: ±60%.
- Emission factors: CO_2 ±40%. CH_4 ±100%. N_2O ±100%.

Thus. the overall uncertainty for activity data was estimated at ±85%. and for emission factors at ±161.55%.

The estimation of emissions from open burning may have a very high level of uncertainty due to the lack of "direct" data on the amount of waste subjected to burning.

The level of uncertainty may be particularly high when determining per capita waste generation and the fraction of waste burned. Overall. the estimation of emissions from open burning remains subject to a very high level of uncertainty due to insufficient information.

7.4.4. Quality assurance and quality control (QA/QC)

QA/QC procedures were carried out in accordance with the QA/QC Plan. In preparing this section. cross-checking was conducted for the initial activity data used in the calculation of coefficients and emission estimates. as well as for data on the amount of waste subjected to burning. The initial data. approaches to reconstructing missing data. and coefficients were discussed at inter-agency working group meetings.

7.4.5. Recalculations

Recalculations for category *5.C.2. Open burning of waste* were carried out in connection with:

- Changes in population size for the period 2010–2020;
- Changes in the approach to estimating the share of households disposing of waste by open burning. Statistical data on "Households disposing of waste by open burning" were available for the period 2007–2023. Based on this part of the time series. a linear model was developed in Microsoft Excel to reflect the trend over time. For projecting values for earlier years (1990–2006). the linear forecast function was applied.

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121 IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 5: Waste, Chapter 5: Incineration and Open Burning of Waste, p. 5.27. https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/5_Volume5/V5_5_Ch5_IOB.pdf

122 IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 1: General Guidance and Reporting, Chapter 3: Uncertainty.https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/1_Volume1/V1_3_Ch3_Uncertainties.pdf

7.4.6. Planned improvements

Introduction of statistical accounting of MSW burning volumes at the district level (inspection data and records of fines). Estimation of burning volumes and shares of individual waste fractions (organic matter. paper. plastics. etc.) based on information from violation reports.

Disaggregation of the composition of burned waste through the study of the baseline morphological profile of the region. supplemented by household surveys.

7.5. Category "5.D. Domestic and industrial wastewater"

According to the 2006 IPCC Guidelines, Volume 5, the estimation of GHG emissions from the treatment of domestic and industrial wastewater includes the following source subcategories:

- 5.D.1. Domestic wastewater
- 5.D.2. Industrial wastewater

Under anaerobic treatment or disposal. wastewater may become a source of CH_4 and N_2O emissions. Wastewater is generated from a variety of domestic, commercial, and industrial sources and may be treated locally (without collection), discharged into a sewer system, or released untreated into water bodies. Domestic wastewater is defined as wastewater resulting from household use, while industrial wastewater is generated as a result of industrial activities. Emissions from these two types of wastewaters were estimated separately.[123].

The main factor in determining the potential for CH_4 generation in wastewater is the amount of degradable organic material it contains. The standard parameters used to measure the amount of organic matter in wastewater are Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Under similar conditions. wastewater with a higher COD or BOD level generally produces more CH_4 than wastewater with lower COD (or BOD) concentrations.

N_2O emissions are associated with the decomposition of nitrogenous compounds in wastewater, such as urea, nitric acid salts, and proteins present in domestic wastewater. Direct N_2O emissions may occur both during nitrification and during denitrification of nitrogen present. Both processes may occur at wastewater treatment plants and in water bodies receiving wastewater discharges.[124]

For the estimation of GHG emissions from domestic and industrial wastewater, Tier 1 was applied in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Due to the lack of sufficient national data, default emission factors and parameters were applied for the estimation of GHG emissions in the Waste sector. Figure 7.9. presents the results of the emission estimates for category 5.D. Wastewater treatment and discharge, disaggregated into subcategories 5.D.1. Domestic wastewater treatment and discharge and 5.D.2. Industrial wastewater treatment and discharge for the period 1990–2023.

123 IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 5: Waste, Chapter 6, p. 6.6.
124 IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 5: Waste, Chapter 6, p. 6.7.

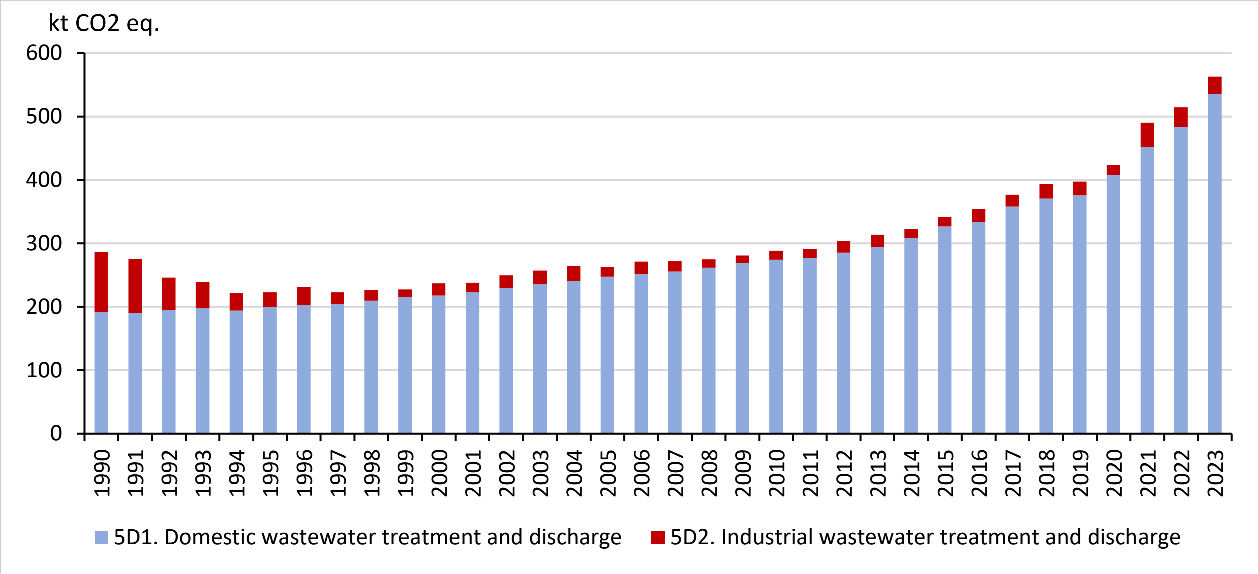

Figure 7.9. Emissions from category "5.D. Wastewater treatment and discharge" by source subcategories for the period 1990–2023

As shown in Figure 7.9. in the early 1990s Kyrgyzstan experienced a decline in emissions (from approximately 286.42 kt CO_2 eq. in 1990 to 227.37 kt CO_2 eq. in the mid-1999s), which was associated with a reduction in water consumption and discharges due to relatively difficult economic conditions. Starting from the early 2000s. emissions began to gradually increase, reaching about 341.81 kt CO_2 eq in 2015, driven by economic recovery, urbanization, and the dominant share of domestic wastewater.

From 2015 to 2023. a more rapid increase was observed, reaching about 562.92 kt CO_2 eq. in 2023. This reflects a further rise in wastewater volumes, improved reporting, population growth, and changes in the structure of sanitation systems during 2016–2023. Thus, the share of households connected to centralized sewerage increased from 12.9% to 15.2%, the share of individual systems (septic tanks, local treatment facilities) increased from 15.0% to 33.0%, while the share of traditional latrines decreased from 71.7% to 51.7%. These changes significantly affect the estimation of emissions: a reduction in the share of latrines lowers the volume of "direct" unaccounted discharges, while the growth of local anaerobic systems requires the application of corresponding emission factors for CH_4/N_2O.

The main factor influencing the increase or decrease in emissions from industrial wastewater is the growth or decline in production in key sectors (sugar. food. oil refining. etc.), which leads to changes in water consumption and, accordinglym wastewater volumes.

7.5.1. Subcategory "5.D.1. Domestic wastewater"

According to the National Statistical Committee of the Kyrgyz Republic, in 2022 the number of centralized sewerage (drainage) networks amounted to 95 units: 55 in urban areas and 40 in rural areas.

In remote towns and district centers, access to sewerage systems has been decreasing annually due to the degradation of existing infrastructure. In 2013, the number of sewerage networks was 117 units, and by the end of 2022 it had decreased by 22 units.[125.] The volume of wastewater discharged in 2023 was 139.3 million cubic meters, including 136.9 million cubic meters in urban settlements and 2.4 million cubic meters in rural areas, of which 137.6 million cubic meters were treated at wastewater treatment plants.

According to the Department for the Development of Drinking Water Supply and Sewerage under the State Water Resources Agency of the Government of the Kyrgyz Republic, as well as a survey conducted under the United Nations Development Programme (UNDP) in the cities of Bishkek and Osh, 23% of the urban population do not have access to sewerage systems, and in five towns such systems are entirely absent.[126.]

In the Kyrgyz Republic, both domestic and industrial wastewater is discharged into centralized sewerage systems. In accordance with the Rules for the Acceptance of Wastewater into Sewerage Systems, the discharge of industrial wastewater into the sewerage systems of settlements may be carried out by industrial enterprises only with a discharge permit and a contract for the discharge and acceptance of wastewater concluded with a water supply and sewerage enterprise.

At wastewater treatment plants, mechanical, physico-chemical, and biological treatment methods are applied. The most common method of domestic wastewater treatment is the biological method, which is carried out under aerobic conditions. The use of anaerobic digesters (methane tanks) for the treatment of domestic wastewater is not practiced in the Kyrgyz Republic. The accumulated sewage sludge is transported to sludge sites; however, accounting of accumulated sludge is virtually not carried out.

7.5.1.1. Methodological issues

The estimation of GHG emissions from wastewater treatment was conducted in accordance with the 2006 IPCC Guidelines using the Tier 1 methodology, since default emission factors were applied and only the shares of treatment/discharge pathways and methods were calculated based on population size and household toilet types.

General equation for estimating CH_4 emissions from wastewater:

$$CH_4 = \left[\sum_{i,j} (U_i \times T_{i,j} \times EF_j)\right](TOW - S) - R$$

Where:

CH_4 emissions – CH_4 emissions in the inventory year. kg CH_4/1990;

Ui – population classes by income group i in the inventory year;

Ti.j – degree of utilization of treatment/discharge systems j by population class i in the inventory year;

i – population group by income level: rural. high-income urban. and low-income urban population;

j – each treatment/discharge pathway or system;

125 https://stat.gov.kg/media/publicationarchive/af2dcba8-afc4-40a2-8aab-4ebc0ab89d6d.pdf

126 Government of the Kyrgyz Republic. 2020. Programme for the Development of Drinking Water Supply and Sewerage Systems in Settlements of the Kyrgyz Republic until 2026. https://cbd.minjust.gov.kg/157536/edition/1037006/ru

EFj – emission factor. kg CH_4/kg BOD;
Si – amount of organic component removed as sewage sludge from treatment/discharge of wastewater;
R – amount of CH_4 recovered in the inventory year.

The CH_4 emission factor for each treatment/discharge pathway or system is calculated using the following equation:

$$EF_j = B_0 \times MCF_j$$

Where:
EFj – emission factor. kg CH_4/kg BOD;
j – each treatment/discharge pathway or system;
Bo – maximum CH_4 producing capacity. kg CH_4/kg BOD = 0.6;
MCFj – methane correction factor (MCF). see Table 7.10.

Table 7.11. Values of methane correction factor (MCF) and CH_4 emission factor for different domestic wastewater treatment/discharge systems (according to Table 6.3, Chapter 6, Volume 5, 2006 IPCC Guidelines).

Table 7.11. Values of methane correction factor (MCF) and CH_4 emission factor for different domestic wastewater treatment/discharge systems.

Type of treatment/discharge system	Methane correction factor (MCF) (2006 IPCC Guidelines. Vol. 5. Ch. 6. Table 6.3)	Emission factor (EF). kg CH_4/kg BOD
Centralized sewerage (aerobic treatment)	0.3	0.18
Septic system	0.5	0.3
Latrine	0.1	0.06
No toilet/other (stagnant sewer)	0.5	0.3

The activity data for category *4D.1. Domestic wastewater* represents the total organically degradable material in wastewater (TOW). This parameter is a function of population and per capita BOD generation and is expressed as biochemical oxygen demand (BOD), kg BOD/year.

The total mass of organically degradable material in domestic wastewater is calculated as follows:

$$TOW = P \times BOD \times 0{,}001 \times I \times 365$$

Where:
TOW – total mass of organic material in wastewater in the inventory year. BOD kg/year;
P – population in the inventory year (persons);
BOD – country-specific per capita BOD in the inventory year. g/person/day. 40 (Vol. 5. Ch. 6. Table 6.4);
0.001 – conversion factor from grams BOD to kilograms BOD;
I – correction factor for additional industrial BOD discharged into sewers (default value: 1.25 for collected. 1.00 for uncollected).

The correction factor *I* is applied to account for the presence of industrial BOD discharged into different types of sewerage: centralized sewerage, septic tanks, latrines, and stagnant sewers. The correction factors for all discharge pathways are as follows:

$$I_{centralized\ sewerage} = 1.25;\ I_{septic\ system} = 1.00;\ I_{latrine} = 1.00;\ I_{stagnant\ sewer} = 1.00$$

For the estimation of N_2O emissions from industrial wastewater, Equation 6.7 (Vol. 5. Ch. 6) was applied:

$$N_2O = TN \times T \times EF \times 44 / 28 \quad (6.7)$$

Where:
TN – total nitrogen input (kg N/year);
T – fraction of wastewater treated in centralized aerobic systems (assumed = 1 for this estimate);
EF – 0.005 kg N_2O-N/kg N;
44/28 – conversion factor from N_2O-N to N_2O.

The parameters used in the estimation of CH_4 and N_2O emissions are presented in Table 7.11.

Factors and Parameters

According to the Integrated Household Budget and Labor Force Survey, the share of the population with sustainable access to sewerage in 2023 was 48.2%. For urban areas, this figure was 75.8%. while in rural areas it was 32.5%. According to the National Statistical Committee, domestic wastewater is treated through three main pathways: centralized sewerage, individual septic systems, and latrines. In 2023, 15.2% of households were connected to centralized sewerage, about 33% used their own septic systems, and more than 51.74% relied on latrines. In 2023, virtually no "open" discharges without facilities were recorded, although until 2018 the category "No toilet/other" accounted for 0.1–0.5% in statistical data.

In accordance with the 2006 IPCC Guidelines, statistical data on the resident population, disaggregated into urban and rural, were used for the calculation of CH_4 and N_2O emissions. Due to the lack of national data on high- and low-income urban populations, the distribution was derived using poverty statistics. In 2023, the poverty rate for the urban population was 30.2%.

The distribution was made in accordance with Table 6.5, Chapter 6, Volume 5 of the 2006 IPCC Guidelines. For each province, and separately for urban and rural populations, the percentage distribution by toilet type was adopted, thereby defining the shares of wastewater flowing into: centralized sewerage, septic systems, latrines, no toilet/other.

The National Statistical Committee provided data from the Integrated Household Budget and Labor Force Survey on household toilet types nationwide for 2010–2023. In the toilet type statistics, the same terminology is used as in the IPCC Guidelines for wastewater treatment pathways, namely: "Централизованная канализация" - "Centralized aerobic treatment", "Индивидуальная канализация (септик)" - "Septic system", "Уборные (выгребные ямы)" - "Latrine" "Туалет отсутствует, другое" - "Stagnant sewer".

This allows each household share to be directly matched with a treatment/discharge pathway specified in the IPCC Guidelines.

No statistical data on toilet types are available for the period 1990–2009. To ensure a continuous time series for 1990–2023, a combined methodology was applied, based on actual statistical data and mathematical extrapolation. Statistical data were available for 2010–2023. Based on this part of the time series, a linear model was developed in Microsoft Excel to reflect the trend of change in the shares of each system over time. For projecting values for the earlier years (1990–2009), the linear forecast function was applied.

Table 7.12. presents shares of sanitation systems (1990–2023) used for the estimation of GHG emissions from domestic wastewater.

Table 7.12. Shares of sanitation systems (1990–2023) used for the estimation of GHG emissions from domestic wastewater

Year	Centralized sewerage (%)	Septic system (%)	Latrine (%)	No toilet/other (%)
1990	12.36	3.81	83.29	0.5
1991	12.48	4.20	82.79	0.5
1992	12.59	4.60	82.29	0.5
1993	12.71	4.98	81.80	0.5
1994	12.82	5.37	81.31	0.5
1995	12.93	5.75	80.83	0.5
1996	13.05	6.13	80.35	0.5
1997	13.16	6.50	79.88	0.5
1998	13.27	6.87	79.41	0.5
1999	13.38	7.24	78.94	0.4
2000	13.48	7.60	78.48	0.4
2001	13.59	7.96	78.03	0.4
2002	13.70	8.32	77.58	0.4
2003	13.80	8.68	77.13	0.4
2004	13.90	9.03	76.68	0.4
2005	14.01	9.38	76.24	0.4
2006	14.11	9.72	75.81	0.4
2007	14.21	10.06	75.37	0.4
2008	14.31	10.40	74.95	0.3
2009	14.41	10.74	74.52	0.3
2010	14.57	11.13	74.12	0.2
2011	14.56	11.35	74.02	0.1
2012	14.89	11.88	72.74	0.5
2013	12.50	14.79	72.25	0.5
2014	12.20	15.88	71.50	0.4
2015	13.06	15.55	71.04	0.3
2016	12.90	14.98	71.70	0.4
2017	13.18	18.13	68.61	0.1
2018	12.60	18.86	68.45	0.1
2019	13.56	17.91	68.54	0.0
2020	13.53	20.85	65.62	0.0
2021	14.64	25.37	59.99	0.0
2022	14.48	28.14	57.26	0.1
2023	15.21	33.03	51.74	0.0

Before starting the calculations for category 5.D.1. Domestic wastewater, it is important to distribute the population according to the "pathways" of wastewater collection and treatment. This distribution is based on official data on household toilet types, collected through the Integrated Household

Budget and Labor Force Survey. Additionally, the urban population is conditionally divided into two groups — low-income and high-income — in order to reflect differences in access to centralized sewerage systems: in wealthier areas, the share of households connected to treatment facilities is significantly higher.

Thus, each percentage of households indicated in the toilet-type statistics corresponds to a specific wastewater treatment system (centralized sewerage, individual septic tanks, latrines, and other arrangements).

Table 7.13. presents the distribution of the population by type of sanitation system, disaggregated into low-income urban, high-income urban, and rural populations in 1990–2023.

Table 7.13. Distribution of the population by type of sanitation system, disaggregated into low-income urban, high-income urban, and rural populations in the period 1990–2023

Year	Rural population			High-income urban			Low-income urban	
	Septic system	Latrine	– No toilet/other	Centralized sewerage	Septic system	Latrine	Septic system	Latrine
1990	0.043	0.950	0.006	0.124	0.038	0.837	0.044	0.956
1991	0.048	0.946	0.006	0.125	0.042	0.832	0.048	0.952
1992	0.053	0.941	0.006	0.127	0.046	0.827	0.053	0.947
1993	0.057	0.937	0.006	0.128	0.050	0.822	0.057	0.943
1994	0.062	0.933	0.006	0.129	0.054	0.817	0.062	0.938
1995	0.066	0.928	0.006	0.130	0.058	0.812	0.066	0.934
1996	0.070	0.924	0.005	0.131	0.062	0.807	0.071	0.929
1997	0.075	0.920	0.005	0.132	0.065	0.802	0.075	0.925
1998	0.079	0.916	0.005	0.133	0.069	0.798	0.080	0.920
1999	0.084	0.911	0.005	0.134	0.073	0.793	0.084	0.916
2000	0.088	0.907	0.005	0.135	0.076	0.788	0.088	0.912
2001	0.092	0.903	0.005	0.136	0.080	0.784	0.093	0.907
2002	0.096	0.899	0.005	0.138	0.084	0.779	0.097	0.903
2003	0.101	0.895	0.005	0.139	0.087	0.774	0.101	0.899
2004	0.105	0.891	0.004	0.140	0.091	0.770	0.105	0.895
2005	0.109	0.887	0.004	0.141	0.094	0.765	0.110	0.890
2006	0.113	0.883	0.004	0.142	0.098	0.761	0.114	0.886
2007	0.117	0.879	0.004	0.143	0.101	0.756	0.118	0.882
2008	0.121	0.875	0.004	0.144	0.104	0.752	0.122	0.878
2009	0.125	0.871	0.004	0.145	0.108	0.748	0.126	0.874
2010	0.130	0.868	0.002	0.146	0.111	0.743	0.131	0.869
2011	0.133	0.866	0.001	0.146	0.114	0.741	0.133	0.867
2012	0.140	0.855	0.006	0.150	0.119	0.731	0.140	0.860
2013	0.169	0.826	0.005	0.126	0.149	0.726	0.170	0.830
2014	0.181	0.814	0.005	0.122	0.159	0.718	0.182	0.818
2015	0.179	0.817	0.004	0.131	0.156	0.713	0.180	0.820
2016	0.172	0.823	0.005	0.130	0.150	0.720	0.173	0.827

Year	Rural population			High-income urban			Low-income urban	
	Septic system	Latrine	– No toilet/other	Centralized sewerage	Septic system	Latrine	Septic system	Latrine
2017	0.209	0.790	0.001	0.132	0.181	0.687	0.209	0.791
2018	0.216	0.783	0.001	0.126	0.189	0.685	0.216	0.784
2019	0.207	0.793	0.000	0.136	0.179	0.685	0.207	0.793
2020	0.241	0.759	0.000	0.135	0.208	0.656	0.241	0.759
2021	0.297	0.703	0.000	0.146	0.254	0.600	0.297	0.703
2022	0.329	0.670	0.001	0.145	0.282	0.573	0.329	0.671
2023	0.390	0.610	0.000	0.152	0.330	0.517	0.390	0.610

7.5.1.2. Uncertainties and time series consistency

The assessment of uncertainty for category *4D.1. Domestic wastewater* was carried out in accordance with Section 6.2.2.5, Chapter 6, Table 6.7 of the 2006 IPCC Guidelines, which presents uncertainty ranges for this category. For combining uncertainties. Approach 1 and Equations 3.1 (p. 3.34) were applied.[127.] Applied parameters and uncertainties were the following:

- Population (P): ±5%
- Degree of utilization of treatment/discharge systems by income groups (T): ±50%
- Income category data: ±15%
- Maximum CH_4 producing capacity (Bo): ±30%
- Correction factor: 0% for uncollected. ±20% for collected
- Amount treated anaerobically (MCF): septic tanks and poorly managed treatment plants ±30%; untreated systems and latrines ±50%
- Per capita BOD: ±30%

As a result of the uncertainty assessment for category 4D.1. Domestic wastewater. the uncertainty for activity data was ±52.44%. and for emission factors ±74.83%.

7.5.1.3. Quality assurance and quality control (QA/QC)

QA/QC procedures were carried out in accordance with the QA/QC Plan. In preparing this section, cross-checking was conducted for the initial activity data used in the calculation of emission factors and emission estimates. The initial data, approaches to reconstructing missing data, and emission factors were discussed at inter-agency working group meetings.

7.5.1.4. Recalculations

Recalculations were made due to changes in population size and adjustments in the calculation of treatment/discharge pathways, with a disaggregation into high- and low-income urban populations and rural populations, with calculations made within each income group (T=1). In the previous

126. IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 1: General Guidance and Reporting, Chapter 3: Uncertainty.https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/1_Volume1/V1_3_Ch3_Uncertainties.pdf

inventory, the calculation of treatment/discharge pathways was based on aggregated data without considering the distribution by income level.

7.5.1.5. Planned improvements

In the event that "direct" national data on high- and low-income urban populations become available, a recalculation of treatment/discharge pathways will be carried out.

7.5.2. Subcategory "5.D.2. Industrial wastewater"

Industrial wastewater is generated in the course of technological processes at enterprises. Under anaerobic conditions (absence of oxygen) during treatment, organic substances in wastewater decompose, releasing greenhouse gases (GHGs). Industrial wastewater contains significant amounts of readily degradable organic matter, which under anaerobic or microbial decomposition during treatment, may result in the formation of CH_4. In addition, nitrogen compounds (ammonium, nitrates) are present in such effluents, which produce N_2O during nitrification and denitrification.

As a rule, industrial wastewater is treated jointly with municipal wastewater of settlements. Highly polluted effluents from individual enterprises undergo preliminary treatment at on-site facilities before being discharged into municipal systems. Industrial enterprises are connected to the sewerage network on the basis of municipal "Rules for the acceptance of industrial wastewater." Methane recovery during the treatment of industrial wastewater is not applied.

The National Statistical Committee provided data on the volumes of production by major industries in the Kyrgyz Republic. Methane emissions from industrial wastewater treatment were calculated for the following production types:

- Ethyl alcohol
- Beer
- Whole milk products
- Processed and preserved fish and fish products
- Meat and edible by-products
- Petroleum products
- Paper production
- Sugar
- Vegetable oil
- Processed and preserved fruits. vegetables. and mushrooms
- Wine production

7.5.2.1. Methodological issues

For the estimation of CH_4 and N_2O emissions from industrial wastewater, the Tier 1 simplified approach was applied, using default values from the 2006 IPCC Guidelines without reference to local measurements. At Tier 1, calculations are based on two components:

- CH_4 is estimated through the organic load of effluents, using production volumes, wastewater generation, and average COD/BOD values.
- N_2O is estimated from the annual total nitrogen load multiplied by the N_2O–N emission factor.

The activity data for this category consist of the total organically degradable matter in wastewater (TOW). This parameter represents a functional relationship between: industrial production volume (tons/year), wastewater generation (m^3/ton of product), and concentration of degradable organic matter in wastewater expressed as COD (kg COD/m^3).

The National Statistical Committee provided data on the major types of industrial production and output volumes for the period 1990–2023 for the country as a whole. Since annual production volumes of industrial enterprises were reported in physical units. normalization (conversion into tons) was carried out using density coefficients accepted from industry sources. For example: Beer – density 1.04 kg/l[128], Ethyl alcohol – density 0.789 kg/l[129], Processed and preserved fruits, vegetables, and mushrooms – 0.6 t per 1.000 standard cans[130], Wine – density 0.99 kg/l.[131]

The data on major types of industrial products, converted to a uniform unit of measurement (thousand tons), are presented in Table 7.14.

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128 Design Center. https://www.center-pss.ru/math/litrivkg/pivo.htm

129 Design Center. https://www.center-pss.ru/math/litrivkg/spirt.htm

130 Order of the Republic of Belarus No. 186 dated 23 August 2006. On the Approval of the Methodology for Compiling Food Resource Balances for Certain Types of Agricultural Products.

131 https://eniw.ru/plotnost-vinoprodukcii.htm

Table 7.14. Output of major types of industrial production in the Kyrgyz Republic

Year	Ethyl alcohol (t)	Beer (t)	Whole milk products (t)	Fish and fish products (t)	Meat and edible by-products (t)	Petroleum products (t)	Paper (t)	Sugar (t)	Vegetable oil (t)	Processed fruits. vegetables and mushrooms (t)	Wine (t)
1990	4450.0	42068.0	284605.0	1242.0	131663.0	NE	5538.0	379882.0	13951.0	74511.0	18720.9
1991	4473.6	46248.8	257510.0	910.0	102138.0	NE	4767.0	371223.0	14799.0	62220.0	23690.7
1992	4852.4	32250.4	124797.0	499.0	76839.0	NE	4229.0	114257.0	549.0	42873.0	12662.1
1993	14454.5	22141.6	76372.0	127.0	48555.0	NE	2063.0	115821.0	4449.0	28383.6	10830.6
1994	17432.2	12743.1	35060.5	64.6	20473.4	NE	857.0	81623.0	3314.1	10012.2	7263.6
1995	18191.2	12628.7	18682.4	64.0	11112.4	NE	527.0	69684.8	2571.0	3618.4	5779.6
1996	15721.6	14812.7	12307.3	74.3	5092.8	12348.3	685.0	166789.8	2973.9	4808.2	5358.9
1997	9182.4	15074.8	13792.6	63.1	3171.2	230291.5	608.0	89833.5	4827.6	4957.7	4888.6
1998	9239.2	13384.8	16224.0	68.6	2648.4	129852.3	391.0	88280.1	6851.3	6657.7	4684.7
1999	3084.2	12662.0	14549.7	42.2	3343.9	172517.9	222.0	70324.4	7518.2	7852.2	3777.8
2000	4932.8	12944.9	16081.6	60.3	2464.8	140784.7	2375.2	58010.9	8747.7	10745.9	4325.3
2001	5196.4	9059.4	22770.9	128.1	1850.8	131007.7	1717.7	30536.3	6920.9	8458.5	4220.4
2002	7699.4	7382.2	22842.1	337.0	3201.5	109739.2	2640.1	51357.0	9385.5	1307.2	4428.2
2003	8558.1	8040.8	24312.8	202.0	5244.2	86837.8	2329.7	75513.6	10700.3	2759.3	3228.6
2004	8205.8	12065.0	26590.1	203.2	4687.7	87346.3	2641.6	88225.0	12321.7	2524.7	2684.3
2005	6764.0	12751.3	31812.9	216.1	3812.2	86303.2	1486.6	44917.6	15357.1	862.0	2098.7
2006	4733.5	11403.0	43760.5	182.8	3590.5	83285.1	2671.3	58384.4	16771.3	1820.0	2643.0
2007	5127.8	14592.4	50201.9	512.8	3725.1	120681.5	1981.8	36837.5	17591.7	1081.1	1936.3
2008	4591.7	16022.9	49232.4	452.1	4450.9	131508.9	1678.4	10858.3	18511.2	1176.6	1632.8
2009	4895.4	15767.6	54909.2	805.7	7984.3	96893.5	1188.8	5804.7	20617.4	1561.7	1547.7
2010	6607.5	18722.3	54987.1	1244.8	9039.9	97211.7	1253.8	14127.8	18063.8	1543.4	1778.0
2011	5542.3	22030.8	44035.4	1258.6	9405.3	87093.6	1239.9	16991.8	15087.4	2254.1	1624.3
2012	6075.4	22754.7	49715.5	1992.1	10155.7	80271.8	2569.4	13228.9	13949.0	1517.6	684.9
2013	6286.5	24868.0	48610.4	1068.7	11744.6	77523.3	2448.0	25206.3	14073.6	1619.8	2394.5
2014	5066.5	28156.5	57677.5	929.9	12389.6	146802.1	1263.2	20354.9	13876.2	1620.7	688.4
2015	4274.4	27384.0	60961.8	973.8	13754.6	307288.0	1270.7	24355.5	13840.9	2437.9	1508.1
2016	3801.2	25005.4	80231.1	1452.4	15653.3	352400.1	1852.6	67721.1	11521.4	2544.3	3428.5
2017	2447.5	26125.7	77490.9	997.2	17753.2	386786.7	450.7	100357.8	11252.5	3515.9	3412.9
2018	3348.9	29653.8	99352.3	1649.5	18931.0	454582.7	820.1	122537.9	11743.1	1309.7	4748.3
2019	3256.4	30207.7	105867.7	982.0	21486.1	301438.7	1218.4	99699.3	9420.5	2042.5	3210.9

Year	Ethyl alcohol (t)	Beer (t)	Whole milk products (t)	Fish and fish products (t)	Meat and edible by-products (t)	Petroleum products (t)	Paper (t)	Sugar (t)	Vegetable oil (t)	Processed fruits. vegetables and mushrooms (t)	Wine (t)
2020	3458.6	18133.1	136367.2	802.0	22997.4	155259.3	143.8	51264.6	7183.8	3602.6	1567.2
2021	3949.9	22383.8	139265.4	702.7	24456.2	268885.2	6773.1	64862.4	5910.1	2467.1	2075.8
2022	5882.1	26079.2	141604.7	614.1	25807.0	303598.4	2972.4	108368.8	6030.0	3896.2	1744.0
2023	9771.2	52055.8	107396.0	597.5	31813.7	326048.7	1439.0	81216.9	6652.6	5603.8	1221.2

Estimation of CH_4 emissions from industrial wastewater was performed in accordance with the 2006 IPCC Guidelines (Tier 1) using default parameters.

The total mass of organically degradable material in industrial wastewater was determined as follows:

$$CH_4 \text{ emissions} = \sum_{t}^{n} [(TOW_t - S_t)\, EF_t - R_t]$$

Where:
CH_4 emissions – CH_4 emissions in the inventory year;
U_i – population classes by income group i in the inventory year (Table 6.5);
$T_{i.j}$ – degree of utilization of treatment/discharge systems.
j – indicator of population class i.j in income group i in the inventory year (Table 6.5);
I – population group by income level: rural. urban high-income. and urban low-income population;
J – each wastewater treatment/discharge pathway or system;
EF_j – emission factor. kg CH_4 / kg BOD_5;
S_i – amount of organic component removed as wastewater sludge;
R – amount of CH_4 recovered in the inventory year.

For determining the CH_4 emission factors from industrial wastewater treatment/discharge, Equation 7.8 was applied:

$$EF_j = Bo \times MCF_j$$

Where:
EF_j – emission factor. kg CH_4/kg COD (from Table 6.8 – aerobic treatment plants);
J – each wastewater treatment/discharge pathway or system;
B_0 – maximum CH_4 producing capacity. kg CH_4/kg COD;
MCF_j – methane correction factor (fraction). (from Table 6.9 – default MCF values for industrial wastewater. IPCC 2006).

For the estimation of the total organically degradable material (TOW), the following equation was applied:

$$TOWi = Pi \times Wi \times CODi$$

Where:
TOW_i – total organically degradable material in industrial wastewater i. kg COD/year;
i – industrial sector;
P_i – total production of industrial sector i. t/year;
W_i – collected wastewater. m^3/t of product;
COD_i – chemical oxygen demand (industrial degradable organic components in wastewater). kg COD/m^3.

For the estimation of N_2O emissions from industrial wastewater, Equation 6.7. Chapter 6, was applied:

$$N_2O = TN \times T \times EF \times 44 / 28$$

Where:
TN – total nitrogen input (kg N/year);

T – fraction of wastewater treated in centralized aerobic systems (in this assessment = 1);
EF – emission factor. 0.005 kg N_2O–N/kg N;
44/28 – conversion factor from N_2O–N to N_2O.

The parameters used for the estimation of CH_4 and N_2O emissions are presented in Table 7.15.

Table 7.15. Parameters for the estimation of CH_4 and N_2O emissions

Type of production	Wastewater generation (m^3/ton)	COD (kg/m^3)	Total nitrogen (kg/m^3)
Ethyl alcohol	24	11	2.4
Beer	6.3	2.9	0.055
Whole milk products	7	2.7	0.042[132]
Fish and fish products. processed and preserved	5*	2.5	0.6
Meat and edible by-products	13	4.1	0.19
Petroleum products	0.6	1.0	0.051[133]
Paper production	162	9	0.3[134]
Sugar	11	3.2	0.044[135]
Vegetable oil	3.1	0.85	0.01
Fruits. vegetables and mushrooms. processed and preserved	20	5.0	0.083
Wine production	23	1.5	0.012

In accordance with the Tier 1 approach. default emission factors were applied in line with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for the estimation of GHG emissions from industrial wastewater.

For the calculation of the total amount of organics. the default values for wastewater generation per unit of product and the concentration of organic load (kg COD/m^3) were used. as provided in Table 6.9 (IPCC Guidelines Chapter 6. p. 6.24).

As an exception. due to the absence of a default value for “Wastewater generation” (m^3/ton) for “Fish processing” in the 2006 IPCC Guidelines, and in order to ensure consistency with international recommendations and comparability, this value was taken from Table 6.12. Chapter 6. p. 6.48 of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The values for **total nitrogen** were adopted in accordance with the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and from industry-specific sources for those types of industries where no coefficients were provided in Table 6.12.

B_0 – maximum CH_4 producing capacity. 0.25 kg CH_4/kg COD (Table 6.2. p. 6.13 of the 2006 IPCC Guidelines). Considering the condition of existing wastewater treatment plants and sewerage systems, which, due to exceeded service life and insufficient capital investment, are in need of rehabilitation or new construction, a value of 0.3 was adopted in accordance with Table 6.8. Chapter

[132] https://www.azuwater.com/solution/dairy-wastewater-treatment-plant/?utm_source=chatgpt.com
[133] https://www.epa.gov/system/files/documents/2024-02/us-ghg-inventory-2024-chapter-7-waste.pdf?utm_source=chatgpt.com
[134] https://www.epa.gov/system/files/documents/2024-02/us-ghg-inventory-2024-chapter-7-waste.pdf?utm_source=chatgpt.com
[135] https://scijournals.onlinelibrary.wiley.com/doi/10.1002/bbb.2579

6. Based on the adopted coefficients, the methane emission factor (EF) for industrial wastewater is 0.075.

In line with the 2006 IPCC Guidelines, the fraction of COD removed with sludge is assumed to be zero, and the amount of CH_4 recovered in the inventory year (kg CH_4/year) is also assumed to be zero.

According to available information, the industrial wastewater is discharged into the general sewerage network and therefore treated at centralized wastewater treatment plants together with domestic wastewater. Additional data on the distribution of industrial wastewater to other treatment systems (e.g., on-site treatment facilities, septic systems, or lagoons) are not available. Based on the above, in the calculation of the "Degree of utilization" coefficient, a parameter value of U_j = 1.0 was applied, in accordance with the methodological recommendations of the 2006 IPCC Guidelines (Volume 5: Waste. Chapter 6. p. 6.19).

Separate N_2O emissions from effluent discharged into water bodies were not estimated, as the 2006 IPCC Guidelines do not provide for their calculation under Tier 1, and reliable data on final water bodies receiving discharges are unavailable. Accordingly, the worksheet "N_2O Emissions from Effluent Wastewater" in the IPCC Inventory Software 2.96 was left blank.

7.5.2.2. Uncertainties and Time Series Consistency

According to the IPCC Guidelines for National Greenhouse Gas Inventories, the uncertainty for industrial wastewater parameters was taken as default, in line with Table 6.10, Chapter 6, with the following values applied:

- Industrial production (P) – ±25%;
- Wastewater generation per unit of product (W) – +100%;
- Maximum CH_4 producing capacity (B_0) – ±30%;
- Methane correction factor (MCF) – ±30%.

Based on the uncertainty assessment for subcategory 5.D.2. activity data uncertainty was estimated at ±103.08%, and emission factor uncertainty at ±58.31%.

7.5.2.3. Quality Assurance and Quality Control

QA/QC procedures were conducted in accordance with the QA/QC Plan. During the preparation of this section, cross-checks were performed for the original activity data, the applied coefficients, emission calculations, waste composition data, and the amounts of waste disposed of at landfills. The source data, approaches to filling data gaps, and applied emission factors were discussed during Inter-Agency Working Group meetings.

7.5.2.4 Recalculations

Recalculation was performed due to the unavailability of previously used industry-specific online sources for wastewater generation (m^3/ton) and COD (kg O_2/m^3) for such industries as fish processing, sugar refining, and vegetable oil production.

For wastewater generation values, coefficient ranges from Table 6.9. Chapter 6. were applied. To obtain values for these activities, the arithmetic mean of the ranges presented in the table was used. This method assumes a uniform distribution within the range.

The recalculation was conducted in accordance with the 2006 IPCC Guidelines (Volume 5, Chapter 6) and aimed at harmonizing input data with international recommendations, ensuring comparability across sectors, and replacing unavailable sources with more reliable ones. The changes concern the input data (W. COD) (Table 7.16). The algorithms, Tier 1 methodology. and formulas remain unchanged.

Table 7.16. Parameters for wastewater generation and COD

Sector	Parameter	Value used in NC4	New value	IPCC Guidelines
Fish processing	Wastewater generation W (m^3/ton)	5.5	5.0	Chapter 6. Table 6.9 (range 2–8)
Sugar refining	Wastewater generation W (m^3/ton)	10.2	11.0	Chapter 6. Table 6.9 (range 4–18)
Vegetable oils	COD (kg O_2/m^3)	0.60	0.85	Chapter 6. Table 6.9 (range 0.5–1.2)

In the previously applied version of the IPCC Inventory Software (v.2.54), the nitrogen concentration from industrial wastewater was not calculated separately: the total nitrogen (N) was accounted for within a single combined flow of “mixed” domestic and industrial wastewater. In Inventory Software v.2.96, industrial and domestic wastewater streams are entered separately.

7.5.2.5. Planned Improvements

Separate N_2O emissions from effluent discharged into water bodies were not estimated due to the lack of data on discharge points, which increases the uncertainty of the assessment. Should data become available, the calculation will be carried out in accordance with the 2019 IPCC Refinement using emission factors of 0.005 or 0.019 kg N_2O-N/kg N for effluent.

8. Other (CRT 6)

Other sources of emissions and removals in the Kyrgyz Republic are not present.

9. Indirect CO_2 and N_2O Emissions

9.1. Description of Sources of Indirect Emissions in the GHG Inventory

Indirect CO_2 emissions were not assessed in the NIR for 1990–2023. while indirect N_2O emissions were estimated in the Agriculture sector.

9.2. Methodological Issues

The uncertainty of indirect N_2O emission estimates is presented in the relevant sections of the Agriculture sector.

9.3. Uncertainties and Time Series Consistency

The uncertainty of indirect N_2O emission estimates is presented in the relevant sections of the Agriculture sector.

9.4. QA/QC and Verification for the Specific Category

QA/QC procedures for indirect N_2O emissions are presented in the relevant sections of the Agriculture sector.

9.5 Recalculations

Recalculations of indirect N_2O emissions are presented in the relevant sections of the Agriculture sector.

9.6. Planned Improvements

Planned improvements in the estimation of indirect N_2O emissions are presented in the relevant sections of the Agriculture sector.

10. Recalculations and Improvements

10.1. Explanations and Justifications for Recalculations

In accordance with paragraph 41(a) of decision 2/CP.17, non-Annex I Parties to the Convention, subject to their capabilities and the level of support provided for reporting, are required to submit their first Biennial Update Report (BUR1). The Kyrgyz Republic submitted its BUR1 on 23 December 2022. In 2023, this document underwent, for the first time, the Technical Analysis procedure conducted by the UNFCCC international expert team in Bonn.

Based on the results of the analysis, the expert team prepared a Summary Report on BUR1, including relevant comments and recommendations.

The following table (Table 10.1) presents the comments of the Technical Analysis Report (TA 2023) on the National GHG Inventory for the period 1990–2018 and the response actions undertaken by the National GHG Inventory Expert Team during the this GHG inventory cycle for 1990–2023.

Table 10.1. Technical Analysis comments and implemented improvements to the National GHG Inventory

TA comments on NGHGI 1990–2018	Implemented in NGHGI 1990–2023
Energy	
1) Information on the methods applied for each category was not clearly presented.	Information on the methods applied for each category has been presented.
2) The Party stated that higher-tier methods could also be applied but did not specify for which categories.	It was specified that higher-tier methods for all categories will be applied once national emission factors are developed and more disaggregated activity data become available.
3) Detailed information on energy consumption by categories. as defined in the 2006 IPCC Guidelines (e.g., coal mining by type. emission factors for fugitive emissions. and parameters such as net calorific value). was unclear.	The required information for the energy sector has been presented. However, due to the absence of national EF, the emission factors and net calorific values from the 2006 IPCC Guidelines were applied.
4) GHG emissions from oil refining (1.A.1.b). pipeline transport (1.A.3.e.i). off-road vehicles and other equipment (1.A.4.c.ii). and road transport (passenger cars (1.A.3.b.i). heavy-duty trucks and buses (1.A.3.b.iii). light trucks (1.A.3.b.ii). and motorcycles (1.A.3.b.iv)) were not reported.	GHG emissions from oil refining (1.A.1.b) have been identified and reported. Emissions related to combustion in pipeline transport (1.A.3.e.i) are **NE** (not estimated), as there are no compressors in gas distribution stations; methane is compressed by facilities in neighboring Kazakhstan, therefore no CO_2 or N_2O emissions occur. GHG emissions from off-road vehicles and other equipment (1.A.4.c.ii) were not reported due to lack of activity data. Road transport emissions: passenger cars (1.A.3.b.i) were reported as part of the aggregated road transport total, while other subcategories (heavy-duty trucks and buses (1.A.3.b.iii). light trucks (1.A.3.b.ii), motorcycles (1.A.3.b.iv)) were not reported due to lack of disaggregated activity data.
5) Information on CO_2 emissions from fuel combustion using the reference approach was not reported.	Information on CO_2 emissions from fuel combustion using the reference approach has been presented.

TA comments on NGHGI 1990–2018	Implemented in NGHGI 1990–2023
6) Information on marine bunker fuels was not included in the BUR of the Kyrgyz Republic, with no explanation.	Information on marine bunker fuels has been presented.
IPPU	
1) Information on the methods used for each category was not clearly presented.	Information on applied methods has been presented: overview in Section 4.1. Table 4.1 (column 3), and details in methodology subsections for each category (e.g. cement production – Section 4.2.2. lime – 4.3.2. etc.).
2) The Party stated that higher-tier methods could be used but did not specify for which categories.	Information has been provided in the relevant sections (see previous point).
3) Activity data for all categories were missing.	Complete activity data series have been presented in subsections “Activity Data” of the methodology sections (4.___.2) for each category.
4) N_2O emissions from product use (2.G.3) were reported as zero, with no explanation.	Section 4.12.1 provides narrative explanation. Section 4.12.2. Table 4.23 specifies for which years no data were available and for which years data were provided. Where data were unavailable, the notation key NE was applied. For 2010, 2014, 2016–2018, data confirmed that no imports of nitrous oxide occurred, hence no emissions; however, estimates were provided.
Agriculture	
1) Information on the methods used for each category was not clearly presented.	Information on applied methods has been presented: overview in Section 5.1, Table 5.1 (column 3). and detailed methodology in subsections for each category (e.g., enteric fermentation – Section 5.2.2. manure management – 5.3.2. etc.).
2) The Party stated that higher-tier methods could also be used but did not specify for which categories.	The relevant subsections (5.___.2 Methodology) explain the method selection for each category.
3) Activity data for category 3.C were missing.	Activity data for category 3.C (Rice cultivation) are presented in Section 5.8.2, Table 5.17.
LULUCF	
1) Information on the methods applied for each category was not clearly presented.	Detailed descriptions of applied methods are provided in the current NIR (Chapter 6. see Sections 6.4.2. 6.5.2. 6.6.2).
2) The Party stated that higher-tier methods could also be used but did not specify for which categories.	Not planned yet for LULUCF.
3) The activity data for AD (land area other than forest and cropland) were unclear.	Section 6.3 presents the national land fund distribution by land-use categories. Activity data series for all subcategories are included.
4) Fully comparable information for tables included in Annex 3A.2 of the IPCC Good Practice Guidance for LULUCF was not presented; data on emissions and removals were not disaggregated by carbon pool (living biomass. dead organic matter. soils) or by gas. with no explanation.	Separate subsections on each carbon pool have been included in the current NIR: living biomass, soil carbon, and GHG emissions from biomass burning (see Sections 6.4.2. 6.5.2. 6.6.2).

TA comments on NGHGI 1990–2018	Implemented in NGHGI 1990–2023
5) Information on carbon stock changes in grasslands. wetlands. settlements. and other lands was not provided in the BUR of the Kyrgyz Republic.	The current inventory includes estimates of carbon stock changes in woody vegetation in grasslands (Section 6.6). For wetlands (Section 6.7), settlements (6.8), and other lands (6.9), explanations were provided for the absence of quantitative assessment, with methodological limitations noted.
6) Information on lands converted from other land-use categories. carbon stock changes in carbon pools for land-use categories other than forest land and cropland (e.g. grasslands. wetlands. settlements. and other lands). as well as on all lands converted to a new land-use category. was not presented. The national land accounting system corresponds to IPCC Approach 1 — no data are available on land-use conversions between categories. Detailed explanations are provided in Section 6.3.	The national land accounting system corresponds to IPCC Approach 1 – no data on land-use conversions are available. Explanations are provided in Section 6.3.
Waste	
1) Information on the methods used for each category was not presented. The Party stated that higher-tier methods could also be applied but did not specify for which categories.	For all categories in the Waste sector, Tier 1 methodology and default emission factors from the 2006 IPCC Guidelines were applied – information is presented.
2) Time series of population. per capita waste generation. waste composition. share of waste incinerated. and share of managed/unmanaged disposal sites were unclear.	Population data for 1969–2023 were provided by the National Statistical Committee of the Kyrgyz Republic (NSC) – information is presented. Per capita waste generation was taken from Bishkek City Hall and industry sources – information is presented. Waste composition was taken from the Analytical Note on the Inventory of Waste Disposal Sites – information is presented. The NSC does not provide direct data on the share of incinerated waste. The amount of incinerated waste was estimated based on the share of the population burning waste, in line with IPCC methodology – information is presented. As there are no landfills in the Kyrgyz Republic that meet the conditions for managed sites, all disposal sites were classified as unmanaged deep or shallow. Classification was based on the total volume of disposed waste (thousand tons/year) – information is presented.
3) Information on population time series. per capita waste generation. waste composition. share of incinerated waste. share of treated/untreated waste. and methane correction factor was not presented.	Population data for 1969–2023 were provided by the NSC – information is presented. Per capita waste generation was taken from Bishkek City Hall and industry sources – information is presented. Waste composition was taken from the Analytical Note on the Inventory of Waste Disposal Sites – information is presented. The NSC does not provide direct data on the share of incinerated waste. The amount of incinerated waste was estimated based on the share of the population burning waste, in line with IPCC

TA comments on NGHGI 1990–2018	Implemented in NGHGI 1990–2023
	methodology – information is presented. No studies on methane correction factors were carried out; all coefficients were adopted from the 2006 IPCC Guidelines (Tier 1) – information is presented. The share of treated waste is reported in the relevant subsections (5.A.2, 5.B, 5.C.2) – information is presented.

During the preparation of the NGHGI for the period 1990–2023. recalculations of GHG emissions and removals across all time series in CO_2 eq. were carried out due to the application of Global Warming Potential (GWP) values from the IPCC Fifth Assessment Report (AR5). In the previous NGHGI (1990–2020). calculations were performed using GWP values from the IPCC Second Assessment Report (AR 2). The GWP values from both reports are presented in Table 10.2.

Table 10.2. GWP values applied in the NIR 1990–2020 (AR 2) and in the NIR 1990–2023 (AR5)

Greenhouse gases	GWP values (AR 2)	GWP values (AR5)
CO_2	1	1
CH_4	21	28
N_2O	310	265
HFC-32	650	677
HFC-125	2,800	3,170
HFC-134a	1,300	1,300
HFC-143a	3,800	4,800
HFC-227ea	2,900	3,350
HFC-245fa	NE	858
HFC-365mfc	NE	804

Recalculations by gases and source categories for each sector are presented in the respective Chapters 3–7. This section presents the results of the recalculations of total and net GHG emissions and removals.

10.2. Implications for Emission Levels

The results of the recalculations of GHG emission estimates by gas type and total emissions between the previous GHG inventory in NC4 and the current inventory in BTR1 are presented in Table 10.3.

Table 10.3. Differences in GHG emission estimates by gas type in 1990 and 2020

Gases	NC4 (SAR). kt CO_2 eq. 1990	BRT 1 (AR5). kt CO_2 eq. 1990	Difference between NC4 and BUR1. %
CH_4	3,846.941	5,040.218	31.0
N_2O	4,138.931	2,548.286	-38.4
HFCs	NE	NE	NE
Gases	NC4. kt CO_2 eq. 2020	BTR1. kt CO_2 eq. 2020	Difference. %
CH_4	3,855.820	5,148.013	33.5
N_2O	2,563.675	1,768.539	-31.0
HFCs	227.723	460.602	102.3

The recalculated values of GHG emission estimates by gas type. total emissions. removals. and net emissions. as well as the differences between the estimates of the previous inventory (which applied

GWP values from the IPCC Second Assessment Report used in NGHGI to report on NC4 and the recalculated values obtained in comparison with the previous estimates, are presented in Table 10.4.

Table 10.4. Recalculation of GHG emissions and removals by gas type and differences resulting from the transition from AR2 to AR5 GWP values

Year	AR 2. CO_2 eq			NC 4				AR5. CO_2 eq			BTR 1				Difference between BTR1 and NC4		
	CH4	N2O	HFC	Total CO_2	Total in CO_2 eq	CO_2 removals	Net CO_2 eq	CH4	N2O	HFC	Total CO_2	Total in CO_2 eq	CO_2 removals	Net CO_2 eq	Total CO_2	Total in CO_2 eq	CO_2 removals
1990	3846.94	4138.93	NE	20304.80	28290.68	-10273.53	18017.15	5040.22	2548.29	0.00	20310.36	27898.86	-9639.98	18258.88	-1.4	-6.2	1.3
1991	3704.49	4356.36	NE	17925.71	25986.55	-10294.48	15692.07	4845.60	2740.77	0.00	17931.12	25517.50	-9722.14	15795.36	-1.8	-5.6	0.7
1992	3352.96	3880.88	NE	14295.31	21529.15	-10289.53	11239.62	4252.10	2386.74	0.00	12895.73	19534.58	-9736.19	9798.39	-9.3	-5.4	-12.8
1993	2971.20	1924.97	NE	10523.65	15419.82	-10293.57	5126.25	3812.72	898.43	0.00	9923.45	14634.60	-9777.53	4857.07	-5.1	-5.0	-5.3
1994	2410.47	1478.60	NE	7277.61	11166.69	-10309.73	856.95	3125.73	680.51	0.00	7282.83	11089.07	-9809.44	1279.63	-0.7	-4.9	49.3
1995	2176.59	1292.49	3.64	5332.96	8805.67	-10323.65	-1517.98	2814.03	582.00	3.64	5338.08	8737.75	-9817.30	-1079.55	-0.8	-4.9	-28.9
1996	2099.49	1275.41	4.09	5136.61	8515.60	-10032.16	-1516.56	2713.58	597.32	4.09	5373.90	8688.89	-9802.59	-1113.70	2.0	-2.3	-26.6
1997	2155.29	1617.68	4.72	5506.41	9284.09	-10303.29	-1019.20	2783.13	853.22	4.72	5975.85	9616.92	-9780.57	-163.66	3.6	-5.1	-83.9
1998	2185.71	1548.41	5.51	4951.28	8690.90	-10331.51	-1640.61	2835.79	790.35	5.51	5401.12	9032.77	-9621.76	-588.99	3.9	-6.9	-64.1
1999	2209.28	1584.08	6.47	4771.13	8570.96	-10339.09	-1768.14	2869.00	817.37	6.47	5201.37	8894.21	-9775.74	-881.53	3.8	-5.4	-50.1
2000	2245.17	1575.33	7.60	4448.40	8276.50	-10303.88	-2027.38	2918.57	798.62	7.60	4778.36	8503.15	-9803.14	-1299.99	2.7	-4.9	-35.9
2001	2265.43	1602.86	8.89	4840.44	8717.62	-10221.40	-1503.78	2947.17	818.25	8.90	5069.94	8844.25	-9703.35	-859.10	1.5	-5.1	-42.9
2002	2306.88	1593.30	10.36	4530.10	8440.64	-10239.26	-1798.62	3007.52	804.15	10.36	4573.72	8395.75	-9703.98	-1308.23	-0.5	-5.2	-27.3
2003	2284.67	1583.98	11.99	4795.25	8675.89	-9914.32	-1238.43	2980.81	802.10	11.99	4621.21	8416.12	-9749.04	-1332.92	-3.0	-1.7	7.6
2004	2329.86	1608.29	13.66	5083.20	9035.01	-10302.87	-1267.85	3060.69	811.52	13.66	4691.62	8577.49	-10013.59	-1436.11	-5.1	-2.8	13.3
2005	2376.82	1661.90	15.76	5486.50	9540.99	-10205.99	-665.00	3110.39	838.64	15.76	5730.71	9695.50	-10045.78	-350.28	1.6	-1.6	-47.3
2006	2447.29	1726.04	17.90	5588.40	9779.62	-10208.93	-429.30	3208.86	870.55	17.90	5849.47	9946.78	-10096.21	-149.43	1.7	-1.1	-65.2
2007	2535.28	1776.34	16.66	6502.90	10831.18	-10309.90	521.28	3330.74	890.95	17.90	6946.74	11186.33	-10089.43	1096.90	3.3	-2.1	110.4
2008	2663.86	1926.46	22.14	7297.92	11910.38	-10250.70	1659.67	3499.85	983.03	23.19	7721.14	12227.21	-10139.25	2087.96	2.7	-1.1	25.8
2009	2769.46	2000.72	24.61	6875.95	11670.73	-10303.40	1367.33	3630.38	1014.66	25.50	7123.15	11793.69	-10133.73	1659.96	1.1	-1.6	21.4
2010	2856.69	1992.97	49.98	6367.90	11267.55	-10334.54	933.00	3744.83	997.84	88.99	6691.21	11522.87	-10136.18	1386.68	2.3	-1.9	48.6
2011	2945.48	2090.93	64.09	7912.95	13013.46	-10295.77	2717.68	3858.56	1055.46	135.17	8165.69	13214.87	-10082.11	3132.76	1.5	-2.1	15.3
2012	3038.02	2169.01	123.82	9474.13	14804.99	-10324.34	4480.65	3987.28	1096.80	229.92	9704.58	15018.58	-10119.29	4899.29	1.4	-2.0	9.3
2013	3098.90	2199.65	165.18	9422.46	14886.19	-10216.19	4670.00	4055.21	1109.23	307.00	9145.68	14617.11	-10116.06	4501.05	-1.8	-1.0	-3.6
2014	3252.00	2381.41	215.74	9705.70	15554.85	-10327.72	5227.13	4266.86	1222.09	379.52	9974.45	15842.93	-10145.37	5697.56	1.9	-1.8	9.0
2015	3322.62	2385.89	219.88	10275.01	16203.40	-10336.53	5866.87	4379.87	1211.83	400.32	10589.67	16581.70	-10151.50	6430.19	2.3	-1.8	9.6
2016	3398.44	2405.13	305.90	8840.46	14949.94	-10302.54	4647.40	4482.81	1213.30	510.10	9328.35	15534.55	-10125.64	5408.91	3.9	-1.7	16.4
2017	3525.35	2528.82	341.55	9449.07	15844.78	-10367.31	5477.47	4678.53	1297.52	562.61	9920.66	16459.32	-10215.40	6243.93	3.9	-1.5	14.0
2018	3661.57	2587.29	193.69	11415.85	17858.41	-10941.37	6917.04	4866.48	1276.05	403.74	11789.24	18335.50	-10304.29	8031.20	2.7	-5.8	16.1
2019	3758.65	2533.81	208.22	8671.71	15172.40	-10954.62	4217.78	4992.72	1336.19	430.20	9828.30	16587.42	-10303.38	6284.03	9.3	-5.9	49.0
2020	3855.82	2563.67	227.72	8064.07	14711.29	-10960.10	3751.19	5148.01	1768.54	460.60	9453.05	16830.20	-10294.15	6536.05	14.4	-6.1	74.2

10.3. Implications for Emission Trends

As shown in Table 10.4. the transition to AR5 GWP values did not significantly affect the emission estimates of NC4 or the GHG emission trends of the current NGHGI/BTR1. The dynamics of total GHG emissions for the period 1990–2020. using SAR GWP values applied in NC4 and AR5 GWP values applied in BTR1. are presented in Figure 10.1.

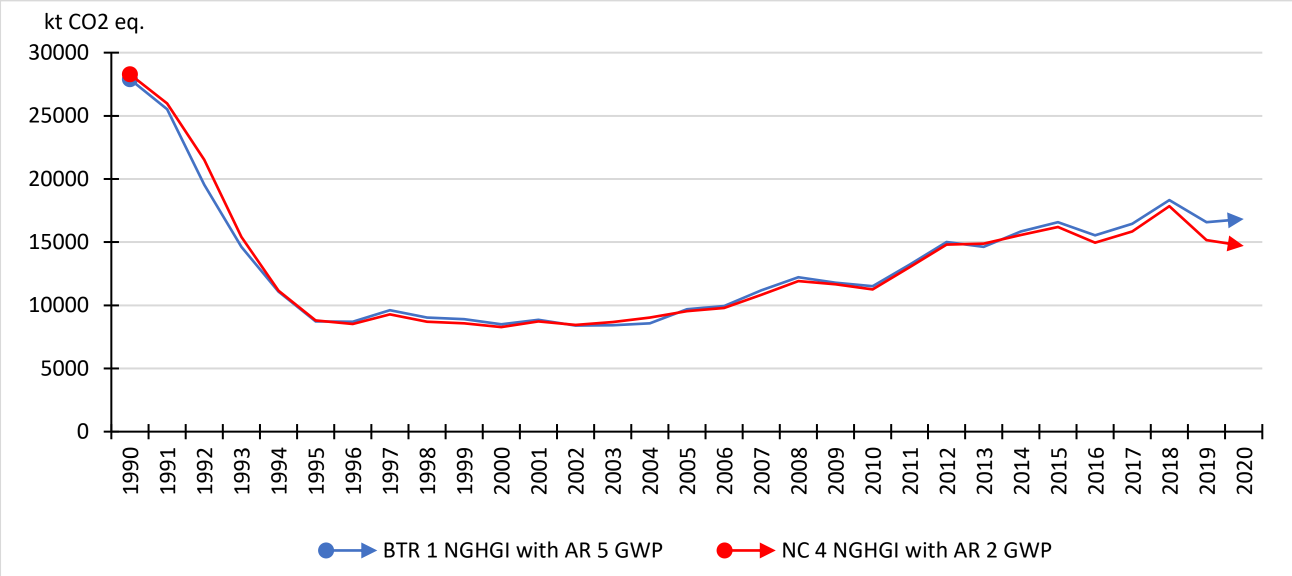

Figure 10.1. Trends of total GHG emissions according to NC4 (SAR GWPs) and BTR1 (AR5 GWPs)

The dynamics of net GHG emissions for the period 1990–2020. using SAR GWP values applied in NC4 and AR5 GWP values applied in BTR1. are presented in Figure 10.2.

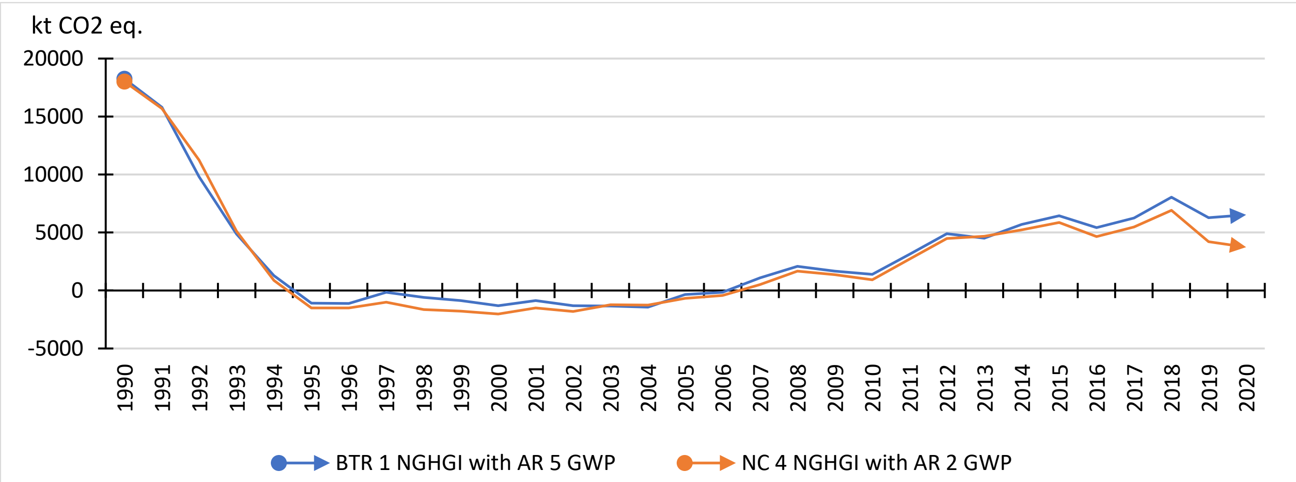

Figure 10.2. Trends of net GHG emissions according to NC4 (SAR GWPs) and BTR1 (AR5 GWPs)

It is evident that the net emission trends were also influenced by the recalculation of removals. which was undertaken based on new data on forest areas obtained through the forest inventory and the Second National Forest Inventory (2024). as well as the inclusion of category 4.C.1 “Grasslands remaining Grasslands” in the assessment of emissions and removals. which was not covered in the previous inventory due to the lack of relevant activity data. The results of the recalculation and the CO_2 removals estimated in the previous NC4 and in the NID/BTR1 are presented in Figure 10.3.

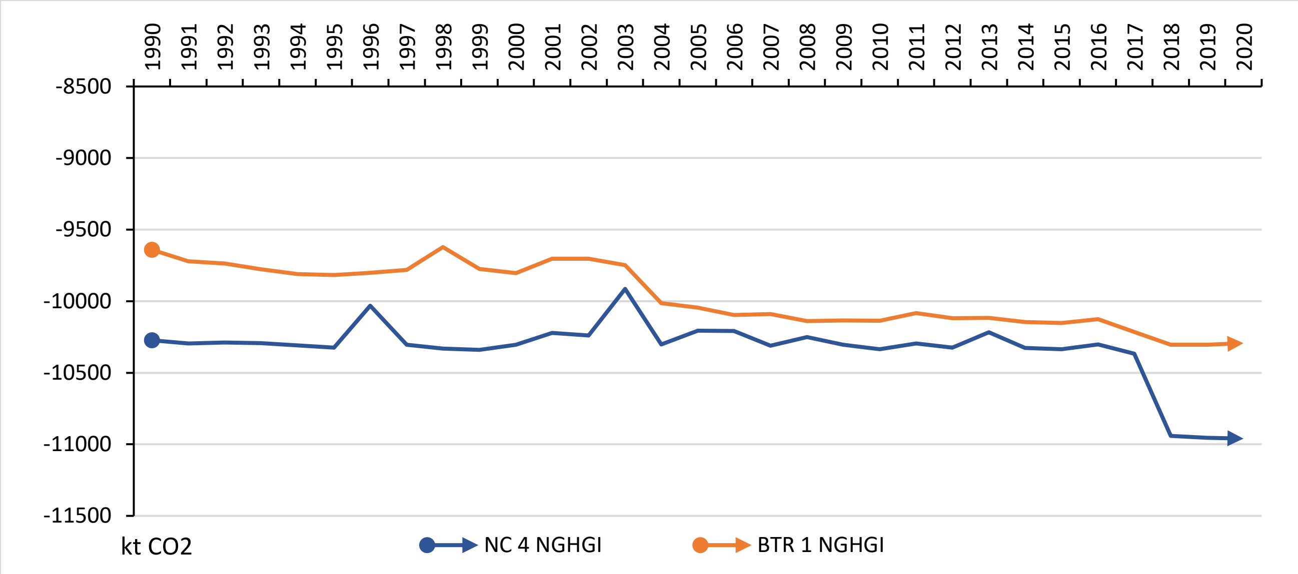

Figure 10.3. Trends of GHG removals according to NC4 and BTR1

10.4. Planned Improvements

Planned improvements to the National Greenhouse Gas Inventory (NGHGI) are presented in the sectoral chapters for each GHG source and sink category.

Planned improvements. where applicable. have been described above for all sectors and for each GHG source and sink category. The consolidated Improvement Plan for the GHG Inventory (sources and sinks by category) will be finalized upon completion of the entire NGHGI process (1990–2023) and submitted to the UNFCCC National Focal Point of the Kyrgyz Republic for review and approval.

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12. Annex 1: Key Categories

For the identification of key categories by level and trend, the approach 1 methodology of the Intergovernmental Panel on Climate Change (IPCC) was applied in accordance with Tables 4.2 and 4.3 of Volume 1 of the 2006 IPCC Guidelines, both including and excluding Land Use, Land-Use Change and Forestry (LULUCF). Tables 12.1 and 12.2 on Kyrgyzstan NGHGI key categories assessment were generated using online ETF reporting tool.

Table 0.1. Key category assessment for 1990 by level and trend with and without LULUCF

Key categories of emissions and removals	Gas	Emissions/removals [1990]	Without LULUCF			(With LULUCF		
		ktCO₂ eq)	Level (%)	Trend (%)	Key category	Level (%)	Trend (%)	Key category
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	2,584.8	9.3		X	6.9		X
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	2,889.2	10.4		X	7.7		X
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	2,648.4	9.5		X	7.1		X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	209.5	0.8		X	0.6		
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	262.0	0.9		X	0.7		X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	795.5	2.9		X	2.1		X
1.A.3.b Road Transportation	CO_2	2,824.6	10.1		X	7.5		X
1.A.3.e Other Transportation	CO_2	1,108.6	4.0		X	3.0		X
1.A.4 Other Sectors - Liquid Fuels	CO_2	459.7	1.6		X	1.2		X
1.A.4 Other Sectors - Solid Fuels	CO_2	5,049.3	18.1		X	13.5		X
1.A.4 Other Sectors - Solid Fuels	CH_4	441.4	1.6		X	1.2		X
1.A.4 Other Sectors - Gaseous Fuels	CO_2	390.2	1.4		X	1.0		X
1.B.1 Fugitive emissions from Solid Fuels	CH_4	337.8	1.2		X	0.9		X
2.A.1 Cement Production	CO_2	591.5	2.1		X	1.6		X
3.A Enteric Fermentation	CH_4	3,347.0	12.0		X	8.9		X
3.B Manure Management	N_2O	250.4	0.9		X	0.7		X
3.D.1 Direct N2O Emissions From Managed Soils	N_2O	1,669.6	6.0		X	4.4		X

Key categories of emissions and removals	Gas	Emissions/removals [1990]	Without LULUCF			(With LULUCF		
		ktCO₂ eq)	Level (%)	Trend (%)	Key category	Level (%)	Trend (%)	Key category
3.D.2 Indirect N2O Emissions From Managed Soils	N_2O	371.7	1.3		X	1.0		X
4.A.1 Forest Land Remaining Forest Land	CO_2	-7,785.1				20.7		X
4.B.1 Cropland Remaining Cropland	CO_2	-1,305.8				3.5		X
4.C.1 Grassland Remaining Grassland	CO_2	-549.1				1.5		X
5.A Solid Waste Disposal	CH_4	182.0	0.7		X	0.5		
5.D Wastewater Treatment and Discharge	CH_4	229.8	0.8		X	0.6		X

Table 0.2. Key Category Assessment for 2023 by level and trend, excluding and including LULUCF.

Key categories of emissions and removals	Gas	Emissions/removals [2023]	Without LULUCF			With LULUCF		
		(ktCO₂ eq)	Level (%)	Trend (%)	Key category	Level (%)	Trend (%)	Key category
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	1,042.8	5.4	6.4	X	3.5	1.6	X
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	2,003.8	10.3	0.0	X	6.8	3.7	X
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	259.1	1.3	13.5	X	0.9	6.8	X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	174.5	0.9	0.2	X	0.6	0.5	
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	250.3	1.3	0.6	X	0.8	0.8	X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	103.0	0.5	3.9	X	0.3	1.9	X
1.A.3.b Road Transportation	CO_2	3,098.2	16.0	9.7	X	10.4	10.9	X
1.A.3.c Railways	CO_2	4.5	0.0	0.7	X	0.0	0.4	
1.A.3.e Other Transportation	CO_2	358.0	1.8	3.5	X	1.2	1.2	X
1.A.4 Other Sectors - Liquid Fuels	CO_2	346.8	1.8	0.2	X	1.2	0.8	X
1.A.4 Other Sectors - Solid Fuels	CO_2	1,700.8	8.8	15.5	X	5.7	5.2	X
1.A.4 Other Sectors - Solid Fuels	CH_4	120.0	0.6	1.6	X	0.4	0.6	X
1.A.4 Other Sectors - Gaseous Fuels	CO_2	379.8	2.0	0.9	X	1.3	1.2	X
1.B.1 Fugitive emissions from Solid Fuels	CH_4	278.2	1.4	0.4	X	0.9	0.7	X

1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH_4	193.9	1.0	1.1	X	0.7	0.9	X
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH_4	39.4	0.2	0.7	X	0.1	0.3	
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH_4	102.5	0.5	0.6	X	0.3	0.5	
2.A.1 Cement Production	CO_2	1,396.2	7.2	8.4	X	4.7	7.1	X
2.A.4 Other Process Uses of Carbonates	CO_2	29.5	0.2	0.6	X	0.1	0.3	
2.F.1 Refrigeration and Air conditioning	F-gases	491.3	2.5	4.2	X	1.7	3.2	X
3.A Enteric Fermentation	CH_4	3,783.7	19.5	12.5	X	12.7	13.7	X
3.B Manure Management	CH_4	108.2	0.6	0.3		0.4	0.4	
3.B Manure Management	N_2O	589.2	3.0	3.6	X	2.0	3.0	X
3.D.1 Direct N2O Emissions From Managed Soils	N_2O	876.3	4.5	2.4	X	3.0	0.3	X
3.D.2 Indirect N2O Emissions From Managed Soils	N_2O	311.4	1.6	0.5	X	1.0	0.8	X
4.A.1 Forest Land Remaining Forest Land	CO_2	-8213.7				27.7	22.5	X
4.B.1 Cropland Remaining Cropland	CO_2	-1 767.2				6.0	1.3	X
4.C.1 Grassland Remaining Grassland	CO_2	-328.4				1.1	3.2	X
5.A Solid Waste Disposal	CH_4	381.9	2.0	2.2	X	1.3	1.9	X
5.D Wastewater Treatment and Discharge	CH_4	486.8	2.5	2.8	X	1.6	2.4	X

13. Annex 2: Uncertainty Assessment

For the identification of uncertainties. the methodology and Table 3.3 of Volume 1 of the 2006 IPCC Guidelines were applied. Table 13.1 was generated using IPCC Software v.2.98.

Table 0.1. Uncertainty assessment according to the IPCC Software

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year T	Inventory trend in national emissions for year t increase with respect to base year (% of base year)	Uncertainty introduced into the trend in total national emissions (%)
1 - Energy									
1.A.1 - Energy Industries - Liquid Fuels	CO2	2584.783	1042.766	8.660	10.628	13.710	0.648	40.342	0.252083391
1.A.1 - Energy Industries - Liquid Fuels	CH4	2.797	1.190	8.660	396.272	396.367	0.001	42.541	0.000242358
1.A.1 - Energy Industries - Liquid Fuels	N2O	5.295	2.253	8.660	396.272	396.367	0.003	42.541	0.000868346
1.A.1 - Energy Industries - Solid Fuels	CO2	2889.157	2003.776	8.660	21.581	23.254	7.627	69.355	1.508788155
1.A.1 - Energy Industries - Solid Fuels	CH4	0.839	0.570	8.660	346.410	346.518	0.000	67.888	0.000020588
1.A.1 - Energy Industries - Solid Fuels	N2O	11.917	8.091	8.660	384.900	384.998	0.034	67.888	0.005120577
1.A.1 - Energy Industries - Gaseous Fuels	CO2	2648.369	259.101	7.071	5.546	8.987	0.016	9.783	0.025261072
1.A.1 - Energy Industries - Gaseous Fuels	CH4	1.322	0.129	7.071	282.843	282.931	0.000	9.783	0.000014704
1.A.1 - Energy Industries - Gaseous Fuels	N2O	1.251	0.122	7.071	282.843	282.931	0.000	9.783	0.000013171
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	CO2	209.506	174.459	15.000	18.408	23.746	0.009	83.272	0.003185254
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	CH4	0.227	0.185	15.000	686.364	686.528	0.000	81.237	0.000002577
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	N2O	0.430	0.350	15.000	686.364	686.528	0.000	81.237	0.000009234
1.A.2 - Manufacturing Industries and Construction - Solid Fuels	CO2	262.017	250.258	16.583	41.325	44.528	0.087	95.512	0.026049323
1.A.2 - Manufacturing Industries and Construction - Solid Fuels	CH4	0.763	0.702	16.583	663.325	663.532	0.000	91.912	0.000040721
1.A.2 - Manufacturing Industries and Construction - Solid Fuels	N2O	1.084	0.996	16.583	737.028	737.214	0.000	91.912	0.000101298
1.A.2 - Manufacturing Industries and Construction - Gaseous Fuels	CO2	795.453	104.091	15.811	12.401	20.094	0.002	13.086	0.007014922
1.A.2 - Manufacturing Industries and Construction - Gaseous Fuels	CH4	0.397	0.052	15.811	632.456	632.653	0.000	13.086	0.000004531
1.A.2 - Manufacturing Industries and Construction - Gaseous Fuels	N2O	0.376	0.049	15.811	632.456	632.653	0.000	13.086	0.000004058
1.A.2 - Manufacturing Industries and Construction - Biomass - solid	CO2	0.000	0.000	7.071	24.850	25.836	0.000	100.000	0.000000000
1.A.2 - Manufacturing Industries and Construction - Biomass - solid	CH4	0.026	0.002	7.071	314.270	314.349	0.000	6.490	0.000000019
1.A.2 - Manufacturing Industries and Construction - Biomass - solid	N2O	0.033	0.002	7.071	388.909	388.973	0.000	6.490	0.000000047
1.A.3.a - Civil Aviation - Liquid Fuels	CO2	413.063	449.034	7.071	5.953	9.243	0.082	108.708	0.027181708
1.A.3.a - Civil Aviation - Liquid Fuels	CH4	0.081	0.088	7.071	141.421	141.598	0.000	108.708	0.000000058
1.A.3.a - Civil Aviation - Liquid Fuels	N2O	3.062	3.329	7.071	212.132	212.250	0.002	108.708	0.000184031
1.A.3.b - Road Transportation - Liquid Fuels	CO2	2824.570	3098.238	5.000	3.068	5.866	3.674	109.689	1.457719622
1.A.3.b - Road Transportation - Liquid Fuels	CH4	27.938	26.746	5.000	244.693	244.744	0.477	95.735	0.027167570
1.A.3.b - Road Transportation - Liquid Fuels	N2O	35.966	40.013	5.000	209.938	209.997	0.785	111.252	0.060059738
1.A.3.b - Road Transportation	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
1.A.3.c - Railways - Liquid Fuels	CO2	125.253	4.461	5.000	2.024	5.394	0.000	3.561	0.000044390
1.A.3.c - Railways - Liquid Fuels	CH4	0.196	0.007	5.000	150.602	150.685	0.000	3.561	0.000000565
1.A.3.c - Railways - Liquid Fuels	N2O	12.811	0.456	5.000	200.000	200.062	0.000	3.561	0.004240724
1.A.3.d - Water-borne Navigation - Liquid Fuels	CO2	4.397	0.000	5.000	4.301	6.596	0.000	0.000	0.000000267
1.A.3.d - Water-borne Navigation - Liquid Fuels	CH4	0.012	0.000	5.000	50.000	50.249	0.000	0.000	0.000000000

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year T	Inventory trend in national emissions for year t increase with respect to base year (% of base year)	Uncertainty introduced into the trend in total national emissions (%)
1.A.3.d - Water-borne Navigation - Liquid Fuels	N2O	0.031	0.000	5.000	140.000	140.089	0.000	0.000	0.000000014
1.A.3.e - Other Transportation - Liquid Fuels	CO2	1108.646	358.047	5.000	3.874	6.325	0.057	32.296	0.020311531
1.A.3.e - Other Transportation - Liquid Fuels	CH4	4.477	0.637	5.000	150.219	150.302	0.000	14.230	0.000175367
1.A.3.e - Other Transportation - Liquid Fuels	N2O	104.968	36.389	5.000	200.000	200.062	0.589	34.667	0.033683156
1.A.4 - Other Sectors - Liquid Fuels	CO2	459.663	347.196	8.660	10.628	13.710	0.079	75.533	0.017361782
1.A.4 - Other Sectors - Liquid Fuels	CH4	1.663	1.476	8.660	346.410	346.518	0.001	88.756	0.000039742
1.A.4 - Other Sectors - Liquid Fuels	N2O	0.944	0.838	8.660	405.067	405.160	0.000	88.756	0.000017861
1.A.4 - Other Sectors - Solid Fuels	CO2	5049.286	1700.786	8.660	21.581	23.254	4.238	33.684	0.860939927
1.A.4 - Other Sectors - Solid Fuels	CH4	441.353	120.005	8.660	346.410	346.518	6.292	27.190	1.261937944
1.A.4 - Other Sectors - Solid Fuels	N2O	20.885	6.724	8.660	382.351	382.449	0.018	32.197	0.003492905
1.A.4 - Other Sectors - Gaseous Fuels	CO2	390.187	379.822	8.660	6.792	11.006	0.063	97.344	0.021792381
1.A.4 - Other Sectors - Gaseous Fuels	CH4	0.974	0.948	8.660	346.410	346.518	0.000	97.344	0.000026753
1.A.4 - Other Sectors - Gaseous Fuels	N2O	0.184	0.179	8.660	346.410	346.518	0.000	97.344	0.000000959
1.A.4 - Other Sectors - Biomass - solid	CO2	0.000	0.000	8.660	30.435	31.643	0.000	100.000	0.000000000
1.A.4 - Other Sectors - Biomass - solid	CH4	9.959	0.509	8.660	346.410	346.518	0.000	5.109	0.002170478
1.A.4 - Other Sectors - Biomass - solid	N2O	1.257	0.064	8.660	433.013	433.099	0.000	5.109	0.000054005
1.B.1.a - Coal mining and handling	CO2	33.096	26.749	0.000	0.000	0.000	0.000	80.821	0.000000000
1.B.1.a - Coal mining and handling	CH4	337.843	278.206	5.000	0.000	5.000	0.000	82.348	0.000000000
1.B.1.c - Fuel transformation	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
1.B.1.c - Fuel transformation	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
1.B.1.c - Fuel transformation	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
1.B.2.a - Oil	CO2	0.838	1.640	0.000	0.000	0.000	0.000	195.555	0.000000000
1.B.2.a - Oil	CH4	151.571	296.405	0.000	0.000	0.000	0.000	195.555	0.000000000
1.B.2.a - Oil	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
1.B.2.b - Natural Gas	CO2	6.693	1.868	0.000	0.000	0.000	0.000	27.915	0.000000000
1.B.2.b - Natural Gas	CH4	175.928	39.410	0.000	0.000	0.000	0.000	22.401	0.000000000
1.B.2.b - Natural Gas	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
1.B.3 - Other emissions from Energy Production	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
1.B.3 - Other emissions from Energy Production	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
1.B.3 - Other emissions from Energy Production	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
1.C - Carbon dioxide Transport and Storage	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2 - Industrial Processes and Product Use									
2.A.1 - Cement production	CO2	591.522	1396.183	78.262	0.000	78.262	132.776	236.033	68.816360866
2.A.2 - Lime production	CO2	65.536	20.256	53.852	0.000	53.852	0.013	30.908	0.006857935
2.A.3 - Glass Production	CO2	69.275	20.123	35.014	0.000	35.014	0.006	29.048	0.002861394
2.A.4 - Other Process Uses of Carbonates	CO2	144.710	29.486	0.000	0.000	0.000	0.000	20.376	0.000000000
2.A.5 - Other (please specify)	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.A.5 - Other (please specify)	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.A.5 - Other (please specify)	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.B.1 - Ammonia Production	CO2	0.000	0.000	5.000	0.000	5.000	0.000	100.000	0.000000000
2.B.2 - Nitric Acid Production	N2O	0.000	0.000	2.000	0.000	2.000	0.000	100.000	0.000000000
2.B.3 - Adipic Acid Production	N2O	0.000	0.000	2.000	0.000	2.000	0.000	100.000	0.000000000
2.B.4 - Caprolactam. Glyoxal and Glyoxylic Acid Production	N2O	0.000	0.000	10.000	0.000	10.000	0.000	100.000	0.000000000

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2.B.5 - Carbide Production	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.B.5 - Carbide Production	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.B.6 - Titanium Dioxide Production	CO2	0.000	0.000	7.071	0.000	7.071	0.000	100.000	0.000000000
2.B.7 - Soda Ash Production	CO2	0.000	0.000	5.000	0.000	5.000	0.000	100.000	0.000000000
2.B.8 - Petrochemical and Carbon Black Production	CO2	0.000	0.000	34.641	0.000	34.641	0.000	100.000	0.000000000
2.B.8 - Petrochemical and Carbon Black Production	CH4	0.000	0.000	24.495	0.000	24.495	0.000	100.000	0.000000000
2.B.9 - Fluorochemical Production	CHF3	0.000	0.000	14.142	0.000	14.142	0.000	100.000	0.000000000
2.B.10 - Hydrogen Production	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.B.10 - Hydrogen Production	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.B.10 - Hydrogen Production	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.C.1 - Iron and Steel Production	CO2	0.596	0.000	26.458	0.000	26.458	0.000	0.000	0.000000000
2.C.1 - Iron and Steel Production	CH4	0.000	0.000	14.142	0.000	14.142	0.000	100.000	0.000000000
2.C.2 - Ferroalloys Production	CO2	0.000	0.000	26.458	0.000	26.458	0.000	100.000	0.000000000
2.C.2 - Ferroalloys Production	CH4	0.000	0.000	10.000	0.000	10.000	0.000	100.000	0.000000000
2.C.3 - Aluminium production	CO2	0.000	0.000	22.361	0.000	22.361	0.000	100.000	0.000000000
2.C.3 - Aluminium production	CF4	0.000	0.000	10.392	0.000	10.392	0.000	100.000	0.000000000
2.C.3 - Aluminium production	C2F6	0.000	0.000	10.392	0.000	10.392	0.000	100.000	0.000000000
2.C.4 - Magnesium production	CO2	0.000	0.000	14.142	0.000	14.142	0.000	100.000	0.000000000
2.C.4 - Magnesium production	SF6	0.000	0.000	14.142	0.000	14.142	0.000	100.000	0.000000000
2.C.5 - Lead Production	CO2	0.000	0.000	10.000	0.000	10.000	0.000	100.000	0.000000000
2.C.6 - Zinc Production	CO2	0.000	0.000	10.000	0.000	10.000	0.000	100.000	0.000000000
2.C.7 - Rare Earths Production	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.C.7 - Rare Earths Production	CF4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.C.7 - Rare Earths Production	C2F6	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.C.7 - Rare Earths Production	C3F8	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.C.8 - Other (please specify)	CO2	0.000	0.191	0.000	0.000	0.000	0.000	0.000	0.000000000
2.D - Non-Energy Products from Fuels and Solvent Use	CO2	0.000	15.695	14.142	0.000	14.142	0.000	0.000	0.000140875
2.D - Non-Energy Products from Fuels and Solvent Use	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.D - Non-Energy Products from Fuels and Solvent Use	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.E - Electronics Industry	CHF3	0.000	0.000	10.000	0.000	10.000	0.000	100.000	0.000000000
2.E - Electronics Industry	CF4	0.000	0.000	17.321	0.000	17.321	0.000	100.000	0.000000000
2.E - Electronics Industry	C2F6	0.000	0.000	14.142	0.000	14.142	0.000	100.000	0.000000000
2.E - Electronics Industry	C3F8	0.000	0.000	10.000	0.000	10.000	0.000	100.000	0.000000000
2.E - Electronics Industry	SF6	0.000	0.000	14.142	0.000	14.142	0.000	100.000	0.000000000
2.E - Electronics Industry	NF3	0.000	0.000	14.142	0.000	14.142	0.000	100.000	0.000000000
2.E - Electronics Industry	CH2F2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.E - Electronics Industry	CH3F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.E - Electronics Industry	CHF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.E - Electronics Industry	c-C4F8	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.E - Electronics Industry	NF3 Remote	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.E - Electronics Industry	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.E - Electronics Industry	n-C6F14	0.000	0.000	10.000	0.000	10.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CH2FCF3	0.000	141.411	7.071	0.000	7.071	0.003	0.000	0.001023941

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2.F.1 - Refrigeration and Air Conditioning	CH3CHF2	0.000	0.000	7.071	0.000	7.071	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CH2F2	0.000	26.732	7.071	0.000	7.071	0.000	0.000	0.000075670
2.F.1 - Refrigeration and Air Conditioning	CHF2CF3	0.000	204.342	7.071	0.000	7.071	0.007	0.000	0.003097957
2.F.1 - Refrigeration and Air Conditioning	CH3CF3	0.000	118.776	7.071	0.000	7.071	0.002	0.000	0.000728912
2.F.1 - Refrigeration and Air Conditioning	CHF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CH3F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CF3CHFCHFCF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CHF2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CH2FCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CF3CHFCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CF3CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CH2FCF2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CH2FCH2F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CH3CH2F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CH2FCF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CHF2CHFCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CHF2CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CH3CF2CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	CF4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	C2F6	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	C3F8	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	C4F10	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	c-C4F8	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	n-C5F12	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.1 - Refrigeration and Air Conditioning	n-C6F14	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CH2FCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CH3CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CF3CHFCF3	0.000	27.096	0.000	0.000	0.000	0.000	0.000	0.000000000
2.F.2 - Foam Blowing Agents	CHF2CH2CF3	0.000	1.130	0.000	0.000	0.000	0.000	0.000	0.000000000
2.F.2 - Foam Blowing Agents	CH3CF2CH2CF3	0.000	6.623	0.000	0.000	0.000	0.000	0.000	0.000000000
2.F.2 - Foam Blowing Agents	CHF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CH2F2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CH3F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CF3CHFCHFCF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CHF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CHF2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CH2FCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CH3CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CF3CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CH2FCF2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CH2FCH2F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CH3CH2F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000

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2.F.2 - Foam Blowing Agents	CH2FCF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CHF2CHFCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	CF4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	C2F6	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	C3F8	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	C4F10	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	c-C4F8	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	n-C5F12	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.2 - Foam Blowing Agents	n-C6F14	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.3 - Fire Protection	CH2FCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.3 - Fire Protection	CH3CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.4 - Aerosols	CF3CHFCHFCF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.4 - Aerosols	CH2FCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.4 - Aerosols	CH3CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.4 - Aerosols	CF3CHFCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.4 - Aerosols	CHF2CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.4 - Aerosols	CH3CF2CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.4 - Aerosols	n-C6F14	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.5 - Solvents	CF3CHFCHFCF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.5 - Solvents	CH3CF2CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.5 - Solvents	n-C6F14	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH2F2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH3F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CHFCHFCF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH2FCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH3CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH2FCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH3CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CHFCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH2FCF2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH2FCH2F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH3CH2F	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH2FCF2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2CHFCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH3CF2CH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000

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2.F.6 - Other Applications (please specify)	C2F6	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	C3F8	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	C4F10	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	c-C4F8	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	n-C5F12	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	n-C6F14	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	SF6	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	NF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	NF3 Remote	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	(CF3)2CFOCH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3OCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2OCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH3OCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CHClOCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CF2OCH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CH2OCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH3OCF2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CF2CF2OCH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2CF2CH2OCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2 CF2OCH2CH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	C4F9OCH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	C4F9OC2H5	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2OCF2OC2F4OCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2OCF2OCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2OCF2CF2OCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CHFOCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CHFOCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CH2OCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2CH2OCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CH2OCH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CF2OCF2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CF2OCH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CF2OCH2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CHFCF2OCH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000

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2.F.6 - Other Applications (please specify)	CHF2CF2CF2OCH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2CF2OCH2CHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CF2CH2OCH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	(CF3)2CHOCHF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	(CF3)2CHOCH3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHF2CF2OCH2CF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3OCF(CF3)CF2OCF2OCF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH2Br2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHCl3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH3Cl	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CH2Cl2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	(CF3)CH2OH	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CF3CF2CH2OH	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	(CF3)2CHOH	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	-(CF2)4CH(OH)-	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.F.6 - Other Applications (please specify)	CHBrF2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	CF4	0.000	0.000	60.000	58.310	83.666	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	C2F6	0.000	0.000	60.000	58.310	83.666	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	C3F8	0.000	0.000	60.000	58.310	83.666	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	C4F10	0.000	0.000	60.000	58.310	83.666	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	c-C4F8	0.000	0.000	60.000	58.310	83.666	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	n-C5F12	0.000	0.000	60.000	58.310	83.666	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	n-C6F14	0.000	0.000	60.000	58.310	83.666	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	SF6	0.000	0.000	60.000	58.310	83.666	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	c-C3F6	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	CHF3	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.G - Other Product Manufacture and Use	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.H - Other	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.H - Other	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
2.H - Other	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3 - Agriculture. Forestry. and Other Land Use									
3.A.1 - Enteric Fermentation	CH4	3346.956	3783.694	0.000	0.000	0.000	0.000	113.049	0.000000000
3.A.2 - Manure Management	CH4	100.226	108.231	0.000	0.000	0.000	0.000	107.986	0.000000000
3.A.2 - Manure Management	N2O	171.728	396.917	0.000	0.000	0.000	0.000	231.131	0.000000000
3.B.1.a - Forest land Remaining Forest land	CO2	-7785.062	-8213.658	32.100	34.000	46.759	1640.337	0.000	461.363674824
3.B.1.b - Land Converted to Forest land	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.2.a - Cropland Remaining Cropland	CO2	-1305.812	-1767.181	18.000	75.000	77.130	206.602	0.000	25.561226226
3.B.2.b - Land Converted to Cropland	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.3.a - Grassland Remaining Grassland	CO2	-549.105	-328.365	0.000	0.000	0.000	0.000	0.000	0.000000000

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3.B.3.b - Land Converted to Grassland	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.4.a.i - Peat Extraction remaining Peat Extraction	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.4.a.iii - Other Wetlands Remaining Other Wetlands	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.4.b.i - Land converted for Peat Extraction	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.4.b.ii - Land converted to Flooded Land	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.4.b.iii - Land converted to Other Wetlands	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.5.a - Settlements Remaining Settlements	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.5.b - Land Converted to Settlements	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.B.6.b - Land Converted to Other land	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.1 - Burning	CO2	0.000	0.000	10.000	0.000	10.000	0.000	100.000	0.000000000
3.C.1 - Burning	CH4	0.000	0.207	10.000	6.600	11.982	0.000	79300.000	0.000000030
3.C.1 - Burning	N2O	0.000	0.108	10.000	6.300	11.819	0.000	79300.000	0.000000008
3.C.2 - Liming	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.3 - Urea application	CO2	0.000	14.924	0.000	0.000	0.000	0.000	0.000	0.000000000
3.C.4 - Direct N2O Emissions from managed soils	N2O	1669.604	876.289	0.000	0.000	0.000	0.000	52.485	0.000000000
3.C.5 - Indirect N2O Emissions from managed soils	N2O	371.703	311.424	0.000	0.000	0.000	0.000	83.783	0.000000000
3.C.6 - Indirect N2O Emissions from manure management	N2O	78.721	192.315	0.000	0.000	0.000	0.000	244.301	0.000000000
3.C.7 - Rice cultivation	CH4	7.452	70.619	0.000	0.000	0.000	0.000	947.711	0.000000000
3.C.8 - CH4 from Drained Organic Soils	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.9 - CH4 from Drainage Ditches on Organic Soils	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.10 - CH4 from Rewetting of Organic Soils	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.11 - CH4 Emissions from Rewetting of Mangroves and Tidal Marshes	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.12 - N2O Emissions from Aquaculture	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.13 - CH4 Emissions from Rewetted and Created Wetlands on Inland Wetland Mineral Soils	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.14 - Other (please specify)	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.14 - Other (please specify)	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.C.14 - Other (please specify)	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.D.1 - Harvested Wood Products	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.D.2 - Other (please specify)	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.D.2 - Other (please specify)	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
3.D.2 - Other (please specify)	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
4 - Waste									
4.A - Solid Waste Disposal	CH4	182.014	381.912	0.000	0.000	0.000	0.000	209.826	0.000000000
4.B - Biological Treatment of Solid Waste	CH4	1.270	1.032	0.000	0.000	0.000	0.000	81.219	0.000000000
4.B - Biological Treatment of Solid Waste	N2O	0.902	0.732	0.000	0.000	0.000	0.000	81.219	0.000000000
4.C - Incineration and Open Burning of Waste	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
4.C - Incineration and Open Burning of Waste	CH4	14.191	12.151	0.000	0.000	0.000	0.000	85.623	0.000000000
4.C - Incineration and Open Burning of Waste	N2O	1.240	1.062	0.000	0.000	0.000	0.000	85.623	0.000000000
4.D - Wastewater Treatment and Discharge	CH4	229.815	486.760	0.000	0.000	0.000	0.000	211.805	0.000000000
4.D - Wastewater Treatment and Discharge	N2O	56.609	76.156	0.000	0.000	0.000	0.000	134.532	0.000000000
4.E - Other (please specify)	CO2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
4.E - Other (please specify)	CH4	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
4.E - Other (please specify)	N2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2 equivalent)	Year T emissions or removals (Gg CO_2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year T	Inventory trend in national emissions for year t increase with respect to base year (% of base year)	Uncertainty introduced into the trend in total national emissions (%)
5 - Other									
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NO_x and NH_3	N_2O	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
5.B - Indirect CO_2 emissions from the atmospheric oxidation of CH_4. CO and NMVOC	CO_2	0.000	0.000	0.000	0.000	0.000	0.000	100.000	0.000000000
Total									
		Sum(C): 18 627.929	Sum(D): 9 482.783				Sum(H): 2 004.530		Sum(M): 561.383
							Uncertainty in total inventory: 44.772		Trend uncertainty: 23.694

14. Annex 3: QA/QC Plan for the NGHGI 1990–2023

QC Activity	Proposed procedures	Task completed		Corrective measures undertaken	
		Name[136]/ Initials	Date	Supporting documents (List the document titles)	Date
1) Verification of data collection. entry and processing					
Objective	• *Cross-checking of activity data (AD) descriptions and emission factors against category information. ensuring their proper recording and archiving.* • *Recording all sources of the same AD. identifying differences and describing the reasons for any discrepancies.*	AN. AT. VSh. ZhB. OZ. RB. EB	February – July 2025	Cross-checking reports Stakeholder consultation protocols Minutes of IAWG meetings	February – July 2025
Verification of transcription errors in input data and references	• *Verification of all references to bibliographic data in internal documentation. including data sheets and methodological documentation.* • *Cross-checking of selected input data from each category (measurements or parameters used in calculations) for transcription errors. Documentation of the results of these cross-checks. Particular attention should be paid to systematic differences. Identification of steps to reduce the frequency of errors in the future. Add these steps to the QA/QC improvement plan.* • *Verification of electronic data to minimize transcription errors.* • *Verification of the use of automated calculations (formulas and lookup functions in Excel) to minimize user/input errors:* • *Verification that formulas do not contain fixed parameters such as emission factors. net calorific values. and assumptions.* • *Verification of the use of lookup functions in Excel to automatically access common values used across all calculations.* • *Verification of the use of cell protection to prevent accidental changes to constant data.*	AT. VSh. ZhB. OZ. RB. EB	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025

[136] Initials of experts responsible for QA and QC: Adil Nurbekov — AN; Alexander Temirbekov — AT; Valeriy Shevchenko — VSh; Zholdosh Bekbosun uulu — ZhB; Oksana Zabenko — OZ; Rajap Bayaliev — RB; Edilbek Bogombaev — ED.

QC Activity	Proposed procedures	Task completed		Corrective measures undertaken	
		Name[136]/ Initials	Date	Supporting documents (List the document titles)	Date
	• *Verification of the integration of automated checks. such as input data range checks. mass balance checks. and internal consistency checks within and between spreadsheets.* • *Preparation of clear instructions for updating and describing the operation of spreadsheets.* • *Ensuring verification that spreadsheets take into account updates. how these were implemented. and verified.*				
Verification of emission/removal calculations	• *Conduct a representative sample of emission/removal calculations.* • *When models are used. perform a selective replication of complex model calculations with simplified computations to assess relative accuracy. This can be done using IPCC Tier 1 methods.* • *In all cases. document the work performed and the results obtained. Record all identified improvements..*	AT. VSh. ZhB. OZ. RB. EB	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025
Verification of correct recording of parameters and units of measurement of emissions/removals. as well as the use of appropriate conversion factors	• *Verify the accuracy of unit designations in calculation sheets and in the data and methodology documentation sheet.* • *Verify the consistency of units of measurement throughout the calculations from start to finish.* • *Verify the correctness of conversion factors.* • *Verify that temporal and spatial adjustment factors are used correctly.*	AT. VSh. ZhB. OZ. RB. EB	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025
Verification of database file integrity	• *Verify that the relevant data processing steps are correctly represented in the database.* • *Verify that data linkages are correctly represented in the database.* • *Verify that data fields are properly labeled and comply with correct design specifications.* • *Ensure proper archiving of documentation on the structure and functioning of the database and the model.*	AT. VSh. ZhB. OZ. RB. EB	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025
Verification of data consistency across categories	• *Identify parameters (e.g.. activity data. constants) that are common to several categories and ensure the consistency of the values used for these parameters in emission/removal calculations.*	AT. VSh. ZhB.	February – July 2025	BTR NID IPCC Software database	February – July 2025

QC Activity	Proposed procedures	Task completed		Corrective measures undertaken	
		Name[136]/ Initials	Date	Supporting documents (List the document titles)	Date
	• *Strive to establish a "main set" of constants that are common to all spreadsheets. rather than separate sets of constants in each spreadsheet.*	OZ. RB. EB		Excel-based databases	
Verification of correct transfer of inventory data between processing stages	• *Verify the correct aggregation of emission/removal data from lower to higher reporting levels during the preparation of summaries.* • *Verify the correct transcription of emission/removal data between different intermediate products.*	AT. VSh. ZhB. OZ. RB. EB	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025
Verification of proper protection of confidential data	• *Verify whether confidential data are processed only by the GHG inventory compilation team and are accessible only to this group.* • • *Ensure that such data are presented in accordance with the requirements agreed with the data source (where applicable).*	AT. VSh. ZhB. OZ. RB. EB		BTR NID IPCC Software database Excel-based databases	
2) Data Documentation					
Verification of internal documentation and archiving	• *Verify the availability of detailed internal documentation to support estimates and ensure replicability of calculations.* • *Verify that each element of primary data has a reference to the data source (through a comment cell or another designation system).* • *Ensure that inventory data. supporting data. and inventory records are archived and stored to facilitate detailed review.* • *Ensure that the archive is closed and stored in a secure location after the completion of the inventory work.* • *Verify the integrity of all archiving mechanisms of external organizations involved in the preparation of the inventory.*	AT. VSh. ZhB. OZ. RB. EB	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025
3) Calculation Checks					
Verification of methodological and informational	• *Verify the consistency of input time series data for each category.* • *Verify the consistency of the algorithm/method used for calculations across all time series.* • *Reproduce a representative sample of emission calculations to ensure mathematical accuracy.*	AT. VSh. ZhB.	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025

QC Activity	Proposed procedures	Task completed		Corrective measures undertaken	
		Name[136]/ Initials	Date	Supporting documents (List the document titles)	Date
changes leading to recalculations		OZ. RB. EB			
Verification of time series consistency	• *Verify the consistency of input time series data for each category.* • *Verify the consistency of the algorithm/method used for calculations across all time series.* • *Verify methodological and data changes leading to recalculations.* • *Ensure that the impact of climate change mitigation activities has been properly reflected in the time series calculations. More advanced IPCC methodologies may be required for a more accurate reflection of mitigation impacts.*	AT. VSh. ZhB. OZ. RB. EB	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025
Verification of completeness	• *Confirm that estimates are provided for all categories and for all years relative to the relevant base year within the current inventory period.* • *For subcategories. ensure that the entire Category is covered.* • *Verify whether the categories of "Other" types are clearly defined.* • *Verify whether known data gaps leading to incomplete emission/removal estimates by category are documented. including a qualitative assessment and an assessment relative to total net emissions (e.g.. subcategories classified as "not estimated").*	AT. VSh. ZhB. OZ. RB. EB	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025
Verification of trends	• *For each category. compare the current inventory estimates with previous estimates. if available. If there are significant changes or deviations from expected trends. re-check the estimates and explain any differences. Significant changes in emissions or removals compared to previous years may indicate possible errors in input data or calculations.* • *Verify the implied emission factors (total emissions/removals divided by activity data) across time series. Verify if changes in emissions or removals being captured?* • *Verify whether there are any unusual or unexplained trends observed in activity data or other parameters across the time series.*	AT. VSh. ZhB. OZ. RB. EB	February – July 2025	BTR NID IPCC Software database Excel-based databases	February – July 2025

Source: This list was adapted from the IPCC Good Practice Guidance and the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

15. Annex 4: National Energy Balance of the Kyrgyz Republic for the Last Inventory Year

According to the fuel and energy balance developed by the National Statistical Committee (NSC). in 2023 the total volume of fuel and energy resources in the Republic amounted to 18.1 million tons of fuel equivalent (tfe). which represents an increase of 1.6% compared to the previous year and an increase of 10% compared to 2019. Out of the total volume of fuel and energy resources. domestic consumption amounted to 14.1 million tfe which is 2.2% higher than in the previous year.

Coal production in 2023 amounted to 4.2 million tons. which is 10.6% higher than in the previous year and 1.6 times higher than in 2019. Coal is primarily used in the domestic market. accounting for 43.8% of total consumption. The national demand for petroleum products is largely met through imports.

In 2023. 125.7 thousand tons of diesel fuel were produced. which is 9.0% higher than in the previous year and 1.5 times higher than in 2019. At the same time. imports of diesel fuel decreased by 22.1% compared to 2019. amounting to 417 thousand tons. The production of motor gasoline reached 25.8 thousand tons. which is 6.2% higher than in the previous year but almost 75% lower compared to 2019. Imports of motor gasoline decreased by 14.6% compared to the previous year but increased by 1.8% compared to 2019. In 2023. approximately 175 thousand tons of fuel oil were produced. which is 1.5 times higher than in 2019 and 6.5% higher than in the previous year.

Overall. in 2023. around 80% of total diesel fuel consumption. about 85% of total motor gasoline consumption. and 19.7% of total fuel oil consumption were used directly as fuel. The Republic's demand for jet kerosene was fully covered by imports.

In 2023. crude oil resources amounted to 311.9 thousand tons. of which about 97% came from domestic production. Almost 310 thousand tons of crude oil. or 99.4% of total distribution. were used as feedstock for production.

In 2023. 94% of natural gas resources were covered by imports. Compared to 2019. domestic gas production increased by 3 million cubic meters. or 12.3%. amounting to 27.4 million cubic meters. Of the total gas resources. 294.7 million cubic meters (63.2%) were used directly as fuel. and 143.7 million cubic meters (about 31%) were used for transformation into other types of energy.

In total. enterprises of the energy sector produced 13.8 billion kWh of electricity in 2023. which is 1.3% less than in 2022 and 8.4% less compared to 2019. About 87% of this volume was generated by hydropower plants. Electricity consumption in 2023 amounted to 17.2 billion kWh. A total of 138.4 million kWh were supplied (exported) outside the Republic.

The production of heat energy in 2023 amounted to 2.9 million Gcal. which is 6% less than in the previous year and 2.5% higher compared to 2019. The entire volume of heat energy was supplied to the domestic market.

Data on the national energy balance in energy units (terajoules). based on NSC data. are presented in Table 15.1.

Table 0.1. National Energy Balance for 2023[137]

[137] NSC. 2023. *Fuel and Energy Balance of the Kyrgyz Republic*.

Fuel and Energy Resources	Resources. TJ			
	Opening balance (for the beginning of the year)	Produced (manufactured)	Import	Total resources
Coal – total	183 091.86	652 193.86	259 791.09	1 095 076.81
Metallurgical coke	5.07	0.00	52.10	57.16
Natural gas	0.00	9 264.54	148 350.30	157 614.84
Crude oil	405.25	126 995.87	3 268.74	130 669.85
Fuel oil	29 431.82	70 069.92	1 929.79	101 431.53
Motor gasoline	86 941.68	11 257.79	215 710.44	313 909.92
Diesel fuel	34 890.09	53 404.64	177 160.78	265 455.51
Liquefied petroleum gas	11 830.99	0.00	45 488.13	57 319.12
Jet kerosene	2 126.33	0.00	39 633.29	41 759.62
Light distillates	1 314.28	0.00	11 485.37	12 799.65
Electricity	0.00	1 396 923.00	352 149.90	1 749 072.91
Heat energy	0.00	127 340.88	0.00	127 340.88
Firewood for heating	47.00	926.29	0.00	973.29
Petroleum bitumen	747.00	0.00	19 187.81	19 934.81
Lubricants and oils	1 472.53	0.00	11 161.89	12 634.42
Total fuels	**352 303.90**	**2 448 376.80**	**1 285 369.61**	**4 086 050.31**