NATIONAL GREENHOUSE GAS EMISSIONS AND REMOVALS INVENTORY DOCUMENT OF GEORGIA *(1990-2022)*

Pursuant to the modalities, procedures, and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement

2024

The preparation of Georgia's National Greenhouse Gas Inventory (1990-2022) Document (NID) was coordinated by the Ministry of Environment Protection and Agriculture of Georgia and the LEPL Environmental Information and Education Centre.

The document was prepared with the support of the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF). The views expressed are those of the authors and do not necessarily reflect the views of the donor organisations.

Forward

This document represents Georgia's National Greenhouse Gas (GHG) Inventory Document (NID) developed in accordance with the commitments under the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC). It is accompanied by the associated Common Reporting Tables (CRTs) and forms part of Georgia's National Inventory Report (NIR) submission for the year 2024. The report provides a comprehensive assessment of Georgia's greenhouse gas emissions and removals over the period from 1990 to 2022, along with detailed descriptions of the methodologies and procedures used in calculating these estimates.

The Environmental Information and Education Centre of the Ministry of Environmental Protection and Agriculture of Georgia extends its sincere gratitude to the Global Environment Facility for their generous support in funding the development of the NID and to the UNDP for their dedicated efforts in implementing this crucial project. We would like to express our sincere gratitude to the Capacity-building Initiative for Transparency - Global Support Programme (CBIT-GSP) for their priceless efforts in conducting the peer-review work for the Land Use, Land Use Change and Forestry (LULUCF) sector. The Center also wish to express our deep appreciation to the numerous individuals and organizations whose invaluable contributions, expertise, and commitment have been instrumental in the preparation of this report. Their efforts have been fundamental in ensuring the comprehensive and accurate completion of this document.

The Greenhouse Gas Inventory (GHGI) has been compiled following the 2006 Guidelines of the Intergovernmental Panel on Climate Change (IPCC). It has been updated to incorporate the most recent data, and methodological improvements have subsequently been applied as needed to maintain a consistent time series. Changes in methodology are implemented to integrate new data sources, updated IPCC guidance, or findings from recent research. The NIR has been prepared according to the modalities, procedures, and guidelines for the transparency framework for action and support, as referred to in Article 13 of the Paris Agreement (MPGs) (see Decision 18/CMA.1). The 2024 national GHG inventory represents the first compliance with these new guidelines.

Since the structure of this report follows the UNFCCC Inventory Reporting Guidelines, it includes information highlighting the latest trends in emissions and removals and offers background details on GHG inventories, national inventory arrangements, the inventory preparation process, methodologies, data sources, key category analysis, quality assurance/quality control (QA/QC) plans, and uncertainty assessment results. The document presents detailed estimation methods for the sources and sinks based on the 2006 IPCC Guidelines.

The report discusses improvements and recalculations made since the previous submission, such as data revisions and the inclusion of new categories. Annexes provide additional information for a deeper understanding of the inventory. Continuous efforts, both domestically and internationally, aim to improve the estimates and minimize uncertainties.

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EXECUTIVE SUMMARY

ES.1. Background information on GHG inventories and climate change

Georgia has developed seven National Greenhouse Gas (GHG) Inventories as part of four National Communications (NCs), two Biennial Update Reports (BURs) and One Biennial Transparency Report (BTR) submitted to the UNFCCC. The most recent inventory, included in the first BTR, covers the years 2018–2022 and incorporates recalculations for the period from 1990 to 2017. Earlier inventories, prepared within the Initial, Second, and Third NCs, followed the 1996 IPCC Guidelines, the IPCC Good Practice Guidance (GPG) (2000), and the GPG for Land Use, Land-Use Change and Forestry (LULUCF) (2003). To improve transparency, consistency, comparability, completeness, and accuracy (TACCC principles), Georgia adopted the 2006 IPCC Guidelines in the Second BUR and Fourth NC, ensuring more robust and internationally aligned reporting.

In its most recent efforts to improve the inventory, Georgia has further updated its national data collection and management system to align with the 2006 IPCC Guidelines. These revisions are designed to address existing data gaps, such as detailed livestock manure management systems and solid waste composition, while enhancing the accuracy and reliability of reported GHG estimates. By continuously refining its inventory process, Georgia aims to provide more precise emissions data and strengthen its commitment to international climate reporting.

ES.2. Summary of trends related to national emissions and removals

Georgia's greenhouse gas (GHG) emissions and removals have undergone significant changes from 1990 to 2022, reflecting economic transitions, policy developments, and advancements in emissions management. The total GHG emissions (excluding land use, land-use change, and forestry—LULUCF) peaked in 1990 at 46,575 Gg CO_2 eq. but experienced a sharp decline during the 1990s due to economic collapse following the dissolution of the Soviet Union. Emissions reached their lowest level in 2001 at 9,514 Gg CO_2 eq., representing an 80% reduction from 1990 levels. From 2003 onward, emissions gradually increased, stabilizing around 17,000–18,000 Gg CO_2 eq. in the late 2010s, driven by economic recovery and growing energy demand. The most recent data from 2022 indicates a continued rise in emissions, reaching 20,096 Gg CO_2 eq., the highest level since the early 1990s, suggesting post-pandemic economic recovery and industrial expansion. LULUCF has played a critical role in offsetting emissions, with removals fluctuating but showing an increasing trend in recent years, reaching a peak of 14,295 Gg CO_2 eq. in 2022, reflecting improved forestry and land management practices.

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

The Energy sector has consistently been the largest contributor to emissions, accounting for 84.73% of total GHG emissions in 1990. It experienced a sharp decline in the 1990s but steadily rebounded, reaching 13,218 Gg CO_2 eq. in 2022. The Industrial Processes and Product Use (IPPU) sector, while contributing less to total emissions, has shown gradual growth, increasing from 1,642 Gg CO_2 eq. in 1990 to 2,571 Gg CO_2 eq. in 2022. The Agriculture sector has remained relatively stable, with emissions fluctuating between 2,300 and 2,800 Gg CO_2 eq. in recent years. The Waste sector has shown a steady increase in emissions, reflecting urbanization and waste generation trends. Among specific GHGs, CO_2 remains the dominant contributor, accounting for 63.9% of total emissions in 2022, with methane (CH_4) contributing 29.4%, nitrous oxide (N_2O) at 4.4%, and hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF_6) showing gradual increases due to industrial activities. These trends highlight the need for continued policy interventions, enhanced emission reduction strategies, and improved land-use practices to mitigate Georgia's growing carbon footprint.

ES.4. Other information (e.g. indirect GHGs, precursor gases)

The indirect nitrous oxide (N_2O) emissions are estimated from agriculture, specifically from manure management and managed soils.

Indirect N_2O emissions result primarily from nitrogen volatilization in the form of ammonia (NH_3) and nitrogen oxides (NO_x). These nitrogen losses begin in animal housing and areas where manure is spread. The detailed information can be seen in Chapter 5.

According to paragraph 50 of Georgia's Nationally Determined Contribution, information on precursor gas emissions is presented in a table in accordance with the Georgian Air Pollutant Emissions Inventory (https://www.ceip.at/status-of-reporting-and-review-results/2024-submission).

ES.5. Key category analysis

The Key Category Analysis (KCA) of greenhouse gas emissions and removals assesses the significance of different emission sources by their absolute levels and trends over time, applying methodologies recommended in the 2006 IPCC Guidelines.

The level assessment identifies key categories that contribute significantly to total emissions, while the trend assessment highlights those with the most substantial changes over time. The analysis was conducted under two scenarios: one including land use, land use change, and forestry (LULUCF) and the other excluding this sector.

In 1990, the key categories consisted mainly of fuel combustion in energy industries, manufacturing, transport, and residential sectors, along with fugitive emissions from natural gas, emissions from enteric fermentation in cattle, cropland, and forest land, and waste management activities. By 2022, the composition of key categories had evolved, with notable reductions in emissions from fuel combustion and fugitive sources, while waste management, cement production, and refrigerant emissions gained prominence.

The methodology involved the application of Approach 1, which uses cumulative threshold criteria (typically 95% of total emissions) to determine key categories. Level assessments were performed using equation 4.1 from the 2006 IPCC Guidelines, while trend assessments applied equation 4.2. Disaggregation adjustments were made for categories with significant variation, such as fuel types in transport and landfill classifications in waste disposal.

Overall, the findings highlight shifts in emissions trends over time, with significant reductions in energy-related emissions, increased emissions from industrial processes and waste management, and a complex role of the LULUCF sector in emission removals. A summary of the key categories is presented in the table below and a detailed analysis is described in Annex I.

Table 1-1. Key categories by greenhouse gas emission-removal Level and trend, including the LULUCF sector

IPCC Category Code	IPCC Category	Greenhouse Gas	Level Assessment (1990) Lx,t	Level Assessment (2022) Lx,t	Trend Assessment Tx,t
1A1	Fuel Combustion - Energy Industries - Liquid fuels	CO_2	L		T
1A2	Fuel Combustion - Manufacturing Industries and Construction - Gaseous fuels	CO_2	L	L	T
1A2	Fuel Combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2		L	T
1B2b	Fugitive Emissions from Natural Gas	CH_4	L	L	T
4A	Forest Land Remaining Forest Land	CO_2	L	L	T
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	CO_2	L	L	T
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	CO_2	L	L	T
1A3e	Fuel Combustion - Transport – Other Transport - Gaseous fuels	CO_2		L	T
1A4b	Fuel Combustion - Residential - Gaseous fuels	CO_2	L	L	
3A1	Enteric Fermentation - Cattle	CH_4	L	L	
4B	Cropland Remaining Cropland	CO_2	L		T
1A1	Fuel Combustion - Manufacture of Solid Fuel and Other Energy Industries - Solid Fuels	CO_2	L		T
1B1	Fugitive Emissions from Solid Fuels	CH_4	L		
1B2c	Fugitive Emissions from Natural Gas	CH_4		L	
1A4b	Fuel Combustion - Residential - Liquid fuels	CO_2	L		
1A4a	Fuel Combustion - Commercial/Institutional-Liquid fuels	CO_2	L		
3D1	Direct N_2O Emissions from Managed Soils	N_2O	L	L	
2B1	Chemical Industry - Ammonia Production	CO_2	L	L	T

IPCC Category Code	IPCC Category	Greenhouse Gas	Level Assessment (1990) Lx,t	Level Assessment (2022) Lx,t	Trend Assessment Tx,t
2B2	Chemical Industry - Nitric Acid Production	N2O		L	T
2A1	Mineral Industry - Cement Production	CO2	L	L	T
4C	Grasslands Remaining Grasslands	CO2	L	L	T
1A4c	Fuel Combustion - Agriculture/Forestry/Fishing/Fish Farms - Liquid fuels	CO2	L		T
2C2	Metal Production -Ferroalloys Production	CO2		L	T
5A3	Solid Waste Disposal -Uncategorised	CH4	L	L	T
5A1	Solid Waste Disposal - Managed	CH4	L	L	T
3A4	Enteric Fermentation - Other Cattle	CH4	L		
5D1	Domestic Wastewater Treatment	CH4	L	L	
1A4b	Fuel Combustion - Residential - Solid Fuels	CO2	L		
3B1	Manure Management - Cattle	CH4	L		
1A4a	Fuel Combustion - Commercial/Institutional-Gaseous fuels	CO2	L	L	T
2F1	Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	HFCs		L	T
1A3b	Fuel Combustion - Transport - Road Transport - Gaseous fuels	CO2		L	
1A2	Fuel Combustion - Manufacturing Industries and Construction - Liquid fuels	CO2		L	T

Table 1-2. Key categories by greenhouse gas emission-removal Level and trend, excluding the LULUCF sector

IPCC Category Code	IPCC Category	Greenhouse Gas	Level Assessment (1990) Lx,t	Level Assessment (2022) Lx,t	Trend Assessment Tx,t
1A1	Fuel Combustion - Energy Industries - Liquid fuels	CO2	L		T
1A2	Fuel Combustion - Manufacturing Industries and Construction - Gaseous fuels	CO2	L	L	T
1A2	Fuel Combustion - Manufacturing Industries and Construction - Solid Fuels	CO2		L	T

IPCC Category Code	IPCC Category	Greenhouse Gas	Level Assessment (1990) Lx,t	Level Assessment (2022) Lx,t	Trend Assessment Tx,t
1B2b	Fugitive Emissions from Natural Gas	CH_4	L	L	T
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	CO_2	L	L	T
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	CO_2	L	L	T
1A3b	Fuel Combustion - Transport - Road Transport - Gaseous fuels	CO_2		L	
1A3e	Fuel Combustion - Transport - Other Transport - Gaseous fuels	CO_2		L	T
1A4b	Fuel Combustion - Residential - Gaseous fuels	CO_2	L	L	T
3A1	Enteric Fermentation - Cattle	CH_4	L	L	T
1A1	Fuel Combustion - Manufacture of Solid Fuel and Other Energy Industries - Solid Fuels	CO_2	L		T
1B1	Fugitive Emissions from Solid Fuels	CH_4	L		T
1A4b	Fuel Combustion - Residential - Liquid fuels	CO_2	L		T
1A4a	Fuel Combustion - Commercial/Institutional- Liquid fuels	CO_2	L		T
3D1	Direct N_2O Emissions from Managed Soils	N_2O	L	L	
2B1	Chemical Industry - Ammonia Production	CO_2	L	L	T
2B2	Chemical Industry - Nitric Acid Production	N_2O		L	T
2A1	Mineral Industry - Cement Production	CO_2	L	L	T
1A4c	Fuel Combustion - Agriculture/Forestry/Fishing/Fish Farms - Liquid fuels	CO_2	L		T
5A3	Solid Waste Disposal -Uncategorised	CH_4	L	L	T
5A1	Solid Waste Disposal - Managed	CH_4	L	L	T
5A2	Solid Waste Disposal - Unmanaged	CH_4		L	
3A4	Enteric Fermentation - Other Cattle	CH_4	L	L	
5D1	Domestic Wastewater Treatment	CH_4	L	L	T

IPCC Category Code	IPCC Category	Greenhouse Gas	Level Assessment (1990) Lx,t	Level Assessment (2022) Lx,t	Trend Assessment Tx,t
1A4b	Fuel Combustion - Residential - Solid Fuels	CO2	L		T
3B1	Manure Management - Cattle	CH4	L		
1A4a	Fuel Combustion - Commercial/Institutional-Gaseous fuels	CO2	L	L	T
2C1	Metal Production - Iron and Steel Production	CO2	L		
2C2	Metal Production -Ferroalloys Production	CO2		L	T
1A2	Fuel Combustion - Manufacturing Industries and Construction - Liquid fuels	CO2	L	L	T
2F1	Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	HFCs		L	T
1B2c	Fugitive Emissions from Natural Gas	CH4		L	

ES.6. Improvements introduced (related to a non-mandatory provision as per para. 7 of the MPGs, with flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 7(c) of the MPGs)

Higher-tier methods (Tier 2 and Tier 3) and country-specific data are applied in several sectors of Georgia's national GHG inventory compared to the previous inventory report.

In the energy sector, Tier 2 methods are used in the energy industry for CO_2, CH_4, and N_2O emissions. In fugitive emissions from oil and natural gas, Tier 2 is applied specifically for CH_4 emissions from natural gas.

For industrial processes and product use, Tier 2 and Tier 3 methods are utilized in the mineral industry for CO_2 emissions, while Tier 3 methods are applied in the chemical industry. In metal production, Tier 2 methods are used for CO_2 emissions. Additionally, certain industrial processes apply Tier 2 methods for N_2O emissions. Country-specific emission factors are applied primarily in the mineral and chemical industries for CO_2 emissions.

Within the agriculture sector, Tier 2 method is used for enteric fermentation. Tier 2 method is applied for CH_4 and N_2O emissions from manure management.

In the land use, land use change, and forestry sector, Tier 2 methods are applied for CO_2 emissions from forest lands.

For the waste sector, Tier 2 methods are used for CH_4 emissions from solid waste disposal.

Country-specific data is applied in fugitive emissions from oil and natural gas, specifically for CH_4 emissions. In the agriculture sector, country-specific emission factors are used for CH_4 emissions from enteric fermentation and manure management, as well as for

N_2O emissions from manure management. The waste sector also incorporates country-specific data for CH_4 emissions from solid waste disposal.

In the LULUCF sector, plant-specific emission factors are applied alongside IPCC default factors in forest lands, croplands, and grasslands.

Chapter 1. National circumstances, institutional arrangements, and cross-cutting information

1.1. Background information on GHG inventories and climate change

Georgia has developed six National Greenhouse Gas (GHG) Inventories as part of four National Communications (NCs) and two Biennial Update Reports (BURs) submitted to the UNFCCC. The most recent GHG inventory (as part of the Fourth National Communication) covered the years 2016–2017, with recalculations for the period 1990–2015.

Early inventories (within the Initial, Second, and Third NCs) were prepared using the 1996 IPCC Guidelines, the IPCC Good Practice Guidance (GPG) (2000), and the IPCC GPG for Land Use, Land-Use Change and Forestry (LULUCF) (2003). Subsequently, to enhance transparency, consistency, comparability, completeness, and accuracy (the TACCC principles), Georgia transitioned to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories in the Second BUR and Fourth NC.

Under the most recent cycle of inventory improvement, the existing national data-collection and management system was further updated in accordance with the 2006 IPCC Guidelines, to the extent possible. These revisions aim to fill identified data gaps (e.g., detailed livestock manure management systems, solid waste composition) and strengthen the quality of reported GHG estimates.

1.2. A description of national circumstances and institutional arrangements

The national inventory system in Georgia is coordinated by the Ministry of Environmental Protection and Agriculture (MEPA), with the LEPL Environmental Information and Education Centre (EIEC) serving as the primary executing entity responsible for inventory compilation. This process is a collaborative effort involving various stakeholders, including government ministries, research institutions, statistical agencies, the private sector, and independent experts, ensuring a comprehensive and robust approach to greenhouse gas inventory management.

MEPA and EIEC lead the entire process, managing the inventory preparation schedule while defining clear roles and responsibilities for data collection and analysis. They are also responsible for implementing and maintaining the overall quality assurance and quality control (QA/QC) plan, ensuring that the inventory adheres to the highest standards of accuracy and reliability.

The inventory compilation relies on experts specialising in key sectors such as energy, industrial processes and product use (IPPU), agriculture, forestry, other land use (AFOLU), and waste. These sectoral experts conduct extensive data collection, develop and refine emission factors, and ensure that methodologies remain consistent with the guidelines established by the Intergovernmental Panel on Climate Change (IPCC). Their work is critical in maintaining the scientific rigor and credibility of the national inventory.

Independent QA/QC experts play a vital role in the verification process by conducting third-party reviews of calculations and documentation. Their involvement helps identify potential areas for methodological improvement while ensuring the transparency of assumptions and uncertainty assessments. By offering an external perspective, they enhance the overall credibility of the inventory and reinforce confidence in its findings.

1.2.1. *National entity or national focal point*

The **Ministry of Environmental Protection and Agriculture (MEPA) of Georgia** is the primary governmental body responsible for environmental governance, including climate change policy, greenhouse gas (GHG) inventory management, and international climate reporting. MEPA plays a crucial role in ensuring Georgia meets its obligations under the **United Nations Framework Convention on Climate Change (UNFCCC)** and the **Paris Agreement**, facilitating the development and submission of National Communications (NCs) and Biennial Transparency Reports (BTRs).

In the context of climate reporting, MEPA oversees the **National Greenhouse Gas Inventory System**, ensuring the collection, verification, and analysis of emissions data. It coordinates with various stakeholders, including research institutions, National Statistics Office of Georgia, the private sector, and independent experts through the LEPL EIEC, to enhance the accuracy and transparency of emissions estimates. Additionally, the LEPL EIEC manages the **Quality Assurance and Quality Control (QA/QC) system**, ensuring compliance with **IPCC Guidelines** and improving the reliability of reported data.

1.2.2. *Inventory preparation process*

The **GHG Inventory** process in Georgia follows a structured framework to ensure accurate data collection, quality control, and reporting in compliance with international standards.

The process begins with the **development of a project proposal for the Global Environment Facility (GEF)** to secure funding for inventory activities. Once approved, the project is implemented through a **GEF-implementing agency**, such as the **United Nations Development Programme (UNDP)**, with execution carried out by the **LEPL Environmental Information and Education Centre (EIEC)**.

Following project initiation, the **GHG inventory team is completed**, ensuring that sectoral experts and data analysts are in place. The team then proceeds with **data compilation and GHG estimation**, where emissions data are collected, verified, and processed according to **IPCC Guidelines**.

The **quality control process** ensures the accuracy and consistency of compiled data. Emission estimates are then aggregated into standardized reporting formats, and national trend tables are prepared. The **report drafting phase** involves compiling and editing submitted data to form the **National Inventory Document (NID)**, which undergoes an internal review by the LEPL **EIEC** before being submitted for **final review by the Ministry of Environmental Protection and Agriculture (MEPA)**.

Once approved, the final **GHG inventory report is submitted to the UNFCCC Secretariat**, ensuring Georgia meets its international climate reporting commitments. The process concludes with **final archiving**, preserving all data, methodologies, and documentation for future reference and transparency.

1.2.3. *Archiving of information*

The **National Inventory Document (NID)** and **Common Reporting Tables (CRTs)**, along with all **QA/QC documentation**, are archived by the **LEPL EIEC** to ensure transparency, accuracy, and continuity in Georgia's GHG inventory process. This archiving process plays a critical role in maintaining institutional knowledge, supporting future inventory cycles, and facilitating external reviews and verifications.

The archived materials include **methodological documentation, sectoral data, calculation spreadsheets, verification reports, and internal review records**, ensuring a comprehensive record of the inventory's development. By preserving these documents in a structured and accessible format, EIEC enables **efficient retrieval for future reporting cycles, national policy development, and compliance with UNFCCC requirements**. Additionally, the archived information supports ongoing improvements in inventory methodologies, enhances institutional memory, and strengthens Georgia's ability to track and manage its emissions trends effectively.

1.2.4. *Processes for official consideration and approval of inventory*

The National Greenhouse Gas Inventory document of Georgia is produced by the LEPL Environmental Information and Education Centre of the Ministry of Environmental Protection and Agriculture, supported by the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP). The final outputs include:

National Inventory Document (NID): A comprehensive report detailing methods, assumptions, data sources, and QA/QC procedures.

Common Reporting Tables (CRTs): Standardized tables summarizing emissions and removals across all relevant sectors, consistent with UNFCCC reporting requirements.

These outputs are disseminated to policy makers and stakeholders, ensuring transparency and broad availability of national GHG information. In addition, this documentation helps guide future inventory improvements, informing climate change policies, mitigation strategies, and research agendas.

1.3. Brief general description of methodologies

The GHG Inventory for 2018–2022, along with recalculations for 1990–2017, was prepared using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and, where applicable, the 2019 Refinement to the 2006 Guidelines. The inventory also integrates relevant practices from the IPCC Good Practice Guidance for LULUCF (2003). Where possible, Tier 2 and 3 methods were applied to key sources to enhance accuracy.

Georgia's inventory compilation uses the most recent version of the GHG Inventory Software for non-Annex I countries, as well as the common reporting tables in line with Decision 5/CMA.3. Global Warming Potential (GWP) values are taken from the IPCC Fifth Assessment Report (AR5). These methodological choices ensure that national submissions meet the latest UNFCCC reporting requirements.

1.4. Brief description of key categories

The key categories in Georgia's greenhouse gas (GHG) emissions and removals are estimated in accordance with the 2006 IPCC Guidelines. It evaluates emissions trends from 1990 to 2022, considering two cases: one including land use, land use change, and forestry (LULUCF) and one without. The key category analysis prioritises sources and removals that significantly impact total emissions, ensuring better resource allocation, methodological improvements, and quality assurance.

The analysis identifies key categories using Approach 1, which consists of level and trend assessments. The level assessment determines which categories contribute the most to total emissions, while the trend assessment identifies categories with the highest impact on emission trends. A cumulative threshold, typically covering 95% of total emissions, is applied to classify key categories.

In 1990, the key categories included 25 sources, with 13 from the energy sector, four from agriculture, two from industry, three from LULUCF, and three from waste. The exclusion of LULUCF results in 24 key categories, with the energy sector having the highest contribution. The most significant sources of emissions included fuel combustion in energy industries, fugitive emissions from natural gas, forest land remaining forest land, and road transport.

By 2022, the number of key categories had decreased to 23, with 11 from the energy sector, two from agriculture, five from industry, two from LULUCF, and three from waste. Major emission sources remained similar but with notable shifts, including a decline in emissions from fuel combustion in energy industries and an increase in waste-related emissions. The exclusion of LULUCF in 2022 resulted in 23 key categories, with energy, IPPU and waste sectors remaining dominant contributors.

The trend analysis indicates that significant reductions occurred in energy-related emissions due to shifts in fuel use and efficiency improvements. However, certain categories, such as solid waste disposal and chemical industry emissions, showed increasing trends. The methodology provides insight into how emission sources evolved over time, enabling targeted mitigation strategies (see Annex I).

1.5. Brief general description of QA/QC plan and implementation

The Quality Assurance (QA) and Quality Control (QC) procedures in Georgia's National Greenhouse Gas Inventory Report are structured into a systematic framework to ensure accuracy, transparency, and continuous improvement. The system follows the 2006 IPCC Guidelines and serves to enhance the credibility of greenhouse gas emissions and removals data and was developed under the CBIT project.

The **Quality Control (QC) Plan** includes general and sectoral quality control measures. General quality control involves routine checks to ensure consistency and accuracy, addressing errors through verification of data and reports. It is mandatory for all key categories and follows a structured reporting and correction process. Sectoral quality control is applied specifically to inventory sectors, ensuring completeness and correctness. It applies to all major sources and non-core categories where errors exceed 20%, methodology has changed, or trends show significant variations.

The **Quality Assurance (QA) Plan** involves independent reviews conducted by experts not involved in inventory preparation. This ensures unbiased verification of data quality. It applies to 50% of key categories and categories with high uncertainty margins or major methodological changes. The QA process includes reviewing inventory documents, proposing corrections, and verifying improvements.

The **Verification Process** is going to introduce in the next inventory cycles and will independently assess the inventory's reliability through comparisons with external data sources, international reports, and alternative calculation methods. It will help identify discrepancies and ensure confidence in emission estimates.

Lastly, the **Archiving System,** which is under development, aims to ensure long-term documentation of data, methodologies, and decisions, promoting transparency and continuity across inventory cycles. The archiving coordinator maintains records and prevents unauthorized edits.

Together, these QA/QC measures ensure that Georgia's greenhouse gas inventory meets international standards, continuously improves over time, and provides reliable data for policy and reporting purposes.

1.6. General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals

The uncertainty assessment of the Georgia's greenhouse gas (GHG) inventory covers all categories using the error propagation method. The total inventory uncertainty is estimated at 8.85 percent, reflecting the overall estimation uncertainty across all emission sources. Additionally, the trend uncertainty is determined to be 4.57 percent, which indicates the reliability of the estimation of emission trends over time.

The methodology follows the 2006 IPCC Guidelines, with calculations performed using Approach 1 (error propagation). This method estimates uncertainty for the base year, the current reporting year, and the overall trend. The Annex II presents a detailed breakdown of emission sources, including fuel combustion, industrial processes, and waste management. Each category includes specific estimates of activity data uncertainty and emission factor uncertainties, providing a comprehensive analysis of Georgia's emissions data.

1.7. General assessment of completeness

1.7.1. *Information on completeness*

The following information regarding the completeness of individual categories serves as a textual complement to the data presented in CRT 9(a).

Georgia's national greenhouse gas (GHG) inventory makes a clear distinction between the following categories:

Source-specific emissions and removals that do not occur (*NO – Not Occurring*), which refers to emissions or removals from sources that are not present in the country or have no occurrence within the reporting period.

Source-specific emissions and removals that are not estimated or reported, either because they are deemed irrelevant to the national context or due to the lack of available, reliable data, or because obtaining such data would be disproportionately costly (*NE – Not Estimated*).

To further strengthen the national GHG inventory, Georgia plans to develop a **comprehensive GHG Improvement Plan**. This plan will aim to enhance resource allocation for targeted improvements in the completeness of the inventory, with particular emphasis on addressing gaps related to **GHG emissions and removals from Land Use Change and Settlements**. These two categories are recognised as key in terms of their potential impact on the overall GHG balance, and dedicated efforts will be made to ensure their accurate representation.

Moreover, Georgia is committed to improving the quality and consistency of **historical data**, with ongoing initiatives designed to close the gaps identified in the sectoral chapters. These efforts will involve further refinement of the data collection process, collaboration with relevant stakeholders, and a continued focus on integrating more precise methodologies, ensuring that the inventory reflects the most current and comprehensive information available.

In addition to these measures, Georgia will explore opportunities for strengthening the overall methodological framework and improving transparency in reporting. By investing in improved data collection, analysis, and reporting practices, Georgia seeks to enhance its contribution to global efforts in tackling climate change while aligning with best practices for national GHG inventory development.

1.7.2. *Description of insignificant categories, if applicable*

According to 24/CP.19 Annex I (cf. FCCC/CP/2013/10/Add.3), emissions classified as "not estimated" (NE) are of minor significance in relation to the overall national emissions and their trends. This is because the estimated quantity of these emissions is typically less than 0.05 percent of the total national greenhouse gas emissions and does not exceed 500 kt CO2 equivalents. In case of national GHG Inventory the notation key also applies categories for which the data are limited, not reliable, obtaining such data would require additional resources.

Table 1-1. Level of insignificance regarding GHG emissions level at the latest inventory year

	GHG emission, 2022 (Gg CO2 eq.)
Total GHG emissions without LULUCF	20,096
thereof 0.1 %	20.10
thereof 0.05 %	10.05
CRT code and name **2G3b Propellants in pressurized and aerosol products (7.8.3.2.)**	**Expected or estimated emissions** <1

1.7.3. *Total aggregate emissions considered insignificant, if applicable*

As the categories marked with the notation key 'NE' are expected to exceed the insignificance threshold, the next GHG inventory report will provide a more detailed breakdown of these categories. This will include emissions deemed insignificant and not estimated due to the unavailability of reliable data or the disproportionately high cost of data collection.

1.8. Metrics

Georgia uses the global warming potentials (GWP), with 100-year time horizons, given in the Fifth IPCC Assessment Report, Table 8.A.1.

Table 1-2. Metric values of the GHGs

Acronym, Common Name or Chemical Name	Chemical Formula	GWP 100-year
Carbon dioxide	CO2	1
Methane	CH4	28
Nitrous Oxide	N2O	265
HFC-32	CH2F2	677
HFC-125	CHF2CF3	3,170
HFC-134a	CH2FCF3	1,300
HFC-143a	CH3CF3	4,800
HFC-227ea	CF3CHFCF3	3,350
Sulphur hexafluoride	SF6	23,500
Nitrogen trifluoride	NF3	16,100

1.9. Summary of any flexibility applied

There is no flexibility applied in Georgia's national greenhouse gas inventory.

Chapter 2. Trends in greenhouse gas emissions and removals

This chapter provides an overview of Georgia's greenhouse gas (GHG) emissions and removal trends from 1990 to 2022, analysing total emissions, sectoral trends, and gas-specific contributions.

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

Georgia's GHG emissions trends from 1990 to 2022 show significant variations over time, with distinct periods of decline and growth.

From 1990 to 2002, total emissions experienced a sharp decline. In 1990, emissions peaked at 46,575 Gg CO_2 eq. (without LULUCF), but they dropped dramatically in the early 1990s due to economic collapse following the dissolution of the Soviet Union. The lowest recorded emissions were in 2001, at 9,514 Gg CO_2 eq., marking an 80% reduction from 1990 levels (Table 2-1).

Table 2-1. Total GHG emission trends of Georgia from 1990 to 2022 with and without LULUCF

Year	Total GHG emissions without LULUCF (Gg CO2 eq.)	Total GHG emissions with LULUCF (Gg CO2 eq.)	Year	Total GHG emissions without LULUCF (Gg CO2 eq.)	Total GHG emissions with LULUCF (Gg CO2 eq.)
1990	46,575	38,396	**2007**	13,733	7,528
1991	38,039	30,458	**2008**	12,470	6,103
1992	31,714	24,043	**2009**	12,064	5,621
1993	26,219	18,761	**2010**	13,644	7,824
1994	16,612	9,459	**2011**	15,965	9,777
1995	13,545	6,311	**2012**	16,769	10,332
1996	14,154	7,056	**2013**	16,260	10,453
1997	12,975	5,697	**2014**	16,981	11,253
1998	12,044	5,235	**2015**	18,484	12,762
1999	10,778	3,913	**2016**	18,661	12,801
2000	11,413	4,677	**2017**	17,784	11,974
2001	9,514	2,581	**2018**	17,655	11,771
2002	11,091	4,381	**2019**	18,001	12,218
2003	12,154	5,567	**2020**	18,297	12,394
2004	12,513	6,034	**2021**	18,797	12,786
2005	11,461	5,451	**2022**	20,096	14,295

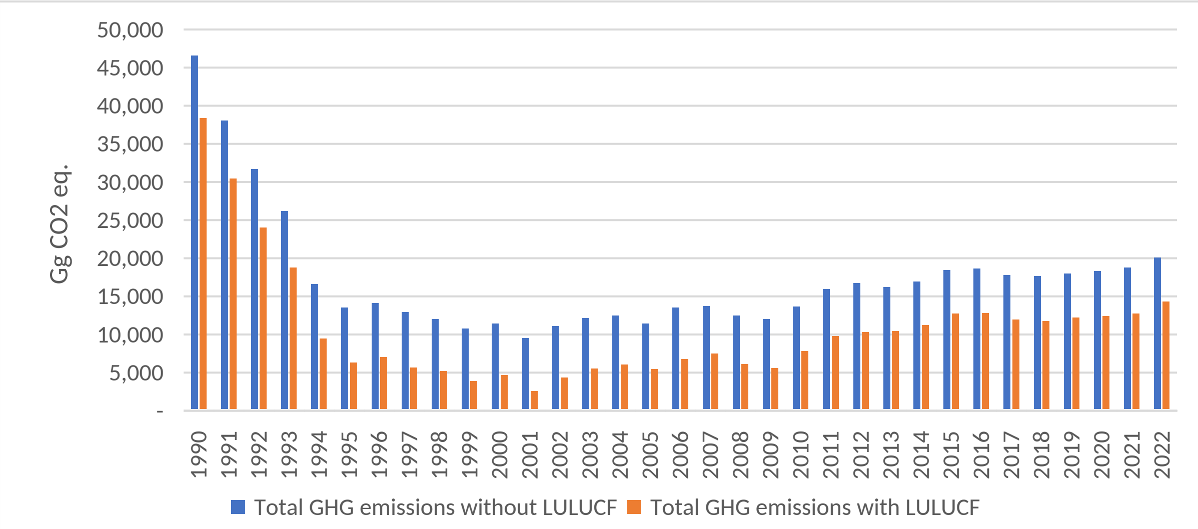
2006	13,556	6,767			

Between 2003 and 2019, emissions showed a gradual increase. After reaching the lowest point in the early 2000s, emissions began to recover, stabilizing around 17,000–18,000 Gg CO_2 eq. in the late 2010s. This period reflects economic growth and increasing energy consumption.

From 2020 to 2022, emissions continued rising, with 2022 reaching 20,096 Gg CO_2 eq., the highest level since the early 1990s. This suggests a post-pandemic recovery and possible expansion in industrial and energy activities.

LULUCF played a crucial role in emissions removals throughout the time series. In 1990, the removals from LULUCF were 8,179 Gg CO_2 eq., helping offset emissions. During the early 1990s, LULUCF removals remained relatively high, ranging between 6,000 and 9,000 Gg CO_2 eq. However, by the early 2000s, the removals dropped to their lowest point, reaching just 2,581 Gg CO_2 eq. in 2001. From 2002 onward, LULUCF removals began increasing again, reaching over 10,000 Gg CO_2 eq. by 2012. The highest recorded removals were in 2022, at 14,295 Gg CO_2 eq., reflecting improved forestry and land management practices (Figure 2-1).

Figure 2-1. Total GHG emission trends of Georgia from 1990 to 2022 with and without LULUCF



Overall, Georgia's emissions trends reflect economic shifts, policy interventions, and changes in land use. The LULUCF sector has consistently contributed to offsetting emissions, with a notable increase in removals in recent years.

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

Energy Sector

The Energy sector has historically been the largest contributor to emissions. In 1990, emissions were 39,465 Gg CO_2 eq., accounting for the majority of total emissions. A sharp decline occurred in the 1990s due to economic downturns, reaching a low of 4,701 Gg CO_2 eq. in 2001, an 88% reduction. From 2002 onward, emissions steadily increased, reflecting economic recovery and energy demand growth. By 2022, energy emissions had risen to 13,218

Gg CO_2 eq., the highest level since 1996, suggesting ongoing reliance on fossil fuels and expanding industrial activities.

Industrial Processes and Product Use (IPPU) Sector

Comparing to the Energy sector the IPPU sector followed a different trend, contributing significantly less to total emissions. In 1990, emissions stood at 1,642 Gg CO_2 eq. and decreased sharply during the 1990s due to industrial decline, reaching a low of 387 Gg CO_2 eq. in 1994. Emissions gradually increased after 2000, reaching 2,571 Gg CO_2 eq. in 2022, reflecting moderate industrial growth.

Agriculture Sector

Agriculture sector emissions showed a more stable pattern compared to other sectors. In 1990, emissions were 4,284 Gg CO_2 eq., with a decline throughout the 1990s. By 2007, emissions had dropped to 2,331 Gg CO_2 eq., marking a decrease in agricultural activities. From 2010 onwards, emissions fluctuated but remained relatively stable, peaking at 2,822 Gg CO_2 eq. in 2015 before decreasing to 2,310 Gg CO_2 eq. in 2022. This sector's relatively minor fluctuations indicate stable agricultural production levels with slight variations.

Waste Sector

The Waste sector exhibited a gradual increase in emissions throughout the time series. Starting at 1,185 Gg CO_2 eq. in 1990, waste-related emissions consistently rose due to urbanization and waste generation, reaching 1,996 Gg CO_2 eq. in 2022. This steady increase suggests limited advancements in waste management and mitigation measures.

LULUCF

LULUCF emissions removals played a critical role in offsetting emissions. In 1990, removals were -8,179 Gg CO_2 eq., significantly reducing net emissions. Over time, removals slightly decreased, reaching a low of -5,807 Gg CO_2 eq. in 2013. However, the trend remained relatively stable, with removals at -5,801 Gg CO_2 eq. in 2022. Compared to the increasing emissions in other sectors, LULUCF removals have not grown proportionally, highlighting the need for enhanced afforestation, reforestation, and land-use policies to maximize carbon sequestration.

In 1990, the Energy sector accounted for 84.73% of total GHG emissions, followed by Agriculture at 9.20%, IPPU at 3.53%, and Waste at 2.54%. By 2022, the Energy sector's share had decreased to 65.78%, while IPPU increased to 12.79%, Agriculture to 11.50%, and Waste to 9.93%. This shift indicates a relative decline in energy emissions' dominance and a growing contribution from industrial processes, agriculture, and waste sectors (Table 2-2).

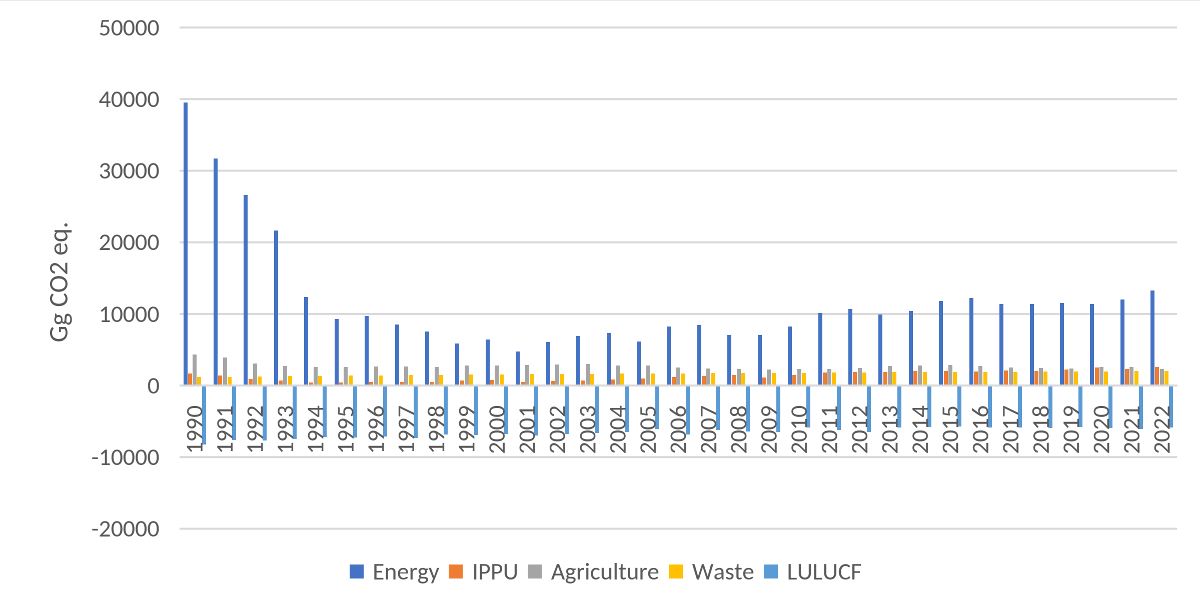
Table 2-2. Sectoral GHG emission and removal trends from 1990 to 2022

Year	Energy	IPPU	Agriculture	Waste	LULUCF
1990	39,465	1,642	4,284	1,185	-8,179
1991	31,652	1,340	3,853	1,193	-7,580
1992	26,577	853	3,041	1,244	-7,672
1993	21,596	655	2,674	1,295	-7,459
1994	12,350	387	2,558	1,316	-7,152
1995	9,251	399	2,536	1,358	-7,233

1996	9,668	492	2,599	1,395	-7,098
1997	8,468	441	2,637	1,429	-7,278
1998	7,544	468	2,572	1,461	-6,809
1999	5,820	693	2,769	1,496	-6,865
2000	6,389	709	2,787	1,530	-6,738
2001	4,701	433	2,817	1,563	-6,933
2002	6,013	576	2,911	1,590	-6,709
2003	6,882	686	2,976	1,611	-6,587
2004	7,272	835	2,773	1,632	-6,478
2005	6,091	942	2,777	1,653	-6,011
2006	8,223	1,166	2,494	1,673	-6,789
2007	8,443	1,267	2,331	1,692	-6,205
2008	7,027	1,425	2,308	1,709	-6,366
2009	7,007	1,091	2,231	1,735	-6,443
2010	8,201	1,445	2,246	1,753	-5,821
2011	10,109	1,769	2,296	1,791	-6,188
2012	10,655	1,876	2,424	1,814	-6,437
2013	9,873	1,886	2,670	1,831	-5,807
2014	10,377	2,022	2,731	1,851	-5,728
2015	11,772	2,029	2,822	1,860	-5,722
2016	12,162	1,918	2,709	1,871	-5,859
2017	11,321	2,070	2,512	1,882	-5,811
2018	11,326	2,019	2,411	1,900	-5,884
2019	11,462	2,236	2,377	1,926	-5,784
2020	11,351	2,452	2,541	1,951	-5,901
2021	11,984	2,305	2,530	1,978	-6,011
2022	13,218	2,571	2,310	1,996	-5,801

Overall, the Energy sector has contributed the most to emissions, while LULUCF has played a key role in carbon sequestration. While industrial and waste emissions have shown moderate increases, agriculture has remained relatively stable (Figure 2-2).

Figure 2-2. GHG emissions and removals trends in Georgia by sectors



Carbon dioxide (CO_2)

Carbon dioxide (CO_2) emissions have been the dominant contributor to total GHG emissions. In 1990, CO_2 emissions stood at 32,543 Gg CO_2 eq. but dropped significantly in the 1990s due to economic collapse, reaching a low of 3,377 Gg CO_2 eq. in 2002. Emissions then gradually increased due to economic recovery and industrial growth, reaching 12,829 Gg CO_2 eq. in 2022, marking a fourfold increase from their lowest level.

Methane (CH_4)

Methane (CH_4) emissions followed a different trend. In 1990, CH_4 emissions were 12,775 Gg CO_2 eq., primarily from agriculture and waste sectors. They declined through the 1990s, reaching a low of 4,869 Gg CO_2 eq. in 1999. Afterward, emissions fluctuated, peaking at 7,523 Gg CO_2 eq. in 2003 before stabilizing around 5,900–6,800 Gg CO_2 eq. in recent years. In 2022, CH_4 emissions were recorded at 5,906 Gg CO_2 eq., showing an overall decrease from 1990 but stability in recent years.

Nitrous oxide (N_2O)

Nitrous oxide (N_2O) emissions exhibited a moderate decline. In 1990, they were 1,258 Gg CO_2 eq. and fell to around 800–900 Gg CO_2 eq. during the early 2000s. The highest recorded emissions were in 2015 at 1,051 Gg CO_2 eq., after which they remained relatively stable. By 2022, N_2O emissions had slightly declined to 879 Gg CO_2 eq.

Hydrofluorocarbons (HFCs)

Hydrofluorocarbons (HFCs) were not recorded in the inventories until 2001, when emissions first appeared at 0.24 Gg CO_2 eq. Since then, they have steadily increased, reaching 480 Gg CO_2 eq. in 2022, reflecting the rising use of refrigerants and other industrial applications.

Sulfur hexafluoride (SF_6)

Sulfur hexafluoride (SF_6) emissions were first recorded in 2010 at 0.55 Gg CO_2 eq. and have remained minimal. By 2022, they had slightly increased to 1.14 Gg CO_2 eq., showing a slow but steady rise.

CO_2 emissions have experienced the most significant fluctuations, while CH_4 and N_2O have been relatively stable over time. HFCs and SF_6 have increased in recent years due to growing industrial applications, though their contribution remains minor compared to the other gases. Unlike LULUCF removals, which help offset CO_2 emissions, there are no equivalent large-scale removal processes for CH_4, N_2O, HFCs, or SF_6, making CO_2 the only gas with a substantial offset potential through forestry and land-use changes (.

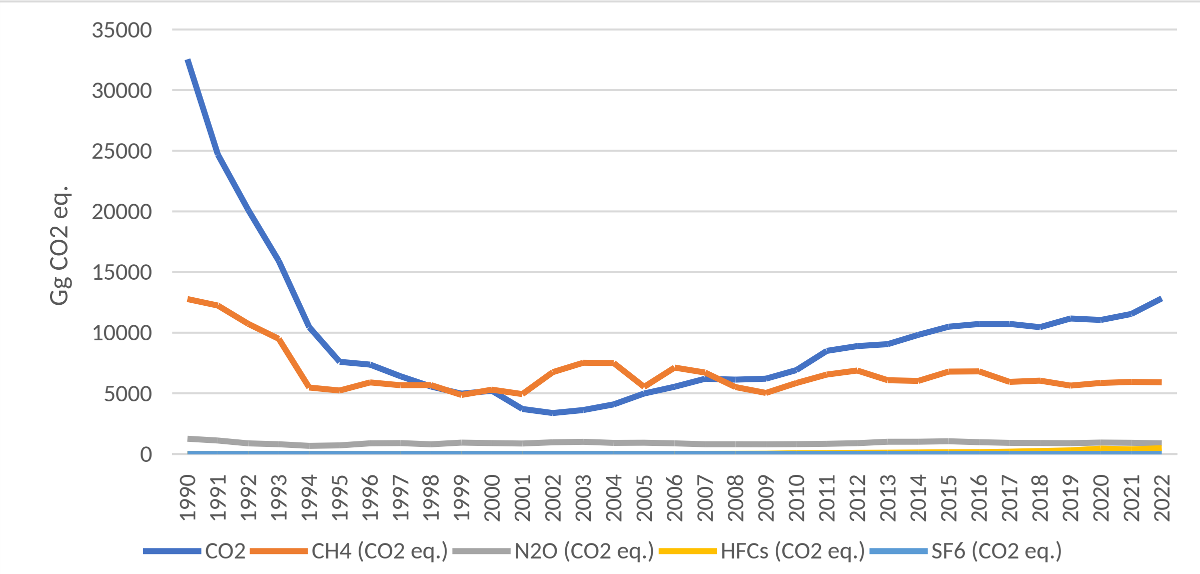
Table 2-3. GHG emissions trend in Georgia by gases from 1990 to 2022

Year	CO2	CH4 (CO2 eq.)	N2O (CO2 eq.)	HFCs (CO2 eq.)	SF6 (CO2 eq.)
1990	32,543	12,775	1,258	NA	NA
1991	24,689	12,239	1,111	NA	NA
1992	20,111	10,726	877	NA	NA
1993	15,918	9,496	805	NA	NA
1994	10,460	5,480	673	NA	NA
1995	7,600	5,234	712	NA	NA
1996	7,370	5,903	881	NA	NA
1997	6,408	5,669	898	NA	NA
1998	5,564	5,681	800	NA	NA
1999	4,972	4,869	938	NA	NA
2000	5,212	5,303	898	NA	NA
2001	3,712	4,938	864	0	NA
2002	3,377	6,749	964	1	NA
2003	3,624	7,523	1,005	3	NA
2004	4,090	7,501	917	5	NA
2005	4,987	5,534	931	9	NA
2006	5,543	7,125	879	9	NA
2007	6,203	6,716	804	10	NA
2008	6,132	5,517	806	15	NA
2009	6,208	5,034	799	22	NA
2010	6,918	5,853	814	59	0.55
2011	8,503	6,550	841	70	0.62
2012	8,895	6,882	892	99	0.68
2013	9,056	6,084	1,011	109	0.68
2014	9,819	6,024	1,012	125	0.74
2015	10,494	6,793	1,051	145	0.79
2016	10,719	6,812	974	154	0.83
2017	10,726	5,946	918	192	0.87
2018	10,455	6,048	905	245	0.93
2019	11,171	5,639	892	299	1.00
2020	11,050	5,859	943	444	1.06
2021	11,545	5,943	924	384	1.12

Year	CO2	CH4 (CO2 eq.)	N2O (CO2 eq.)	HFCs (CO2 eq.)	SF6 (CO2 eq.)
2022	12,829	5,906	879	480	1.14

In 1990, CO_2 accounted for 71.2% of total emissions, CH_4 contributed 28.0%, and N_2O made up 2.8%. HFCs and SF_6 were not recorded. By 2022, CO_2 emissions had increased their share to 63.9%, CH_4 had declined to 29.4%, N_2O represented 4.4%, HFCs accounted for 2.4%, and SF_6 remained at only 0.01%. These changes indicate that while CO_2 remains dominant, the share of industrial gases such as HFCs has grown, reflecting increased industrialization and the widespread use of synthetic gases.

Figure 2-3. GHG emissions trend in Georgia by gases from 1990 to 2022



3.1. Sector overview and general information

Emissions from the energy sector consist of two main categories: fuel combustion and Fugitive Emissions from fuels. Fuel combustion includes emissions released into the atmosphere from the combustion of fossil fuels (e.g., coal, petroleum products, and natural gas). Fugitive Emissions are the intentional or unintentional release of gases from fossil fuels as a result of anthropogenic activities (extraction, transportation, and/or storage of fossil fuels).

In Georgia, fossil fuels are used to produce energy for a variety of purposes (e.g., industry, transportation, and energy consumption). As a result, CO2 (carbon dioxide), CH_4(methane), N_2O(nitrous oxide), NOX (nitrogen oxide), CO (carbon monoxide), and non-methane volatile organic compounds (NMVOCs) are produced during the processes.

The methodologies are shown in the **Table 3-1** below.

Table 3-1. Methodologies used in the energy sector

Categories	CO_2		CH_4		N_2O	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1.A - Fuel Combustion	T1	D	T1	D	T1	D
1.A.1 - Energy Industries	T1, T2	D	T1, T2	D	T1, T2	D
1.A.2 - Manufacturing Industries and Construction	T1	D	T1	D	T1	D
1.A.3 –Transport	T1	D	T1	D	T1	D
1.A.4 – Other Sectors	T1	D	T1	D	T1	D
1.A.4.a - Commercial/Institutional	T1	D	T1	D	T1	D
1.A.4.b – Residential	T1	D	T1	D	T1	D
1.A.4.c – Agriculture/Forestry/ Fishing/ Fish Farms	T1	D	T1	D	T1	D
1.A.5 Non-Specified	T1	D	T1	D	T1	D
1.B - Fugitive emissions from fuels	T1	D	T1, T2	D, CS	T1	D
1.B.1 – Solid Fuels	T1	D	T1	D	NO	NO
1.B.2 - Oil and Natural Gas	T1	D	T1, T2	D, CS	T1	D
1.B.2.a –Oil	T1	D	T1	D	T1	D
1.B.2.b – Natural Gas	T1	D	T2	CS	T1	D
1.C. CO2 Transport and Storage	NO	NO				

Note: D: IPCC default, T1: Tier1, T2: Tier2, T3: Tier3, CS: country specific method or EF

In 2022, GHG emissions (CO_2, CH_4, N_2O) from the energy sector amounted to 13,218 Gg CO_2 equivalent, which is about 67% of Georgia's total GHG emissions (excluding LULUCF). In 2022, the following source categories had the largest shares in the total GHG emissions from the Energy Sector: Transport – 34%, Other Sectors – 25%, Oil and Natural Gas – 15%, Energy Industries – 11.5%, Manufacturing Industries and Construction – 13.5%. Compared to 1990, the total GHG emissions from the energy sector had decreased by 66.5%.

Table 3-2. Enery Sectoral Table for 1990 and 2022

Categories	1990 emissions (Gg)			2022 emissions (Gg)		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
1 – Energy	31,027.92	296.89	0.46	10,954.92	78.44	0.25
1.A - Fuel combustion	30,961.36	8.78	0.46	10,947.62	4.75	0.25
1.A.1 - Energy industries	13,731.86	0.41	0.09	1,522.86	0.03	0.00
1.A.2 Manufacturing Industries and Construction	7,534.96	0.45	0.07	1,787.23	0.11	0.02
1.A.3 –Transport	4,411.55	1.31	0.21	4,403.69	1.71	0.18
1.A.4 – Other sectors	5,282.99	5.49	0.08	3,233.84	2.91	0.05
1.A.4.a - Commercial/Institutional	1,076.52	0.45	0.01	518.37	0.06	0.00
1.A.4.b – Residential	3,688.24	4.79	0.06	2,661.19	2.83	0.04
1.A.4.c – Agriculture/ Forestry/ Fishing/ Fish Farms	518.23	0.24	0.00	54.28	0.02	0.01
1.A.5 Non-Specified	NO	1.13	0.02	NO	NO	NO
1.B **- Fugitive Emissions from Fuels**	66.56	288.11	0.00	7.30	73.68	0.00
1.B.1 – Solid Fuels	54.91	34.10	0.00	4.85	3.33	NO
1.B.2 - Oil and Natural Gas	11.65	254.01	0.00	2.45	70.35	0.00
1.B.3 - Other Emissions from Energy Production	NO	NO	NO	NO	NO	NO
1.C - CO2 Transportation and Storage	NO	NO	NO	NO	NO	NO

The significant decline in greenhouse gas emissions during the 1990s resulted from the collapse of the Soviet Union and the fundamental changes in the country's economy. However, since 2000, the national economy has been growing, with an average annual real GDP growth rate of 8.4% until 2008. In 2008–2009, economic growth in Georgia slowed due to the Russo-Georgian War. Since 2010, the country's real GDP has been expanding again, averaging 5.2% per year until 2020. In the first year of the COVID-19 pandemic (2020), GDP contracted by 6.3%, followed by a 10% growth rate in the subsequent years.[1.]

In 2010, hydropower generation reached its peak capacity, while thermal power generation was at its lowest level in a decade. Since 2011, emissions from the energy sector have increased, primarily due to the rise in thermal power generation and improved economic conditions. The table below presents energy sector emissions in CO2 equivalents. The global

[1] National Statistics Office of Georgia - www.geostat.ge – Real increase of GDP

warming potentials used to convert greenhouse gases into CO2 equivalents are based on the Fifth Assessment Report.

Table 3-3. ***GHG Emissions from the Energy Sector (Gg, CO_2 eq.)***

Year	1A – fuel Combustion	1B - Fugitive Emissions from Fuels	1C - CO_2 Transport and Storage	Total from Energy Sector
1990	31,330	8,134	NO	39,464
1991	23,755	7,897	NO	31,652
1992	19,712	6,865	NO	26,577
1993	15,845	5,751	NO	21,596
1994	10,285	2,065	NO	12,350
1995	7,350	1,704	NO	9,054
1996	7,406	2,262	NO	9,668
1997	6,398	2,070	NO	8,468
1998	5,469	2,075	NO	7,544
1999	4,684	1,136	NO	5,820
2000	4,895	1,493	NO	6,388
2001	3,599	1,102	NO	4,701
2002	3,177	2,837	NO	6,014
2003	3,326	3,556	NO	6,882
2004	3,658	3,614	NO	7,272
2005	4,373	1,717	NO	6,090
2006	4,737	3,485	NO	8,222
2007	5,317	3,126	NO	8,443
2008	5,084	1,944	NO	7,028
2009	5,509	1,497	NO	7,006
2010	5,928	2,273	NO	8,201
2011	7,193	2,916	NO	10,109
2012	7,499	3,156	NO	10,655
2013	7,761	2,112	NO	9,873
2014	8,414	1,963	NO	10,377
2015	9,092	2,681	NO	11,773
2016	9,390	2,773	NO	12,163
2017	9,291	2,030	NO	11,321
2018	9,101	2,225	NO	11,326
2019	9,663	1,799	NO	11,462
2020	9,444	1,908	NO	11,352
2021	10,014	1,970	NO	11,984
2022	11,148	2,070	NO	13,218

As shown in the table, a significant share of emissions from the energy sector originates from fuel combustion (84% in 2022), while the remaining 16% is attributed to fugitive emissions. Among the emission source categories, the most substantial increase since 2000 has been observed in fugitive emissions from the transformation[2] of solid fuel, rising from 30 Gg CO_2 equivalent in 2000 to 170 Gg CO_2 equivalent in 2017. This increase was driven by the intensification of coal mining operations in recent years. However, since 2017, coal mining has significantly declined due to the enforcement of technical inspections for mine safety regulations following a series of fatal workplace accidents[3].

Emissions by greenhouse gases are shown in the table below.

Table 3-4 **GHG Emissions from the Energy Sector (Gg)**

YEAR	CO_2	CH_4	CH_4 in CO_{2eq}	N_2O	N_2O in CO_{2eq}	Total CO_{2eq}
1990	31,028	297	8,313	0.465	123	39,464
1991	23,475	289	8,084	0.349	92	31,652
1992	19,346	255	7,143	0.330	88	26,577
1993	15,351	220	6,152	0.349	92	21,595
1994	10,110	78	2,194	0.174	46	12,350
1995	7,052	70	1,951	0.192	51	9,054
1996	6,961	94	2,626	0.305	81	9,668
1997	6,041	84	2,361	0.251	67	8,469
1998	5,162	83	2,328	0.202	53	7,544
1999	4,392	49	1,378	0.186	49	5,820
2000	4,624	61	1,719	0.171	45	6,388
2001	3,326	47	1,329	0.172	45	4,701
2002	2,901	110	3,067	0.174	46	6,014
2003	3,051	135	3,784	0.177	47	6,881
2004	3,378	137	3,846	0.179	47	7,272
2005	4,196	66	1,856	0.144	38	6,090
2006	4,550	130	3,633	0.152	40	8,222
2007	5,108	117	3,288	0.179	47	8,443
2008	4,885	75	2,099	0.164	44	7,028
2009	5,304	59	1,652	0.190	50	7,006
2010	5,723	87	2,425	0.197	52	8,200
2011	7,013	109	3,043	0.198	53	10,108
2012	7,325	117	3,277	0.204	54	10,656
2013	7,490	83	2,314	0.264	70	9,874
2014	8,131	78	2,172	0.28	74	10,377
2015	8,829	102	2,869	0.282	75	11,773

[2] See the table 3-32.

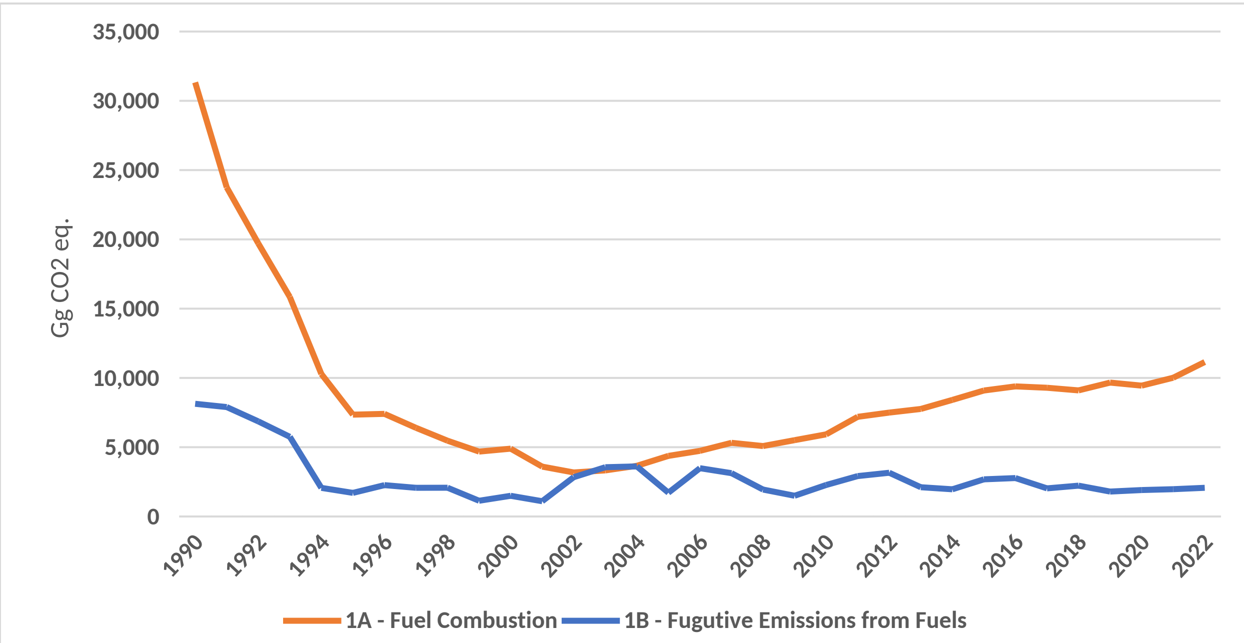
[3] The deaths of miners have ignited a wave of protests in Georgia.

2016	9,125	106	2,957	0.305	81	12,162
2017	9,043	79	2,203	0.281	74	11,321
2018	8,890	85	2,369	0.257	68	11,326
2019	9,457	69	1,936	0.264	70	11,462
2020	9,258	73	2,031	0.237	63	11,352
2021	9,821	75	2,097	0.251	66	11,984
2022	10,955	78	2,196	0.253	67	13,218

Between 2000 and 2022, emissions from the industrial and transport sectors increased by approximately 2.6 times and 4.2 times, respectively. The rise in greenhouse gas emissions in the transport sector was primarily driven by the expansion of the vehicle fleet, which mainly consists of used cars. The number of registered vehicles in Georgia grew from 319,600 in 2002 to 1,563,165[4] in 2022.

Since 2006, the construction of energy transit pipelines—such as the South Caucasus Gas Pipeline and the Baku-Tbilisi-Erzurum Oil Pipeline—has required additional gas and diesel for their operation. Figure 3-1 illustrates the trends in greenhouse gas emissions in the energy sector from 1990 to 2022.

Figure 3-1. 1 GHG Emissions trends in the energy sector, 1990-2022 (Gg CO_{2eq})



The results of the uncertainty analysis in the energy sector are presented in subsection 3.3.

3.2. Fuel combustion (1.A.)

3.2.1. *Source category description and calculated emissions*

Greenhouse gas emissions from the fuel combustion source category in 2022 amounted to 11,148 Gg CO_2 equivalent. In that year, carbon dioxide, methane and nitrous

[4] National Statistics Office of Georgia 2023 https://automobile.geostat.ge/ka/

oxide accounted for 98.2%, 1.2% and 0.6% of emissions from the fuel combustion source category, respectively. The transport sector (1.A.3) has the highest share (34%) of sectoral greenhouse gas emissions. The residential sector has the highest methane emissions, while the transport sector is the leading emitter of nitrous oxide.

3.2.2. *Methodological issues*

Evaluation method

Emissions in the source-category are calculated using the IPCC methodology Tier 1 – sectoral approach. The sectoral approach for assessing emissions from Fuel Combustion Stationary Source-categories is based on the data on actual consumption of fuel combusted in the source category provided in the country's energy balance and emission factor. Emission Factors are derived from the default values provided together with associated uncertainty range.

The following equation is used to calculate greenhouse gas emissions from stationary combustion according to the sectoral approach:

$$Emissions = Fuel\ Consumption fuel \times Emission\ Factor GHG, fuel$$

$$Emissions_{\mathrm{GHG,fuel}} = Fuel\ Consumption_{fuel} \times Emission\ Factor_{GHG,fuel}$$

Where:

$Emissions_{\mathrm{GHG,fuel}}$ – Emissions of a given GHG by type of fuel (kg GHG)

$Fuel\ Consumption_{fuel}$ – Amount of fuel combusted (TJ)

$Emission\ Factor_{GHG,fuel}$ – Default emission factor of a given GHG by type of fuel (kg gas/TJ). For CO_2, it includes the carbon oxidation factor, assumed to be 1.

Not all fuel supplied to an economy is combusted for heat energy. Certain volume is used as a feedstock for manufacturing of products, such as plastics or in a non-energy use (e.g. bitumen for road construction), without oxidation (emissions) of carbon. This is called stored carbon and is deducted from the carbon emissions calculation. The estimation of the stored carbon requires data for fuel consumption by activities using the fuel as raw material.

Recalculations in GHGs emission inventories for previous years were carried out are mainly due to shifting from IPCC 1996 to IPCC 2006 guidelines and availability of the new data sources.

Emission factors

The emission factor is a coefficient that relates the Activity Data to the amount of the chemical compound, which is the source of later emissions. Emission Factors for CO_2 from fossil fuel combustion are expressed on a per unit energy basis, since the carbon content of fuels is generally less variable when expressed on a per unit energy basis, compared to per unit mass basis. Therefore, net calorific values (NCVs) are used to convert fuel consumption data on a per unit mass or volume basis, to data on a per unit energy basis. Country specific NCV-s of different fuels were obtained from the GEOSTAT energy balance (2013-2022).

Table 3-5. Conversion coefficients and carbon emission factors for different fuel types

Fuel type	Unit	Net calorific Values (TJ/Unit)	Carbon content (kg C/GJ)
Crude oil	1000 T	42.5	20.0
Motor gasoline	1000 T	44.0	18.9
Aviation Kerosene	1000 T	43.2	19.5
Other Kerosene	1000 T	43.2	19.6
Gas/diesel fuel	1000 T	43.3	20.2
Household fuel	1000 T	40.4	21.1
Compressed gas	1000 T	45.0	17.2
Crude oil	1000 T	44.5	20.0
Bitumen	1000 T	38.0	22.0
Lubricants	1000 T	38.0	20.0
Fuels	1000 T	41.9	20.0
Other oil products	1000 T	43.3	20.0
Anthracite	1000 T	29.3	26.8
Lignite	1000 T	17.0	27.6
Semi-bituminous coal	1000 T	18.9	26.2
Other bituminous coal	1000 T	25.0	25.8
Coke coal	1000 T	28.2	25.8
Coke oven/gas coke	1000 T	29.3	29.2
Natural gas (NG)	1 000 000 m^3	36.0	15.3
Firewood	1000 m^3	7.8	30.5
Petroleum coke	1000 T	32.5	26.6
Charcoal	1000 T	30.8	26.6
Briquette fuel	1000 T	29.0	26.6
Other primary solid biomass	1000 T	18.0	27.3

Emission Factors for CO_2 are in units of kg CO_2/GJ on a net calorific value basis and reflect the carbon content of the fuel. CO_2 Emission Factors for all Tiers reflect the full carbon content of the fuel less any non-oxidized fraction of carbon retained in the ash, particulates, or soot. Since this fraction is generally small, the Tier 1 default Emission Factors neglect this effect by assuming a complete oxidation of the carbon contained in the fuel (carbon oxidation factor equal to 1). Emission Factors for CH_4 and N_2O for different source categories differ due to the differences in combustion technologies applied in the various source categories. The default factors presented for Tier 1 apply to technologies without emission controls[5].

Activity Data

Generally, in the energy sector the national energy balance is the basis for the assessment of greenhouse gas emissions during fuel combustion. In production of fuel, its import, export, changes in stocks and consumption, energy balance is provided in physical units (tons or m3) or in energy units (terajoules or kilo tons of oil equivalent). For comparison of data in the energy balance, physical units are converted into energy units using fuel specific net calorific values (NCV).

[5] Emission Factor Database.

In 2014, the National Statistics Office of Georgia published its first energy balance for 2013. The quality of the data is improving every year. It is also possible to obtain activity data from various sources.

The data below is provided by various sources:

- Energy balances for 2013-2022 were provided by the National Statistics Office of Georgia[6];
- Energy balances for 1990-2012 were provided by the International Energy Agency;
- Natural gas balances for 2010-2012, data on aviation fuel and firewood stocks and consumption were obtained from the Ministry of Energy of Georgia;
- Information on natural gas and crude oil transit was provided by the Georgian Oil and Gas Corporation[7];
- Electricity balances for 2007-2022 were obtained from the electricity market operator[8];
- Information on natural gas transmission and distribution losses was provided by the Georgian National Energy and Water Regulatory Commission[9];
- Data on natural gas and diesel consumption for the operation of energy transit pipelines for 2010-2017 were provided by British Petroleum Georgia[10].
- Data on diesel consumption for inland navigation for 2014-2022 and 2016-2022 were provided by the Batumi and Poti seaports.
- Data on natural gas consumption for each thermal power plant for 2000-2022 was provided by the Ministry of Economy and Sustainable Development[11.]

Based on the provided data, aggregated energy balances were compiled for the period 1990-2012.

3.2.3. *The Sectoral Approach vs the Reference Approach*

This chapter explains a comparison between the reference approach and the sectoral approach in accordance with the UNFCCC Inventory Reporting Guidelines (Decision 24/CP.19 Annex I, paragraph 40). The Reference Approach is a top-down approach, using a country's energy supply data to calculate the emissions of CO_2 from combustion of mainly fossil fuels. The Reference Approach is a straightforward method that can be applied on the basis of relatively easily available energy supply statistics. Improved comparability between the sectoral and the reference approaches continues to allow a country to produce a second independent estimate of CO_2 emissions from fuel combustion with limited additional effort and data requirements. The Reference Approach provides an upper bound to CO_2 emissions inferred from the country's supply of fossil fuels by identifying the carbon content, subtracting from it the excluded carbon - carbon stored in non-energy products and products made from fuels used as raw material, adjusting for carbon, which remains unburnt, and multiplying by 44/12. Under the Reference Approach, carbon dioxide emissions are calculated using the following formula:

$$\text{Carbon dioxide emissions (Gg}CO_2\text{) =}$$

[6] National Statistics Office of Georgia - Energy Statistics
[7] www.gogc.ge
[8] www.esco.ge
[9] www.gnerc.org
[10] www.bpgeorgia.ge
[11] www.economy.ge

$$= \sum_i \left\{ \left[\begin{array}{c} Apparent\ Consuption\ of\ fuel\ (Units) \\ \times \text{Calorific value of fuel} \left(\frac{TJ}{Unit}\right) \\ \times \text{Carbon emission factor } \frac{(\frac{tc}{TJ})}{1000} - \text{Excluded carbon} \end{array} \right] \times Fraction\ of\ carbon\ oxidized \right\} \times \frac{44}{12}$$

Where the lower index i refers to the type of fuel, and apparent consumption for each primary fuel is calculated as:

Apparent Consumption = Production + Imports – Exports – International Bunkers – Stock Change

While for secondary fuels, apparent consumption is calculated as:

Apparent Consumption =Imports –Exports –International Bunkers–Stock Change

Usually, the value of fraction of carbon oxidized is 1, reflecting complete oxidation.

Excluded carbon is calculated using the formula:

$$Excluded\ Carbon\ (Gg\ C) = non\text{-}energy\ use\ (10^3 t)\ x\ Calorific\ value\ of\ fuel\ (\frac{TJ}{10^3 t})\ x\ Carbon\ emission\ factor\ (t\frac{c}{TJ})\ x\ Fraction\ of\ Excluded\ Carbon\ x\ 10^3$$

The Reference approach is an upper bound, as some of the carbon will be emitted in forms other than CO_2, in part because complete combustion of the fuel is not always the case, and in addition, fuels may leak or evaporate. Consequently, the CO_2 emissions figure obtained from the Reference Approach will include carbon emitted as CH_4, CO, N_2O or NMVOC.

The Reference Approach uses a simple assumption: once carbon is brought into the national economy in fuel, it is either saved in some way or it must be released to the atmosphere. To calculate the carbon released, it is not necessary to know exactly how the fuel was used or what intermediate transformations it underwent. In this respect, the methodology may be termed a “top-down” approach compared with the “bottom-up” methods used for other gases. The “bottom-up” methods are a higher-level approach when the information about fuel consumption and Emission Factors is collected at the level of specific enterprises. The sectoral approach is an intermediate approach between these two approaches since it uses information about fuel consumption at the level of economic sectors.

The table below shows the carbon dioxide emissions for the years 1990-2022 calculated using these two approaches for different fuel types, accompanied by an explanation of the differences.

Table 3-6. Comparison of CO2 emissions calculated using reference and sectoral approaches

Year	Liquid Fuel			Solid Fuel			Gaseous fuel			Total		
	RA *	SA* gg	%	RA gg	SA gg	RA *	SA* gg	%	RA	BA gg	RA *	SA*

	gg					gg			gg		gg	gg
1990	16,442	15,951	3.07	4,737	4,734	0.06	10,360	9,617	7.73	31,539	30,303	4.08
1991	12,385	11,788	5.06	2,237	2,238	-0.02	9,644	8,862	8.83	24,266	22,888	6.02
1992	8,791	8,509	3.31	1,449	1,450	-0.02	9,664	8,960	7.86	19,904	18,919	5.21
1993	7,369	7,190	2.48	724	724	0.01	7,781	7,182	8.35	15,874	15,096	5.15
1994	5,799	5,686	1.99	793	793	0.04	3,698	3,497	5.76	10,291	9,976	3.15
1995	4,888	4,882	0.12	135	107	26.65	2,207	2,035	8.45	7,231	7,024	2.94
1996	4,073	4,090	-0.42	70	70	0.07	2,045	1,820	12.39	6,189	5,980	3.48
1997	3,543	3,495	1.38	56	56	-0.30	1,627	1,423	14.32	5,227	4,975	5.06
1998	2,960	2,963	-0.09	100	100	-0.06	1,540	1,335	15.34	4,600	4,398	4.60
1999	2,471	2,471	0.06	104	104	0.07	1,366	1,260	8.37	3,940	3,833	2.79
2000	2,148	2,133	0.72	61	61	0.11	2,263	1,972	14.77	4,473	4,166	7.36
2001	1,668	1,671	-0.18	76	76	0.07	1,715	1,542	11.27	3,460	3,289	5.20
2002	1,598	1,601	-0.22	64	64	0.08	1,435	1,168	22.80	3,096	2,833	9.28
2003	1,598	1,602	-0.23	25	25	0.09	1,629	1,324	23.08	3,252	2,950	10.23
2004	1,605	1,609	-0.23	31	31	0.09	1,908	1,612	18.35	3,544	3,252	8.99
2005	2,054	2,033	1.05	39	39	0.04	2,078	2052	1.26	4,172	4,124	1.15
2006	2,009	2,018	-0.47	35	35	0.09	2,828	2,462	14.88	4,872	4,515	7.90
2007	2,503	2,518	-0.56	121	106	13.79	3,093	2,449	26.28	5,717	5,073	12.70
2008	2,232	2,223	0.43	265	265	0.04	2,370	2,363	0.27	4,867	4,851	0.33
2009	2,581	2,593	-0.44	473	473	0.08	2,379	2,201	8.08	5,434	5,267	3.17
2010	2,922	2,723	7.32	898	896	0.15	2,238	2,037	9.88	6,058	5,656	7.11
2011	2,904	2,930	-0.89	1,191	1,190	0.12	3,581	3,300	8.52	7,677	7,420	3.46
2012	2,863	2,851	0.43	1,307	1,306	0.13	3,923	3,612	8.60	8,094	7,769	4.18
2013	2,714	2,736	-0.80	1,350	1,349	0.12	3,382	3,388	-0.20	7,446	7,473	-0.36
2014	2,886	2,930	-1.51	1,235	1,234	0.10	3,916	3,955	-0.96	8,038	8,119	-1.00
2015	3,326	3,355	-0.87	1,151	1,149	0.11	4,339	4,312	0.64	8,816	8,816	-0.01
2016	3,969	3,938	0.79	1,113	1,110	0.30	4,146	4,065	1.99	9,228	9,112	1.27
2017	3,362	4,045	-16.88	1,237	1,131	9.35	4,345	3,855	12.69	8,944	9,032	-0.97
2018	3,840	3,454	11.16	1,274	1,166	9.25	4,804	4,263	12.70	9,918	8,883	11.64
2019	4,194	3,615	16.01	1,006	905	11.19	5,443	4,934	10.32	10,643	9,454	12.58
2020	3,977	3,498	13.71	891	810	9.95	5,463	4,944	10.48	10,331	9,253	11.65
2021	4,153	3,772	10.07	958	866	10.64	5,662	5,175	9.41	10,773	9,813	9.78
2022	4,219	3,781	11.60	1,000	898	11.35	6,777	6,269	8.11	11,997	10,948	9.59

* **BA** denotes reference approach; **SA** denotes sectoral approach

The discrepancy in liquid fuel calculations arises from minor inaccuracies in the petroleum products subsector data within the National Statistics Office of Georgia's energy balances. For example, the reference approach relies on data related to production, imports, and exports of petroleum products. However, for certain categories of petroleum products, the National Statistics Office of Georgia only publishes export statistics, while their domestic production is not officially recorded. These products result from blending multiple petroleum products, including imported crude oil, which is not accounted for in the sectoral approach calculations. As a result, this discrepancy leads to inconsistencies between the reference and sectoral approaches.

The difference in gaseous fuel calculations is primarily due to natural gas losses during transportation and distribution. In the sectoral approach, these losses are classified as methane emissions, whereas in the reference approach, they are considered combusted and converted into carbon dioxide.

International Bunker Fuels

All emissions from fuels used for international aviation and water-borne navigation (bunkers) are to be excluded from national totals and reported separately as memo items. Emissions from international aviation are defined as emissions from flights that depart in one country and arrive in a different country, including take-offs and landings for these flight stages.

Emissions from international water-borne navigation are sourced from fuels used by vessels of all flags that are engaged in international water-borne navigation. The international navigation may take place at sea, on inland lakes and waterways and in coastal waters. It includes emissions from journeys that depart in one country and arrive in a different country.

Table below provides emissions from the International Aviation and Marine Bunkers.

Table 3-7. GHG emissions from international bunkers

Year	International Aviation Bunkers				International Marine Bunkers			
	CO_2 (Gg)	CH_4 (Gg)	N2O(GG)	CO_2 (Gg)	CH_4 (Gg)	CH4 (GG)	CO_2 (Gg)	CH_4 (Gg)
1990	609	0.004	0.017	**613**	490	0.046	0.013	495
1991	590	0.004	0.017	**595**	392	0.036	0.010	396
1992	507	0.004	0.014	**511**	280	0.026	0.007	283
1993	387	0.003	0.011	**390**	189	0.017	0.005	191
1994	198	0.001	0.006	**199**	166	0.015	0.004	168
1995	12	0.000	0.000	**12**	158	0.014	0.004	159
1996	240	0.002	0.007	**242**	144	0.013	0.004	145
1997	212	0.001	0.006	**214**	130	0.012	0.003	131
1998	295	0.002	0.008	**297**	116	0.011	0.003	117
1999	249	0.002	0.007	**251**	102	0.009	0.003	103
2000	46	0.000	0.001	**47**	88	0.008	0.002	89
2001	40	0.000	0.001	**40**	74	0.007	0.002	75
2002	71	0.000	0.002	**71**	60	0.006	0.002	61
2003	80	0.001	0.002	**80**	55	0.005	0.001	56
2004	114	0.001	0.003	**115**	50	0.005	0.001	51
2005	114	0.001	0.003	**115**	46	0.004	0.001	46
2006	114	0.001	0.003	**115**	41	0.004	0.001	41
2007	145	0.001	0.004	**146**	36	0.003	0.001	37
2008	123	0.001	0.003	**124**	31	0.003	0.001	32
2009	123	0.001	0.003	**124**	27	0.003	0.001	27
2010	127	0.001	0.003	**128**	22	0.002	0.001	22
2011	108	0.001	0.003	**109**	17	0.002	0.000	17
2012	211	0.001	0.006	**212**	13	0.001	0.000	13
2013	261	0.002	0.007	**263**	8	0.001	0.000	8
2014	248	0.002	0.007	**250**	3	0.000	0.000	3
2015	215	0.002	0.006	**216**	5	0.000	0.000	5
2016	218	0.002	0.006	**220**	2	0.000	0.000	2
2017	292	0.002	0.008	**294**	5	0.000	0.000	5
2018	315	0.002	0.009	**318**	5	0.000	0.000	5
2019	311	0.002	0.009	**313**	7	0.001	0.000	7
2020	170	0.001	0.005	**171**	12	0.001	0.000	12

2021	290	0.002	0.008	**292**	9	0.001	0.000	9
2022	407	0.003	0.011	**410**	10	0.001	0.000	10

Due to data insufficiency, information on greenhouse gas emissions from fuel consumed by international marine bunkers is available only for the years 1991-1995, 2002 and 2014-2022. Data for 1991-1995 and 2002 were provided by the International Energy Agency, while data for the latter period were taken from the energy balance of the National Statistics Service of Georgia. For the time periods where data are not available, an interpolation methodology was used to fill in the data.

3.2.4. *Feedstocks and Non-Energy Use of Fuels*

Not all fuel supplied to an economy is burned for heat energy. Certain volume is used as a feedstock for manufacturing products such as plastics, or in a non-energy use (e.g. bitumen for road construction, natural gas for ammonia, naphtha, ethane, paraffin and candle production), without oxidation (emissions) of carbon. This is called excluded/stored carbon and is deducted from the carbon emissions calculation. The values of the consumption of fossil fuel products for non-energy purposes are provided in the table below.

Table 3-8. The Consumption of Fossil Fuel for Non-Energy Purposes (TJ)

Year	Lubricants (TJ)	Bitumen (TJ)	Natural gas (TJ)	Year	Lubricants (TJ)	Bitumen (TJ)	Natural gas (TJ)
1990	4,560	9,880	6,000	**2007**	714	3,900	2,902
1991	7,266	3,861	6,000	**2008**	714	3,783	3,052
1992	5,586	3,861	3,410	**2009**	0	312	3,070
1993	5,586	3,471	2,841	**2010**	386	3,542	4,078
1994	2,698	1,748	2,000	**2011**	520	2,273	4,422
1995	420	78	2,273	**2012**	644	3,878	4,646
1996	966	0	0	**2013**	571	3,005	5,666
1997	336	390	2,313	**2014**	638	3,105	5,610
1998	462	390	4,489	**2015**	755	3,378	5,900
1999	378	312	6,427	**2016**	796	3,980	4,823
2000	304	342	0	**2017**	699	3,990	5,424
2001	210	858	3,429	**2018**	753	4,051	6,019
2002	126	1,014	2,868	**2019**	702	6,492	6,369
2003	210	1,170	3,256	**2020**	860	4,971	6,389
2004	462	1,443	3,815	**2021**	817	4,425	5,836
2005	380	2,584	7,385	**2022**	924	4,841	6,276
2006	630	2,613	7,273				

Carbon emissions from the use of fuels listed above as feedstock are reported within the source categories of the Industrial Processes and Product Use (IPPU) chapter. Lubricating oil statistics usually cover use of lubricants in engines, as well as oils and greases for industrial purposes and heat transfer and cutting oils. Bitumen/asphalt is used for road paving and roof covering and the carbon it contains remains stored for long periods of time. Consequently, there are no fuel combustion emissions arising from the deliveries of bitumen within the year of the inventory. Natural gas is mainly used in production of fertilizers.

3.2.5. *Energy industry (1.A.1.)*

3.2.5.1. *Source category description and calculated emissions*

The energy industry source category comprises emissions from fuels combusted by the fuel extraction or energy-producing industries, including the following sub-categories:

- Main Activity Electricity and Heat Production (1.A.1.a) includes emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants. Main activity producers (formerly known as public utilities) are defined as undertakings which produce electricity and heat as their principal activity and supply it to the public. They may be in public or private ownership.
- Petroleum refining (1.A.1.b) covers all combustion activities supporting the refining of petroleum products including on-site combustion for the generation of electricity and heat for own use.
- Manufacture of Solid Fuels and Other Energy Industries (1.A.1c) - combustion emissions from fuel use during manufacturing secondary and tertiary products from solid fuels including production of charcoal. Emissions from own on-site fuel use should be included. Also includes combustion for the generation of electricity and heat for own use in these industries.

Currently, electricity in Georgia is primarily generated by hydroelectric and thermal power plants, with the latter operating on natural gas. Georgia is rich in hydro resources, and a significant portion of its energy comes from hydroelectric power. As of 2022, the country had 90 hydroelectric power plants (totaling 3,407 MW), five thermal power plants running on natural gas (1,141.2 MW), and one wind power plant (20.7 MW)[12].

The highest share of hydroelectric power generation—93% of total electricity production—was recorded in 2010 due to high precipitation levels. However, since 2013, thermal power generation has increased to meet rising electricity demand. Between 2010 and 2019, the average annual electricity consumption growth rate was 5%[13], followed by a 10% decline in 2020 and a 13% increase in 2021.

In 2013, four new hydroelectric power plants with a combined installed capacity of 46 MW (producing 250 GWh annually) were completed. In 2015, a 230 MW natural gas-fired thermal power plant was commissioned in Gardabani. Between 2018 and 2022, sixteen additional hydroelectric power plants were brought online.

During the Soviet era (until 1991), centralized heating systems operated in Georgia's major cities, relying on natural gas and heavy fuel oil. Over time, these systems became completely obsolete, leading to a drastic reduction in greenhouse gas emissions from this subsector, reaching near zero. Currently, most of the population relies on firewood and natural gas for heating, with emissions from these fuels accounted for in the household energy subcategory.

[12] The National Statistics Office of Georgia, Energy Balance 2022

[13] Electricity Market Operator – Electricity Balance

Table 3-9. GHGs Emissions from the Energy Industry (Gg)

GAS/SUBSECTORS	CO2 Gg	CH4	CH4 CO2eq	N2O	N2O CO2eq	Total CO2eq	Electricity Generation (Gg CO2eq)	Heat Plants (Gg CO2eq)	Other energy industries (Gg CO2eq)
1990	13,732	0.409	11.452	0.087	22.982	13,767	6,216	7,550	NE
1991	8,750	0.258	7.231	0.058	15.381	8,772	5,099	3,673	NE
1992	8,035	0.221	6.199	0.046	12.299	8,054	3,779	4,275	NE
1993	5,345	0.152	4.266	0.028	7.332	5,357	2,755	2,602	NE
1994	4,078	0.128	3.572	0.023	6.072	4,088	2,736	1,351	NE
1995	4,342	0.138	3.867	0.025	6.638	4,352	3,336	1,016	NE
1996	2,044	0.058	1.629	0.010	2.609	2,048	1,201	848	NE
1997	1,769	0.049	1.362	0.008	2.129	1,773	1,048	679	46
1998	1,794	0.046	1.295	0.007	1.927	1,797	1,253	511	34
1999	1,614	0.040	1.110	0.006	1.583	1,617	1,192	342	83
2000	1,600	0.037	1.044	0.005	1.416	1,603	1,296	173	133
2001	1,036	0.020	0.573	0.002	0.637	1,037	850	5	182
2002	763	0.016	0.439	0.002	0.513	764	404	206	155
2003	870	0.018	0.504	0.002	0.595	871	440	238	192
2004	1,097	0.023	0.639	0.003	0.760	1,098	619	256	223
2005	1,343	0.028	0.782	0.004	0.930	1,345	797	176	371
2006	1,521	0.029	0.811	0.003	0.856	1,523	1,042	96	385
2007	1,428	0.027	0.753	0.003	0.780	1,430	958	149	323
2008	1,155	0.022	0.611	0.002	0.636	1,156	822	144	190
2009	1,308	0.028	0.785	0.004	0.966	1,310	781	349	180
2010	692	0.016	0.454	0.002	0.614	693	558	NO	136
2011	1,364	0.025	0.704	0.003	0.712	1,365	1,274	NO	91
2012	1,424	0.025	0.711	0.003	0.679	1,426	1,379	NO	47
2013	993	0.018	0.495	0.002	0.478	994	992	NO	2
2014	1,130	0.020	0.564	0.002	0.541	1,131	1,129	NO	2
2015	1,285	0.023	0.641	0.002	0.614	1,286	1,284	NO	2
2016	1,077	0.019	0.527	0.003	0.666	1,078	1,076	NO	2
2017	1,116	0.019	0.542	0.003	0.760	1,117	1,116	NO	2
2018	1,028	0.018	0.505	0.002	0.613	1,029	1,028	NO	1
2019	1,370	0.024	0.684	0.002	0.649	1,371	1,371	NO	1
2020	1,244	0.022	0.621	0.002	0.591	1,245	1,244	NO	1
2021	1,003	0.018	0.500	0.002	0.478	1,004	1,003	NO	1
2022	1,523	0.027	0.760	0.003	0.724	1,524	1,523	NO	1

Data for other energy industries (1990–1996) and thermal power plants (2010–2022) in Table 3-9 are not presented due to data insufficiency and production suspension. The collection of statistical data from the 1990s posed significant challenges, primarily due to the socio-economic and political instability of that period. The reliability of extrapolating missing data for the seven-year time series (1990–1996) is low, given the transition from a planned economy to a free-market system and the impact of the civil war. Regarding thermal power plant operations, no recorded activity has been documented in the country since 2010.

Table 3-10 below provides the net calorific value of natural gas by year, as determined by the National Statistics Office of Georgia.

Table 3-10. Net calorific value of natural gas by year (Gg) as determined by the National Statistics Office of Georgia

Natural Gas	
Net calorific value (TJ/Unit)	**Year**
35	1990-2014
35.25	2015-2016
36	2017-2022

Table 3-11 presents the results of a comparison of greenhouse gas emissions according to "Tier 1" and "Tier 2" for the years 2000-2022 in the electricity generation subsector (1.A.1.a.i) by thermal power plants. The results show that "Tier 2" shows on average 1.8% higher emissions than emissions calculated according to "Tier 1".

Table 3-11. Results of comparison of greenhouse gas emissions according to "Tier 1" and "Tier 2" for the electricity generation subsector (1.A.1.a.i) by thermal power plants for 2000-2022.

Year	Tier 1				Tier 2				
	CO_2 Gg	CH_4	N_2O	Total CO_2	CO_2 Gg	CH_4	N_2O	Total CO_2	Percentage Difference %
2000	1,000	0.018	0.002	1,001	1,010	0.018	0.018	1,016	1.49%
2001	773	0.014	0.001	774	783	0.014	0.014	787	1.67%
2002	324	0.006	0.001	325	328	0.006	0.006	330	1.53%
2003	361	0.006	0.001	361	366	0.006	0.006	368	1.92%
2004	508	0.009	0.001	508	515	0.009	0.009	517	1.76%
2005	620	0.011	0.001	620	627	0.011	0.011	630	1.60%
2006	1,324	0.024	0.002	1,325	1,341	0.033	0.024	1,348	1.72%
2007	894	0.016	0.002	895	906	0.020	0.016	910	1.66%
2008	767	0.014	0.001	768	776	0.018	0.014	780	1.55%
2009	571	0.010	0.001	572	578	0.012	0.010	581	1.56%
2010	387	0.007	0.001	387	392	0.007	0.007	394	1.79%
2011	1,235	0.022	0.002	1,236	1,249	0.025	0.022	1,256	1.61%
2012	1,378	0.025	0.002	1,379	1,394	0.028	0.025	1,401	1.58%
2013	991	0.018	0.002	992	1,002	0.018	0.018	1,007	1.50%
2014	1,128	0.020	0.002	1,129	1,142	0.021	0.020	1,147	1.58%
2015	1,283	0.023	0.002	1,284	1,297	0.024	0.028	1,305	1.62%
2016	1,075	0.019	0.002	1,076	1,086	0.020	0.065	1,104	2.57%
2017	1,114	0.019	0.003	1,116	1,125	0.020	0.081	1,147	2.74%
2018	1,027	0.018	0.002	1,028	1,037	0.020	0.060	1,053	2.40%
2019	1,369	0.024	0.002	1,371	1,383	0.027	0.044	1,395	1.74%
2020	1,243	0.022	0.002	1,244	1,251	0.024	0.052	1,266	1.75%

2021	1,002	0.018	0.002	1,003	1,007	0.019	0.046	1,020	1.68%
2022	1,522	0.027	0.003	1,523	1,532	0.029	0.060	1,549	1.69%

3.2.5.2. *Methodological issues*

Evaluation method

The IPCC "Tier 1" and "Tier 2" sectoral approach, explained in the paragraph above, was used to calculate emissions.

Emission factors

To convert physical units of fuel consumed into energy units, the net calorific value of fuel typical for the country was used (Table 3-5).

The table below shows the following default emission factors:[14].

Table 3-12. Default emission factors for stationary combustion in the energy industries (kg GHG/TJ net calorific value)

Fuel/Greenhouse Gases	CO_2	CH_4	N_2O
Natural gas	56,100	1.0	0.1
Diesel	74,100	3.0	0.6
Lignite	101,000	1	1.5

The table below shows emission factors taking into account the technology of the thermal power plant.

Table 3-13. Emission factors for thermal power plants taking into account technology for stationary combustion (kg Greenhouse gasses/TJ net calorific value)

Thermal Power Plant	Technology	Tier 2 – Specific emission factors for thermal power plants (kg/TJ energy input)		
		CO_2	CH_4	N_2O
Mtkvari	Boilers, 33-34% efficiency, natural gas	56,855	1	1
Tbilsresi	Boilers, 27-28% efficiency, natural gas	56,602	1	1
GPower	Gas turbines >3MW, 29-30% efficiency, natural gas	57,143	4	1
Gardabani Thermal Power Plant 1	Combined cycle, CCGT, 54% efficiency, natural gas	56,483	1	3
Gardabani Thermal Power Plant 2	Combined cycle, CCGT, 53.5% efficiency, natural gas	56,100	1	3
Tkibuli Thermal Power Plant	Lignite, atmospheric liquid	101,000	NA	71

Source: CO_2 emission factor, MEPA. CH_4 and N_2O emission factors (IPCC, 2006), Table 2.6

Activity data

[14] IPCC 2006, Volume 2, table 2.2 - Standard emission factors for stationary combustion in the energy industry.

Information on the energy industry was obtained from the National Statistics Office of Georgia (National Statistics Office of Georgia), the International Energy Agency, and the Ministry of Economy and Sustainable Development of Georgia.

Table 3-14. Activity data in the energy industry sector

YEAR	Crude oil (TJ)	Gas/Diesel Oil (TJ)	Lignite (TJ)	Natural Gas (dry (TJ))	Other bituminous coal (TJ)	Residual Fuel Oil (TJ)
1990	NO	736.61	NO	82,071.90	10,100	104,878.4
1991	NO	511.00	NO	49,172.00	8,700	66,280.0
1992	NO	724.00	NO	62,182.00	6,425	50,200.0
1993	NO	724.00	NO	43,967.00	1,225	35,000.0
1994	NO	563.29	NO	26,021.70	NO	33,289.6
1995	NO	384.00	NO	25,723.00	NO	37,080.0
1996	NO	NO	NO	12,921.00	NO	6,120.0
1997	NO	NO	NO	12,947.00	NO	4,720.0
1998	NO	NO	NO	16,768.00	NO	4,440.0
1999	NO	NO	NO	16,078.00	NO	3,720.0
2000	NO	259.98	NO	17,826.62	NO	3,555.2
2001	168	1,022.00	NO	16,897.75	NO	NO
2002	168	1,065.00	NO	11,978.69	NO	NO
2003	421	1,065.00	NO	13,545.88	NO	NO
2004	463	1,491.00	NO	16,973.97	NO	NO
2005	NO	2,383.15	NO	20,788.63	NO	NO
2006	253	852.00	NO	25,661.00	NO	NO
2007	NO	852.00	NO	24,334.90	NO	NO
2008	NO	725.00	NO	19,631.46	NO	NO
2009	NO	2,812.00	NO	19,598.82	NO	NO
2010	NO	2,300.39	NO	6,889.99	NO	NO
2011	NO	511.29	NO	22,008.41	NO	NO
2012	NO	NO	NO	24,557.38	NO	NO
2013	NO	NO	24.12	17,660.24	NO	NO
2014	NO	NO	20.79	20,111.55	NO	NO
2015	NO	NO	19.40	22,867.62	NO	NO
2016	NO	NO	468.86	18,386.31	NO	NO
2017	NO	NO	649.40	18,693.06	NO	NO
2018	NO	NO	370.60	17,674.08	NO	NO
2019	NO	NO	6.10	24,408.70	NO	NO
2020	NO	NO	8.40	22,157.14	NO	NO
2021	NO	NO	11.70	17,859.36	NO	NO

2022	NO	NO	11.90	27,123.99	NO	NO

3.2.5.3. *Uncertainty assessment and time series consistency*

Uncertainty assessment

See information in Annex II.

Consistency of time series

The same sources for activity data were used across time series.

3.2.5.4. *Category-appropriate quality control and assurance and verification*

Quality control procedures for the general inventory were conducted in accordance with the 2006 IPCC Guidelines. These procedures focus on verifying activity data parameters, emission factors, and archiving reference materials. Quality assurance was also carried out following IPCC guidelines and involved reviewing the text structure, completeness, clarity, as well as the accuracy and time intervals of calculations, emission factors, and activity data. A summary of quality assurance and quality control activities is provided in Chapter 1.

3.2.5.5. *A category-specific, explained and justified recalculation, a description of changes related to the inspection process and their impact on the emission trend*

Recalculations were performed for the data from the previous report (1990-2017) for several reasons:

Category 1.A.1.a.i (electricity generation): Data on natural gas consumption for 2013–2017 has been updated in the National Statistics Office's energy balance, and data for 2018–2022 has been added.

Category 1.A.1.a.iii (heat production): Missing data for 1996–2000 was reconstructed using interpolation methodology.

Category 1.A.1.c (solid fuel production and other energy industries): Missing data for 1999, 2000, and 2010–2012 was reconstructed using interpolation methodology. Additionally, the National Statistics Office's energy balance has been updated with data for 2013–2017, and data for 2018–2022 has been incorporated.

Greenhouse gas emissions from thermal power plants for 2010–2022 were not estimated due to insufficient data. Oil refineries do not consume fuel, as processing is conducted using natural sedimentation. Solid fuel production is also not estimated due to minimal activity and the absence of recorded data. Similarly, greenhouse gas emissions from other energy industry categories for 1990–1996 were not estimated due to data limitations.

*Table 3-15. Results of GHG recalculation from category 1.A.1.**

Years	GHG emissions before conversion (Gg CO2 eq.)	GHG emissions after conversion (Gg CO2 eq.)	Difference (Gg CO2 eq.)
1990	13,768	13,767	-1 (0.01%)

1991	8,773	8,772	-1 (0.01%)
1992	8,054	8,054	0 (0%)
1993	5,357	5,357	0 (0%)
1994	4,088	4,088	0 (0%)
1995	4,352	4,352	0 (0%)
1996	1,201	2,048	847 (52.14%)
1997	1,093	1,773	680 (47.45%)
1998	1,286	1,797	511 (33.15%)
1999	1,192	1,617	425 (30.26%)
2000	1,447	1,603	156 (10.23%)
2001	1,162	1,037	-125 (11.37%)
2002	783	764	-19 (2.46%)
2003	813	871	58 (6.89%)
2004	1,019	1,098	79 (7.46%)
2005	1,200	1,345	145 (11.39%)
2006	1,523	1,523	0 (0%)
2007	1,755	1,430	-325 (20.41%)
2008	976	1,156	180 (16.89%)
2009	1,354	1,310	-44 (3.3%)
2010	560	693	133 (21.23%)
2011	1,274	1,365	91 (6.9%)
2012	1,379	1,426	47 (3.35%)
2013	1,000	994	-6 (0.6%)
2014	1,534	1,131	-403 (30.24%)
2015	1,622	1,286	-336 (23.11%)
2016	1,473	1,078	-395 (30.97%)
2017	1,533	1,117	-416 (31.4%)

* Emissions were recalculated using updated global warming potential (GWP) values. Instead of the previous values of 21 for methane (CH_4) and 310 for nitrous oxide (N_2O), the revised values of 28 and 265, respectively, were applied.

3.2.6. *Manufacturing industries and construction (1.A.2.)*

3.2.6.1. *Source category description and calculated emissions*

Manufacturing industries and the construction sub-sector, comprise emissions produced by the burning of fuel from various industries, such as cast iron and steel production, ferroalloys, chemicals, paper, food products, drinks and tobacco production, etc., as well as emissions from construction materials production.

Following the collapse of the Soviet Union, nearly a third of Georgia's factories ceased production. However, since 1995, political stabilization and the establishment of new industrial partnerships have led to relative stability in key industrial indicators and GDP growth.

Georgia's heavy industry plays a crucial role in exports, employment, and overall economic value. In 2023, the manufacturing and construction sectors contributed 17.8% and 12% to GDP, respectively, while together accounting for 17.6% of national employment[15]. The most significant subsectors of heavy industry include the production of ferroalloys, steel/iron, fertilizers, and cement.

Four plants operate in ferroalloy production: Georgian Manganese[16] (also known as Zestaponi Ferroalloy Plant), Ruseloisi[17], Rusmetali[18] and GTM Group[19]. The Zestaponi Ferroalloy Plant is the largest producer of silicon-manganese, with an annual output of nearly 200,000 tons.

Fertilizers are among Georgia's top export products. Rustavi Azoti20 is the largest chemical enterprise in the Transcaucasus, specializing in the production of mineral fertilizers and industrial chemicals.

Heidelberg Cement, the largest non-metallic construction materials company in Georgia, operates three cement factories—one in Kaspi and two in Rustavi. The company's annual production capacity is approximately 2 million tons of cement, 1.9 million tons of clinker, and 1 million tons of concrete.[21].

Steel and iron[22] production in Georgia is concentrated in three factories: Geosteel[23], Rustavi Metallurgical Plant[24], and Iberia Steel. These factories produce steel by melting scrap and slag in electric furnaces. The majority of steel production (80-85%) comes from secondary steel production, where scrap metal is melted and reused.

In 2022, the construction sector contributed 5 billion GEL in value added, accounting for 8% of Georgia's GDP. Over the past decade, the sector's share in GDP has remained relatively stable at around 8%. Between 2013 and 2017, Georgia's economy grew at an average annual rate of 3.8%, while the construction sector experienced a significantly higher average growth rate of 12.8%.

However, in 2018, the construction sector saw a 7.2% decline, followed by a modest 0.7% increase in 2019. This two-year slowdown was primarily driven by stricter construction and banking regulations. In 2020, the sector declined further by 8%, and in 2021, a sharp 24% decline was recorded. Despite government subsidies aimed at supporting the sector during the pandemic, a significant downturn persisted. In the post-pandemic period, the construction industry rebounded strongly, recording a 14.8% growth in 2022[25].

Table 3-16 presents data on GhGs emissions from the manufacturing and construction. Between 1990 and 2022, emissions from these sources decreased by approximately fourfold.

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15 National Statistics Office - www.geostat.ge
16 „Georgian Manganese" - www.gm.ge
17 „Ruseloisi" - www.rusalloys.com
18 „Rusmetali" - www.rusmetali.com
19 Ferroalloy Plant - www.gtmgroup.ge
20 Rustavi Azot - www.rustaviazot.ge
21 „Heidelbergcement "Georgia - www.heidelbergcement.ge
22 According to the 2006 IPCC Guidelines, emissions from fuel combustion in coke ovens in iron and steel production should be considered under the category of other energy industries (1.A1.c.ii) and not under the category of manufacturing industries (1.A.2).
23 „Geosteel "- www.geosteel.com.ge
24 Rustavi Metallurgical Plant- www.rmp.ge
25 https://forbes.ge/saqarthvelos-samsheneblo-seqtoris-machveneblebi-da-tendentsiebi/

Table 3-16. GHGs Emissions from the Manufacturing Industries and Construction (Gg)

Year	CO_2 Gg	CH_4	CH_4 in CO_{2eq}	N_2O	N_2O in CO_{2eq}	Total in CO_{2eq}
1990	7,535	0.450	12.591	0.070	18.434	7,566
1991	6,463	0.254	7.102	0.038	10.117	6,480
1992	3,851	0.152	4.250	0.020	5.209	3,861
1993	2,968	0.114	3.183	0.017	4.403	2,976
1994	2,146	0.116	3.259	0.017	4.437	2,153
1995	985	0.036	0.997	0.005	1.408	987
1996	1,212	0.055	1.554	0.008	2.078	1,216
1997	814	0.054	1.514	0.008	2.047	817
1998	518	0.054	1.511	0.008	2.075	522
1999	289	0.049	1.363	0.007	1.829	292
2000	684	0.064	1.803	0.009	2.358	689
2001	327	0.058	1.626	0.008	2.121	331
2002	266	0.056	1.554	0.008	2.015	269
2003	243	0.052	1.461	0.007	1.876	246
2004	256	0.052	1.462	0.007	1.862	259
2005	302	0.009	0.260	0.001	0.347	303
2006	424	0.010	0.291	0.001	0.360	425
2007	482	0.011	0.307	0.001	0.393	483
2008	626	0.023	0.633	0.003	0.850	628
2009	636	0.024	0.663	0.003	0.888	638
2010	796	0.043	1.217	0.006	1.709	799
2011	1,154	0.078	2.194	0.012	3.107	1,160
2012	1,513	0.110	3.069	0.016	4.371	1,520
2013	1,912	0.147	4.115	0.022	5.873	1,922
2014	1,805	0.137	3.823	0.021	5.451	1,814
2015	1,847	0.133	3.727	0.020	5.339	1,856
2016	1,652	0.121	3.392	0.018	4.828	1,660
2017	1,774	0.125	3.506	0.019	5.003	1,783
2018	1,881	0.135	3.788	0.020	5.422	1,891
2019	1,688	0.114	3.194	0.017	4.591	1,695
2020	1,585	0.103	2.889	0.016	4.134	1,592
2021	1,634	0.108	3.013	0.016	4.330	1,641
2022	1,787	0.114	3.181	0.017	4.583	1,795

3.2.6.2. *Methodological issues*

Evaluation method

The IPCC "Tier 1" sectoral approach was used to calculate emissions. Due to the absence of specialized laboratories and relevant data, it is not feasible to perform higher-tier emission calculations.

Emission factors

The country-specific net calorific value of fuel was used to convert physical units of fuel consumed into energy units (Table 3-5). Standard emission factors are presented in Table 3-17.[26].

Table 3-17. Default Emission Factors for Stationary Combustion in Manufacturing Industries and Construction (1.A.2.) (kg/TJ on a Net Calorific Basis)

Fuel/GHGs	CO_2	CH_4	N_2O
Natural gass	56,100	1	0.1
Diesel	74,100	3	0.6
Anthracite	98,300	10	1.5
Other bituminous coal	94,600	10	1.5
Lignite	101,000	10	1.5
Liquefied petroleum gases	63,100	1	0.1
Kerosene	71,900	3	0.6
Residual fuel oil	77,400	3	0.6
Wood/Wood Waste	112,000	30	4
Other primary solid biomass	100,000	30	4
Coke oven gas	107,000	10	1.5
Charcoal	112,000	200	4

Activity Data

The fuel consumption data for the manufacturing industry and construction subsectors from 1990 to 2022 were obtained from the National Statistics Office of Georgia (Geostat) and the International Energy Agency.

Table 3-18. Activity data in the manufacturing industries and construction subsector

GAS/ SUBSECTORS	Anthracite (TJ)	Coke oven coke (TJ)	Coking coal (TJ)	Gas/diesel oil (TJ)	Lignite (TJ)	Liquefied petroleum gas (LPG)	Motor gasoline (TJ)	Natural gas (dry) (TJ)	Other bituminous coal (TJ)	Other kerosene (TJ)	Other petroleum products (TJ)	Other primary solid biomass (TJ)	Patent fuel (TJ)	Residual fuel oil (TJ)	Wood/ wood waste (TJ)
1990	NO	23,858.34	NO	519.96	7,225.00	NO	88.00	35,789.55	2,500.00	561.73	NO	NO	NO	24,846.00	NO
1991	NO	NO	9,856.00	4,516.00	NO	NO	88.00	64,139.00	2,425.00	430.00	NO	NO	NO	17,200.00	NO
1992	NO	NO	3,968.00	1,576.00	NO	NO	88.00	44,595.45	2,125.00	430.00	NO	NO	NO	8,000.00	NO
1993	NO	NO	3,200.00	2,044.00	NO	NO	88.00	33,198.55	900.00	430.00	NO	NO	NO	6,840.00	376.00
1994	NO	1,758.60	NO	1,343.23	204.00	NO	352.00	22,227.10	2,150.00	259.26	NO	NO	NO	4,444.00	1,128.00
1995	NO	NO	192.00	724.00	NO	NO	748.00	8,165.65	275.00	NO	NO	NO	NO	2,320.00	380.00
1996	NO	NO	NO	2,684.00	NO	NO	1,584.00	15,194.00	475.00	NO	NO	NO	NO	80.00	750.00
1997	NO	NO	NO	2,045.00	NO	NO	1,716.00	9,052.00	375.00	NO	NO	NO	NO	NO	1,000.00
1998	NO	NO	480.00	1,917.00	NO	NO	1,012.00	3,900.00	150.00	NO	NO	NO	NO	360.00	1,130.00

[26] IPCC 2006, Volume 2, Table 2.3 - Standard emission factors for stationary combustion in manufacturing industries and construction

1999	NO	NO	NO	1,406.00	NO	NO	704.00	2,030.25	NO	NO	NO	NO	NO	280.00	1,316.00
2000	NO	NO	NO	953.26	NO	NO	1,584.00	8,254.80	300.00	NO	NO	NO	NO	161.60	1,501.00
2001	NO	477.00	NO	554.00	NO	NO	NO	2,937.00	150.00	NO	NO	NO	NO	720.00	1,501.00
2002	NO	427.00	NO	639.00	NO	NO	NO	2,455.00	75.00	NO	NO	NO	NO	360.00	1,501.00
2003	NO	NO	NO	554.00	NO	NO	NO	2,788.00	150.00	NO	NO	NO	NO	400.00	1,501.00
2004	NO	NO	NO	85.00	NO	NO	NO	3,265.00	175.00	NO	NO	NO	NO	640.00	1,501.00
2005	NO	NO	NO	86.66	NO	NO	NO	3,833.10	325.00	NO	NO	NO	NO	646.40	NO
2006	NO	NO	NO	85.00	NO	NO	NO	6,223.00	200.00	NO	NO	NO	NO	640.00	NO
2007	NO	NO	NO	85.00	NO	NO	NO	6,858.00	50.00	NO	NO	NO	NO	1,120.00	NO
2008	NO	NO	NO	85.00	NO	NO	NO	7,497.00	1,125.00	NO	NO	NO	NO	1,200.00	NO
2009	NO	NO	NO	NO	NO	NO	NO	7,574.00	1,250.00	NO	NO	NO	NO	1,200.00	NO
2010	NO	2,835.35	NO	NO	1,030.88	NO	262.24	5,692.39	1,683.35	NO	NO	NO	NO	19.39	NO
2011	NO	3,778.72	NO	NO	5,141.82	NO	766.94	8,118.85	2,026.46	NO	NO	NO	NO	252.68	NO
2012	NO	3,828.19	NO	2,482.72	7,076.51	NO	376.00	8,945.86	1,892.42	21.61	NO	NO	NO	52.00	10.00
2013	218.97	4,257.68	NO	2,506.10	6,923.76	NO	375.14	6,304.80	1,760.00	8.64	NO	NO	NO	35.18	8.76
2014	76.84	3,943.68	NO	2,787.24	4,999.80	0.80	NO	6,582.90	3,058.13	0.07	NO	0.20	34.73	22.90	13.25
2015	68.40	3,180.60	NO	3,422.80	5,097.00	11.10	NO	7,508.80	2,960.30	NO	391.90	3.50	NO	11.80	31.00
2016	55.69	3,701.27	NO	3,195.90	4,349.28	1.35	NO	6,881.10	2,290.00	NO	286.90	NO	NO	20.50	63.18
2017	167.07	3,104.66	NO	3,411.79	3,807.83	NO	NO	8,116.70	3,439.50	NO	57.00	0.24	NO	40.20	46.02
2018	177.30	3,674.81	NO	3,957.00	1,960.10	3.70	NO	8,079.80	5,477.50	NO	NO	NO	NO	101.70	70.90
2019	210.40	2,941.98	NO	4,312.80	56.40	12.50	NO	8,267.80	5,937.10	NO	NO	NO	NO	6.80	46.10
2020	132.20	2,185.12	NO	3,851.70	1,423.00	6.10	NO	8,704.90	4,424.10	NO	NO	2.80	NO	27.50	36.30
2021	72.30	3,302.35	NO	4,179.20	2,548.60	6.60	NO	8,158.20	2,607.60	NO	NO	NO	NO	15.70	52.20
2022	149.60	3,003.77	NO	4,914.10	2,389.50	1.20	NO	9,436.40	3,327.80	NO	NO	NO	NO	17.80	21.80

3.2.6.3. *Uncertainties and Consistency of time series*

Uncertainty assessment

See information in Annex II.

Consistency of time series

The same sources for activity data were used across time periods.

3.2.6.4. *Category-appropriate quality control and assurance and verification*

Quality control procedures for the general inventory were conducted in accordance with the 2006 IPCC Guidelines. These procedures focused on verifying activity data parameters, emission factors, and archiving reference materials. Quality assurance measures, also aligned with IPCC guidelines, involved reviewing text structure, completeness, clarity, and ensuring the accuracy and consistency of calculations, emission factors, and activity data over time. A summary of quality assurance and quality control activities is provided in Chapter 1.

3.2.6.5. *A category-specific, explained and justified recalculation, a description of changes related to the verification process and the impact on the emission trend*

Recalculations were performed for data from the previous report (1990-2017) for several reasons:

The National Statistics Office's energy balance was updated with revised data for 2013-2017, and new data for 2018-2022 was added.

- In **category 1.A.2.a** (Iron and Steel), missing data for 2010-2012 was restored using the interpolation methodology.

- In **category 1.A.2.c** (Chemicals), missing data for 1996, 2000-2005, and 2010-2012 was restored using the interpolation methodology.

- In **category 1.A.2.d** (Pulp, Paper and Print), missing data for 2006-2012 was restored using the interpolation methodology.

- In **category 1.A.2.e** (Food Processing, Beverages and Tobacco), missing data for 2009-2012 was restored using the interpolation methodology.

- In **category 1.A.2.f** (Non-Metallic Minerals), missing data for 2010-2012 was restored using the interpolation methodology.

- In **category 1.A.2.g** (Transport Equipment), missing data for 2006-2012 was restored using the interpolation methodology.

- In **category 1.A.2.h** (Machinery), missing data for 2006-2012 was restored using the interpolation methodology.

- In **category 1.A.2.k** (Construction), missing data for 1995 and 2009-2012 was restored using the interpolation methodology.

- In **category 1.A.2.l** (Textile and Leather), missing data for 1990, 1991, 1993-2000, and 2006-2012 was restored using the interpolation methodology.

- In **category 1.A.2.m** (Non-specified Industry), emissions data provided by the International Energy Agency for 2010-2012 ranged from 900-2000 CO_2 Gg, whereas emissions in previous and subsequent years fluctuated between 200-300 and 1-3 CO_2 Gg. Given this inconsistency, the International Energy Agency's data for 2010-2012 was deemed unreliable, and new values were estimated using the interpolation methodology.

Greenhouse gas emissions for the following sectors were not estimated due to insufficient data:

- 1990-2000: Cast Iron and Steel (1.A.2.a), Cellulose, Paper, and Printing Activities (1.A.2.d), Food Products, Beverages, and Tobacco (1.A.2.e), Non-Metallic Mineral Products (1.A.2.f), Transport Equipment (1.A.2.g), and Machinery and Equipment (1.A.2.h).
- 1990-2012: Mining (1.A.2.i) and Wood and Wood Products (1.A.2.j).

During the 1990s, Georgia faced a fragile and unstable political and economic situation, making it difficult to reconstruct multi-year data using existing interpolation methodologies.

In this document, emissions from fuel combustion in coke ovens are categorized under the iron and steel industry (1.A.2.a). This differs from the fourth inventory report, where these emissions were attributed to the energy activity category (1.A.1.c). According to the 2006 IPCC Guidelines, emissions from fuel combustion in coke ovens used for electricity generation within the iron and steel industry (1.A.2.a) should be classified under the other energy activity category (1.A.1.c) rather than the manufacturing industry.27 However, in Georgia, Rustavi Azoti is the only facility that produces its own electricity, and it belongs to the chemical industry, not the iron and steel industry. Therefore, emissions from fuel combustion in coke ovens should be classified under the manufacturing industry.

*Table 3-19. Results of GHG recalculation from category 1.A.2.**

Year	GHG emissions before conversion (Gg CO_2 eq.)	GHG emissions after conversion (Gg CO_2 eq.)	Difference (Gg CO_2 eq.)
1990	7,566	7,566	0 (0.00%)
1991	6,480	6,480	0 (0%)
1992	3,860	3,861	1 (0.03%)
1993	2,976	2,976	0 (0%)
1994	2,153	2,153	0 (0%)
1995	790	987	197 (22.17%)
1996	1,216	1,216	0 (0%)
1997	817	817	0 (0%)
1998	522	522	0 (0%)
1999	292	292	0 (0%)
2000	688	689	1 (0.15%)
2001	279	331	52 (17.05%)
2002	223	269	46 (18.7%)
2003	246	246	0 (0%)
2004	259	259	0 (0%)
2005	303	303	0 (0%)
2006	424	425	1 (0.24%)
2007	483	483	0 (0%)
2008	628	628	0 (0%)
2009	637	638	1 (0.16%)
2010	910	799	-111 (12.99%)
2011	1,652	1,160	-492 (34.99%)
2012	2,031	1,520	-511 (28.78%)
2013	1,514	1,922	408 (23.75%)
2014	1,026	1,814	788 (55.49%)
2015	1,064	1,856	792 (54.25%)
2016	915	1,660	745 (57.86%)
2017	1,015	1,783	768 (54.9%)

27 IPCC 2006, Table 8.2

**Emissions were recalculated using updated global warming potential (GWP) values. Instead of the previous values of 21 for methane (CH_4) and 310 for nitrous oxide (N_2O), the revised values of 28 and 265, respectively, were applied.*

3.2.7. *Transport (1.A.3.)*

3.2.7.1. *Source category description and calculated emissions*

Georgia serves as a transport hub for the South Caucasus region (Georgia, Armenia, and Azerbaijan) and Central Asia (Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan), providing key transit routes to Russia, Turkey, and Europe via the Black Sea. The country's oil and gas pipelines, Black Sea ports, railway network, and airports—which offer direct air routes to 20 destinations—play a crucial role in connecting the East and the West.

As in most countries, the transport sector in Georgia is one of the major sources of GHG emissions. Consequently, significant attention is given to inventorying emissions from this sector and implementing emission reduction measures.

The growth of transport sector emissions in Georgia is primarily driven by several factors:

- The annual increase in the vehicle fleet
- The high share of used cars in the fleet
- The expansion of transit traffic

As a transit country, Georgia has seen a rise in transit trucks, which consume fuel purchased within its territory. This, along with the growing local vehicle fleet, has led to an increase not only in carbon dioxide (CO_2) and other greenhouse gases but also in local air pollutants, which pose serious risks to human health.

Additionally, energy transit pipelines pass through Georgia, including the Baku-Tbilisi-Supsa oil pipeline, Baku-Tbilisi-Ceyhan oil pipeline, and the South Caucasus gas pipeline. The operator, British Petroleum (BP), consumes natural gas and diesel at substations to operate these pipelines.

The Georgian GHG inventory for the transport sector includes road transport, rail transport, civil aviation, inland navigation, and pipelines. Trends in greenhouse gas emissions from the sector are presented in Tables 3-20 and 3-21. As shown in the tables, carbon dioxide (CO_2) remains the dominant greenhouse gas, accounting for 97.9% of total emissions in 2022, similar to other fuel combustion source categories.

Table 3-20. GHG Emissions from the Transport Sector (Gg)

Year	CO_2 Gg	CH_4 Gg	CH_4 Gg CO_{2eq}	N_2O Gg	N_2O in Gg CO_{2eq}	Total in Gg CO_{2eq}
1990	4,412	1.309	36.65	0.212	56.291	4,504
1991	3,383	1.096	30.694	0.160	42.511	3,456
1992	2,758	0.823	23.041	0.134	35.534	2,817
1993	2,261	0.668	18.706	0.114	30.086	2,309
1994	1,613	0.428	11.990	0.076	20.146	1,645
1995	1,059	0.220	6.156	0.045	11.870	1,077

1996	2,676	1.082	30.306	0.125	33.100	2,740
1997	2,188	0.914	25.601	0.102	27.111	2,241
1998	1,423	0.538	15.062	0.065	17.317	1,456
1999	1,263	0.476	13.335	0.058	15.462	1,292
2000	1,052	0.348	9.745	0.049	13.008	1,075
2001	1,195	0.496	13.885	0.056	14.763	1,223
2002	1,252	0.510	14.276	0.059	15.749	1,282
2003	1,280	0.521	14.587	0.062	16.322	1,311
2004	1,244	0.474	13.278	0.061	16.227	1,274
2005	1,555	0.561	15.696	0.077	20.486	1,592
2006	1,617	0.563	15.772	0.081	21.533	1,654
2007	2,021	0.697	19.522	0.102	26.909	2,067
2008	1,732	0.614	17.190	0.088	23.378	1,772
2009	2,109	0.607	16.996	0.110	29.100	2,155
2010	2,390	0.620	17.360	0.116	30.856	2,438
2011	2,514	0.682	19.082	0.122	32.207	2,565
2012	2,623	0.743	20.801	0.129	34.159	2,678
2013	3,115	1.445	40.467	0.156	41.455	3,197
2014	3,504	1.747	48.906	0.176	46.689	3,600
2015	3,842	1.864	52.190	0.189	50.010	3,944
2016	4,326	1.845	51.654	0.216	57.159	4,434
2017	3,863	1.684	47.144	0.194	51.329	3,962
2018	3,760	1.620	45.364	0.185	48.910	3,854
2019	3,905	1.554	43.506	0.187	49.454	3,998
2020	3,776	1.376	38.542	0.169	44.679	3,859
2021	4,168	1.443	40.405	0.179	47.355	4,256
2022	4,404	1.705	47.746	0.183	48.368	4,500

Greenhouse gas emissions by sub-category for 1990-2022 are presented by sub-sector in Table 3-21. The road transport sub-sector is the dominant source of emissions, accounting for 85% of total transport emissions in 2022. Since Georgia's railway transport is almost entirely electrified, its contribution to greenhouse gas emissions remains minimal. Due to insufficient data, greenhouse gas emissions from civil aviation (1990-2010) and inland navigation (1990-2011) were not estimated.

Table 3-21. GHGs Emissions from Transport Sub-Categories (Gg CO2 eq)

Year	1.A.3.a Civil aviation total CO_{2eq} Gg	1.A.3.b Road transportation total CO_{2eq} Gg	1.A.3.c Railways total CO_{2eq} Gg	1.A.3.d National Navigation Total CO_{2eq} Gg	1.A.3.e Other Transportation (pipelines, off-road) Total CO_{2eq} Gg	Total CO_{2eq} Gg from the sector
1990	NE	4,276	128.1	NE	100.1	4,504
1991	NE	3,222	133.6	NE	100.1	3,456
1992	NE	2,646	65.2	NE	105.1	2,817
1993	NE	2,218	36.2	NE	54.7	2,309
1994	NE	1,466	126.7	NE	52.6	1,645
1995	NE	851	202.8	NE	23.5	1,077
1996	NE	2,697	37.4	NE	5.1	2,740
1997	NE	2,224	12.1	NE	4.8	2,241

1998	NE	1,399	50.8	NE	5.9	1,456
1999	NE	1,251	34.2	NE	7.0	1,292
2000	NE	1,035	31.4	NE	8.2	1,075
2001	NE	1,183	31.4	NE	9.3	1,223
2002	NE	1,243	31.5	NE	7.8	1,282
2003	NE	1,271	31.5	NE	8.9	1,311
2004	NE	1,232	31.6	NE	10.4	1,274
2005	NE	1,544	31.6	NE	15.8	1,592
2006	NE	1,601	31.7	NE	21.2	1,654
2007	NE	2,010	31.7	NE	25.4	2,067
2008	NE	1,713	31.7	NE	27.5	1,772
2009	NE	2,113	31.8	NE	10.6	2,155
2010	NE	2,216	31.8	NE	190.2	2,438
2011	1.8	2,317	31.9	NE	215.1	2,565
2012	1.8	2,436	31.8	4.2	203.9	2,678
2013	2.2	2,963	32.0	4.1	195.3	3,197
2014	2.5	3,327	36.6	3.1	230.8	3,600
2015	2.1	3,693	20.4	2.9	226.3	3,944
2016	3.4	4,171	36.6	3.7	220.2	4,434
2017	1.9	3,727	37.3	5.0	191.2	3,962
2018	0.9	3,548	37.4	4.8	263.0	3,854
2019	1.9	3,641	34.6	4.6	316.0	3,998
2020	0.3	3,484	6.9	4.1	364.0	3,859
2021	1.9	3,718	6.4	3.7	526.6	4,256
2022	1.5	3,830	4.4	4.2	659.4	4,500

3.2.7.2. *Methodological Issues*

Evaluation method

Emissions from the transport sector across all subcategories were calculated using the IPCC "Tier 1" sectoral approach. Carbon dioxide (CO_2) emissions were estimated based on fuel consumption statistics using the "Tier 1" ("top-down") approach, as the CO_2 emission factor depends solely on the type of fuel consumed rather than the type of transport used. In contrast, methane (CH_4) and nitrous oxide (N_2O) emissions are influenced by several factors, including vehicle type, catalyst type, and operating conditions. For these gases, higher-tier methodologies are recommended for more accurate estimation. However, due to the lack of detailed data in Georgia, the "Tier 1" sectoral approach is applied for all greenhouse gases.

Emission factor

To convert physical units of fuel consumption to energy units, the country-specific net calorific value was used (Table 3-5). The following standard emission factors are given in Table 3-22.[28].

Table 3-22. Default Emission Factors for Mobile category (kg/TJ on a Net Calorific Basis)

Fuels/GHGs	CO_2	CH_4	N_2O
Civil Aviation			
Jet Kerosene	71,500	0.5	2
Road Transportation			

[28] IPCC 2006, Volume 2, Tables 3.2.1, 3.2.2, - Standard emission factors for CO2, CH4, N2O from road transport

Gasoline	69,300	33	3.2
Diesel	74,100	3.9	3.9
Natural Gas	56,100	92	3
LPG	63,100	62	0.2
Railways			
Sub-bituminous Coal	96,100	2	1.5
Other Petroleum Products	NA	5	0.6
Water-borne Navigation			
Diesel	74,100	7	2
Pipelines			
Natural Gas	56,100	1	0.1
Diesel	74,100	3	0.6
Off-Road			
Gasoline	69,300	80	2
Diesel	74,100	4.15	28.6

Activity data

Information on the transport subsector was obtained from the National Statistics Office of Georgia (Geostat), the International Energy Agency, and the seaports of Batumi and Poti.

Table 3-23. Activity data in the transport subsector

Year	Gas/Diesel oil (TJ)	Jet Kerosene (TJ)	Lignite (TJ)	Liquefied petroleum gas (LPG) (TJ)	Motor Gasoline (TJ)	Natural gas (dry)(TJ)	Natural gas liquids(NGL)(TJ)	Other petroleum products (TJ)	Residual fuel oil (TJ)	Semi-bituminous coal (TJ)
1990	776.26	8,512.37	NO	3.00	824.00	1,405.80	NO	NO	1,089.00	450
1991	1590.00	8,256.00	NO	3.00	702.00	1,406.00	NO	NO	5,240.00	450
1992	1292.00	7,095.00	NO	2.00	520.00	1,496.00	NO	NO	3,200.00	450
1993	960.00	5,418.00	NO	2.00	419.00	599.00	NO	NO	2,320.00	150
1994	720.60	2,765.44	NO	1.00	258.00	747.90	NO	NO	3,032.00	300
1995	492.00	172.00	NO	NO	115.00	NO	NO	NO	4,320.00	NO
1996	131.00	3,354.00	NO	NO	722.00	90.00	NO	NO	480.00	NO
1997	89.00	2,967.00	NO	NO	615.00	85.00	NO	NO	NO	125
1998	86.00	4,128.00	NO	NO	356.00	NO	NO	NO	560.00	75
1999	80.00	3,483.00	NO	NO	315.00	NO	NO	NO	440.00	NO
2000	101.00	648.15	NO	NO	225.00	NO	NO	404	NO	NO
2001	57.00	559.00	NO	NO	311.00	487.00	NO	NO	NO	NO
2002	874.00	989.00	NO	NO	323.00	407.00	NO	NO	NO	NO
2003	68.00	1,118.00	NO	NO	328.00	462.00	NO	NO	NO	NO
2004	92.00	1,591.00	NO	NO	290.00	541.00	NO	NO	NO	NO
2005	143.00	1,598.77	NO	NO	334.00	502.00	NO	NO	NO	NO
2006	165.00	1,591.00	NO	NO	328.00	963.00	NO	NO	NO	NO
2007	211.00	2,021.00	18	NO	409.00	1,122.00	NO	NO	NO	NO
2008	174.00	1,720.00	NO	NO	351.00	1,244.00	NO	NO	NO	NO
2009	304.00	1,720.00	NO	NO	350.00	649.00	NO	NO	NO	NO
2010	628.91	1,773.09	NO	NO	350.00	3,503.31	NO	NO	NO	NO
2011	600.00	2,290.13	NO	NO	399.00	3,878.55	NO	NO	NO	NO
2012	1054.50	2,973.71	NO	NO	424.00	3,931.28	NO	NO	NO	NO

2013	17,413.72	3,687.31	NO	93.60	16,434.60	12,078.40	NO	NO	NO	NO
2014	19,845.11	3,504.20	NO	94.50	16,746.60	15,442.80	NO	NO	17.39	NO
2015	22,357.52	3,031.10	NO	11.50	18,602.30	15,982.70	NO	NO	18.90	NO
2016	24,009.53	3,095.13	NO	31.50	26,250.80	12,874.90	NO	NO	18.09	NO
2017	21,084.86	4,112.95	NO	128.80	23,553.20	3,405.50	8,848.70	NO	18.49	NO
2018	19,042.99	4,420.40	NO	165.60	23,706.30	12,448.60	NO	NO	19.30	NO
2019	20,342.59	4,371.90	NO	793.90	24,173.30	12,055.50	NO	NO	10.00	NO
2020	19,649.79	2,381.20	NO	925.30	23,911.30	10,965.10	NO	NO	15.10	NO
2021	20,558.42	4,085.80	NO	1,306.70	26,181.80	13,451.60	NO	NO	10.80	NO
2022	19,066.34	5,716.00	NO	1,703.00	26,830.10	18,409.30	NO	NO	NO	NO

3.2.7.3. *Uncertainties and Consistency of time series*

Uncertainty assessment

See information in Annex II.

Consistency of time series

The same sources for activity data were used across time series.

3.2.7.4. *Category-appropriate quality control and assurance and verification*

Quality control procedures for the general inventory were conducted in accordance with the 2006 IPCC Guidelines. These procedures focused on verifying activity data parameters, emission factors, and archiving reference materials. Quality assurance measures, also aligned with IPCC guidelines, involved reviewing text structure, completeness, clarity, and ensuring the accuracy and consistency of calculations, emission factors, and activity data over time. A summary of quality assurance and quality control activities is provided in Chapter 1.

3.2.7.5. *A category-specific, explained and justified recalculation, a description of changes related to the verification process and the impact on the emission trend*

Recalculations were performed for data from the previous report (1990-2017) for several reasons:

- The National Statistics Office's energy balance was updated with revised data for 2013-2017, and new data for 2018-2022 was added.

- In **category 1.A.3.a** (Civil Aviation), fuel consumption data from the International Energy Agency indicated that emissions in 2011 were 55.61 Gg CO_2, while emissions in subsequent years ranged between 1.7-3.5 Gg CO_2. Due to this inconsistency, the 2011 data was deemed unreliable, and the 2012 values were copied into the 2011 field.

- In **category 1.A.3.b** (Road Transportation), based on recommendations, motor gasoline previously categorized under Private and Public Services (1.A.4.a) and Households (1.A.4.b) was fully reallocated to road transport.

- In **category 1.A.3.c** (Railways), missing data for 2001-2011 was restored using interpolation methodology. While interpolation is typically used for smaller intervals, the similarity in data from preceding (1999-2000) and subsequent (2012-2013) years suggests a stable trend. Therefore, we assume that data variability in the 2001-2011 period aligns with both previous and following years.

- In **category 1.A.3.d** (Water-borne Navigation), emissions for 2014-2022 were recalculated using fuel consumption data from the ports of Poti and Batumi.

- In **category 1.A.3.e** (Other Transportation – Pipelines, Off-Road), missing pipeline data for 1995, 1998, 1999, 2000, and 2005 was restored using interpolation methodology.

*Table 3-24. Results of GHG recalculation from category 1.A.3.**

Years	GHG emissions before recalculation (Gg CO2 eq.)	GHG emissions after recalculation (Gg CO2 eq.)	Difference (Gg CO2 eq.)
1990	3,823	4,504	681 (16.36%)
1991	2,767	3,456	689 (22.14%)
1992	2,353	2,817	464 (17.95%)
1993	2,004	2,309	305 (14.14%)
1994	1,419	1,645	226 (14.75%)
1995	845	1,077	232 (24.14%)
1996	2,512	2,740	228 (8.68%)
1997	1,933	2,241	308 (14.76%)
1998	1,230	1,456	226 (16.83%)
1999	1,116	1,292	176 (14.62%)
2000	945	1,075	130 (12.87%)
2001	1,181	1,223	42 (3.49%)
2002	1,242	1,282	40 (3.17%)
2003	1,268	1,311	43 (3.33%)
2004	1,230	1,274	44 (3.51%)
2005	1,537	1,592	55 (3.52%)
2006	1,607	1,654	47 (2.88%)
2007	2,016	2,067	51 (2.5%)
2008	1,723	1,772	49 (2.8%)
2009	2,104	2,155	51 (2.39%)
2010	2,579	2,438	-141 (5.62%)
2011	2,563	2,565	2 (0.08%)
2012	2,672	2,678	6 (0.22%)
2013	3,301	3,197	-104 (3.2%)
2014	3,735	3,600	-135 (3.68%)
2015	4,139	3,944	-195 (4.82%)

2016	4,658	4,434	-224 (4.93%)
2017	4,143	3,962	-181 (4.47%)

** Emissions were recalculated using updated global warming potential (GWP) values. Instead of the previous values of 21 for methane (CH_4) and 310 for nitrous oxide (N_2O), the revised values of 28 and 265, respectively, were applied..*

3.2.8. *Other sectors (1.A.4.)*

3.2.8.1. *Source category description and calculated emissions*

Emissions from this source category include the following subsectors:

- Commercial and Public Services (1.A.4.a);
- Residential (1.A.4.b);
- Agriculture, Fishing and Forestry (1.A.4.c).

Greenhouse gas emissions from this source category are presented in Table 3-25. Compared to other source categories, the share of methane (2.4% in 2022) and nitrous oxide (0.4% in 2022) is relatively high, primarily due to the significant consumption of firewood in the residential sector.

Table 3-25. GHG Emissions from The Other Sectors (Gg)

Year/gas	CO2 gg	CH4 gg	CH4 CO2equiv.gg	N2O gg	N2O CO2equiv.gg	Total CO2equiv.gg
1990	5,283	5.485	153.584	0.081	21.426	5,458
1991	4,847	6.247	174.929	0.092	24.438	5,047
1992	4,686	9.286	260.022	0.130	34.464	4,980
1993	4,769	13.681	383.075	0.191	50.633	5,203
1994	2,265	4.234	118.563	0.058	15.496	2,399
1995	860	8.575	240.102	0.117	31.047	1,131
1996	937	11.941	334.346	0.162	42.996	1,314
1997	1,177	9.668	270.701	0.132	35.091	1,483
1998	1,339	8.693	243.396	0.120	31.851	1,614
1999	1,145	8.292	232.170	0.113	30.016	1,407
2000	1,228	7.870	220.356	0.107	28.455	1,477
2001	735	7.764	217.386	0.105	27.924	980
2002	592	7.811	218.716	0.105	27.893	838
2003	623	7.879	220.610	0.106	28.097	872
2004	745	7.962	222.940	0.107	28.450	996
2005	970	4.506	126.161	0.062	16.392	1,112
2006	970	4.824	135.083	0.066	17.514	1,123
2007	1,128	5.149	144.162	0.071	18.775	1,291
2008	1,252	4.961	138.916	0.068	18.123	1,409
2009	1,074	4.957	138.806	0.068	18.129	1,231
2010	1,592	4.955	138.728	0.066	17.512	1,749
2011	1,880	4.094	114.635	0.058	15.445	2,010

2012	1,748	3.891	108.936	0.054	14.304	1,871
2013	1,453	6.176	172.921	0.083	22.111	1,648
2014	1,679	5.993	167.793	0.081	21.497	1,869
2015	1,842	5.166	144.649	0.070	18.646	2,005
2016	2,058	5.037	141.034	0.069	18.214	2,217
2017	2,278	4.766	133.442	0.065	17.291	2,429
2018	2,213	3.582	100.305	0.049	13.057	2,327
2019	2,491	3.292	92.178	0.057	15.193	2,599
2020	2,648	3.084	86.355	0.051	13.452	2747
2021	3,009	3.207	89.807	0.054	14.224	3113
2022	3,234	2.909	81.449	0.050	13.244	3,329

Greenhouse gas emissions by sub-sector for 1990-2022 are presented in Table 3-26. The residential sector (1.A.4.b) is the dominant source, accounting for 82.6% of total emissions in 2022. In comparison, emissions from the commercial/institutional sector (1.A.4.a) and the agricultural sector (1.A.4.c) were 15.6% and 1.8%, respectively.

Table 3-26. GHG Emissions from Commercial/Institutional/Residential/Agriculture/Fishing/ Forestry Source-Categories, By Sub-Categories (Gg CO_{2eq})

Year	1.A.4.a - Commercial total CO_{2eq} Gg.	1.A.4.b – Residential total CO_{2eq} Gg	1.A.4.c – Agriculture/Forestry/Fishing, Total CO_{2eq} Gg	Total from sector CO_{2eq} Gg
1990	1,092	3,840	526	5,458
1991	1,110	3,075	862	5,047
1992	902	3,423	655	4,980
1993	898	3,778	527	5,203
1994	605	1,321	472	2,399
1995	129	728	275	1,131
1996	112	844	358	1,314
1997	344	792	347	1,483
1998	255	1,036	324	1,614
1999	66	1,110	230	1,407
2000	182	1,114	182	1,477
2001	70	835	76	980
2002	60	662	117	838
2003	67	677	129	872
2004	78	727	191	996
2005	126	705	282	1,112
2006	77	741	306	1,123
2007	100	803	388	1,291
2008	186	1,033	191	1,409
2009	205	860	166	1,231
2010	229	1,211	309	1,749
2011	376	1,304	330	2,010
2012	565	1,232	74	1,871
2013	276	1,340	32	1,648
2014	459	1,384	25	1,869
2015	408	1,559	38	2,005
2016	411	1,738	69	2,217

2017	423	1,938	69	2,429
2018	414	1,859	54	2,327
2019	462	2,081	56	2,599
2020	359	2,342	46	2747
2021	519	2,546	48	3113
2022	520	2,751	57	3,329

3.2.8.2. *Methodological issues*

Evaluation method

The IPCC "Tier 1" sectoral approach was used to calculate emissions. Due to the absence of specialized laboratories and relevant data, it is not feasible to perform higher-tier emission calculations.

Emission coefficient

To convert the physical units of fuel consumption into energy units, the country-specific net calorific value was applied (Table 3-5). The corresponding standard emission factors are provided in Table 3-27[29].

Table 3-27. Default Emission Factors for commercial/institutional and residential and agriculture/forestry/fishing categories (kg/TJ on a Net Calorific Basis)

Fuels/GHGs	CO_2	CH_4	N_2O
Commercial/Institutional			
Anthracite	98,300	10	1.5
Lignite	101,000	10	1.5
Wood	112,000	300	4
Other Primary Solid Biomass	100,000	300	4
Natural Gas	56,100	5	0.1
LPG	63,100	5	0.1
Residual Fuel Oil	77,400	10	0.6
Residential			
Lignite	101,000	300	1.5
Wood	112,000	300	4
Other Primary Solid Biomass	100,000	300	4
Natural Gas	56,100	5	0.1
LPG	63,100	5	0.1
Other Keosene	71,900	10	0.6
Charcoal	112,000	200	1
Agriculture/Forestry/Fishing			
Wood	112,000	300	4
Natural Gas	56,100	5	0.1
Anthracite	98,300	10	1.5
Lignite	101,000	300	1.5
Gasoline	69300	10	0.6
Diesel	74100	10	0.6
LPG	63100	5	0.1

[29] IPCC 2006, Volume 2, Tables 2.4, 2.5

Activity Data

Information on other subsectors was obtained from the National Statistics Office of Georgia (Geostat) and the International Energy Agency.

Table 3-28. Activity data in other subsectors

Year	Anthracite (TJ)	Charcoal (TJ)	Gas/diesel fuel (TJ)	Lignite (TJ)	LPG (TJ)	Motor gasoline (TJ)	Natural gas (dry) (TJ)	Other bituminous coal (TJ)	Other kerosene (TJ)	Other primary solid biomass (TJ)	Household fuel (TJ)	Wood and wood products (TJ)
1990	NO	NO	1,906.52	1,581.00	3,006.00	2,992.00	52,163.10	600.0	2,290.13	NO	10,059.60	15,430.00
1991	NO	NO	5,709.00	1,514.00	2,208.00	4,444.00	43,249.00	600.0	2,236.00	NO	8,080.00	18,054.00
1992	NO	NO	4,558.00	1,637.00	1,518.00	880.00	51,444.00	600.0	2,279.00	NO	6,560.00	28,210.00
1993	NO	NO	8,648.00	1,619.00	1,564.00	616.00	50,249.00	450.0	3,913.00	NO	5,600.00	42,879.00
1994	NO	NO	4,939.62	2,924.00	1,485.00	352.00	13,339.80	600.0	3,500.01	NO	3,918.80	11,021.00
1995	NO	NO	1,235.00	598.00	1,702.00	88.00	2,393.00	25.0	3,612.00	NO	2,560.00	27,830.00
1996	NO	NO	5,027.00	229.00	1,196.00	NO	3,051.00	25.0	2,236.00	NO	NO	39,270.00
1997	NO	NO	4,260.00	88.00	2,576.00	1,012.00	3,289.00	NO	1,935.00	NO	NO	31,810.00
1998	NO	NO	4,175.00	281.00	4,140.00	616.00	3,127.00	50.0	4,558.00	NO	360.00	28,285.00
1999	NO	NO	2,769.00	370.00	3,404.00	440.00	4,354.00	NO	3,741.00	NO	280.00	26,899.00
2000	NO	NO	1,863.19	323.00	2,430.00	484.00	9,067.60	NO	3,283.96	NO	525.20	25,513.00
2001	NO	NO	1,066.00	106.00	966.00	NO	6,670.00	NO	2,924.00	NO	NO	25,513.00
2002	NO	NO	1,194.00	106.00	966.00	NO	5,578.00	NO	1,204.00	NO	NO	25,513.00
2003	NO	NO	938.00	106.00	736.00	NO	6,332.00	NO	1,118.00	NO	NO	25,513.00
2004	NO	NO	1,364.00	141.00	690.00	NO	7,418.00	NO	1,118.00	NO	NO	25,513.00
2005	NO	NO	2,253.16	85.00	1,125.00	NO	11,455.20	NO	1,123.46	NO	NO	14,612.00
2006	NO	NO	2,513.00	158.00	1,288.00	NO	10,814.00	NO	1,118.00	NO	NO	15,617.00
2007	NO	NO	3,238.00	246.00	1,794.00	NO	11,342.00	350.0	1,118.00	NO	NO	16,287.00
2008	NO	NO	2,982.00	563.00	2,162.00	NO	13,038.00	275.0	1,118.00	NO	NO	15,616.00
2009	NO	NO	426.00	1,848.00	2,162.00	NO	10,627.00	450.0	1,118.00	NO	NO	15,408.00
2010	NO	NO	1,115.31	1,091.40	786.15	524.04	19,855.10	NO	2,778.40	NO	NO	14,932.55
2011	NO	NO	3,621.95	NO	844.65	NO	24,619.48	NO	2,464.70	NO	NO	13,019.76
2012	NO	NO	349.74	21.42	706.77	36.31	26,964.13	NO	2,182.11	NO	39.49	12,404.82
2013	12.96	NO	505.57	20.95	652.42	36.22	24,351.90	NO	8.64	306.08	26.71	19,828.09
2014	23.50	NO	457.80	22.40	721.40	35.20	28,353.70	NO	4.30	166.80	25.10	19,290.00
2015	24.60	3.20	983.70	30.90	803.70	4.300	30,496.20	NO	1.20	123.20	21.00	16,514.00
2016	28.14	14.17	1,026.70	45.05	707.40	37.40	34,311.10	NO	0.78	224.80	30.00	15,888.86
2017	25.80	3.08	924.85	30.77	630.20	57.20	38,507.60	NO	NO	162.08	4.02	15,002.44
2018	7.30	5.90	509.10	11.90	796.70	48.40	37,783.20	5.0	NO	166.40	NO	11,092.90
2019	1.80	0.70	453.70	0.30	464.60	40.90	43,212.10	12.1	NO	168.80	NO	10,054.20
2020	NO	3.80	292.30	0.90	405.10	27.60	46,309.70	4.9	NO	71.70	NO	9,416.60
2021	NO	NO	320.20	3.50	341.30	29.90	52,778.60	NO	NO	50.20	NO	9,746.90
2022	NO	NO	328.70	48.70	237.80	68.20	56,770.70	NO	NO	50.50	NO	8,640.40

3.2.8.3. *Uncertainties and Consistency of time series*

Uncertainty assessment

See information in Annex II.

Consistency of time series

The same sources for activity data were used across time series.

3.2.8.4. *Category-appropriate quality control and assurance and verification*

Quality control procedures for the general inventory were conducted in accordance with the 2006 IPCC Guidelines. These procedures focused on verifying activity data parameters, emission factors, and archiving reference materials. Quality assurance measures, also aligned with IPCC guidelines, involved reviewing text structure, completeness, clarity, and ensuring the accuracy and consistency of calculations, emission factors, and activity data over time. A summary of quality assurance and quality control activities is provided in Chapter 1.

3.2.8.5. *A category-specific, explained and justified recalculation, a description of changes related to the inspection process and their impact on the emission trend.*

Recalculations were performed for data from the previous report (1990-2017) for several reasons:

- The National Statistics Office balance was updated with revised data for 2013-2017, and new data for 2018-2022 was added.
- In category 1.A.4.a (Public Services), based on recommendations, motor gasoline was fully reallocated to road transport (1.A.3.b).
- Wood and wood products, which were not included in the previous inventory report, have now been added to the new report.
- In category 1.A.4.b (Households), following recommendations, motor gasoline was fully reallocated to road transport (1.A.3.b).
- In category 1.A.4.c.i (Agriculture, Forestry, and Fishing), data for 1997 and 2002-2004 were missing; therefore, empty fields were restored using interpolation methodology.

*Table 3-29. Results of GHG recalculation from category 1.A.4.**

Year	GHG emissions before conversion (Gg CO_2 eq.)	GHG emissions after conversion (Gg CO_2 eq.)	Difference (Gg CO_2 eq.)
1990	5,427	5,458	31 (0.57%)
1991	5,010	5,047	37 (0.74%)
1992	4,924	4,980	56 (1.13%)
1993	5,117	5,203	86 (1.67%)
1994	2,372	2,399	27 (1.13%)
1995	1,076	1,131	55 (4.98%)
1996	1,238	1,314	76 (5.96%)
1997	1,410	1,483	73 (5.05%)
1998	1,560	1,614	54 (3.4%)
1999	1,355	1,407	52 (3.77%)
2000	1,427	1,477	50 (3.44%)
2001	931	980	49 (5.13%)
2002	755	838	83 (10.42%)
2003	757	872	115 (14.12%)
2004	851	996	145 (15.7%)

2005	1,084	1,112	28 (2.55%)
2006	1,092	1,123	31 (2.8%)
2007	1,258	1,291	33 (2.59%)
2008	1,377	1,409	32 (2.3%)
2009	1,199	1,231	32 (2.63%)
2010	1,717	1,749	32 (1.85%)
2011	1,984	2,010	26 (1.3%)
2012	1,846	1,871	25 (1.35%)
2013	1,579	1,648	69 (4.28%)
2014	1,859	1,869	10 (0.54%)
2015	1,993	2,005	12 (0.6%)
2016	2,206	2,217	11 (0.5%)
2017	2,608	2,429	-179 (7.11%)

* Emissions were recalculated using updated global warming potential (GWP) values. Instead of the previous values of 21 for methane (CH_4) and 310 for nitrous oxide (N_2O), the revised values of 28 and 265, respectively, were applied.

3.2.9. *Unspecified (1.A.5.)*

3.2.9.1. *Source category description and calculated emissions*

Includes all remaining emissions from fuel combustion that are not specified elsewhere. The same emission factors were used here as in commercial and residential sectors.

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Table 3-30. GHG Emissions from Non-specified Source-Category (Gg)

Year	CO_2 Gg	CH_4 Gg	CH_4 Gg CO_{2eq}	N_2O Gg	N_2O in Gg CO_{2eq}	Total in Gg CO_{2eq}
1990	0	1.128	31.584	0.015	3.986	36
1991	NE	NE	NE	NE	NE	NE
1992	NE	NE	NE	NE	NE	NE
1993	NE	NE	NE	NE	NE	NE
1994	NE	NE	NE	NE	NE	NE
1995	NE	NE	NE	NE	NE	NE
1996	88	0.009	0.248	0.000	0.079	88
1997	84	0.009	0.243	0.001	0.152	84
1998	80	0.008	0.237	0.001	0.225	80
1999	76	0.008	0.232	0.001	0.299	76
2000	52	0.005	0.150	0.001	0.156	52
2001	27	0.002	0.069	0.000	0.013	28
2002	23	0.002	0.057	0.000	0.011	23
2003	26	0.002	0.065	0.000	0.012	26
2004	31	0.003	0.076	0.000	0.014	31
2005	22	0.002	0.054	0.000	0.010	22
2006	13	0.001	0.032	0.000	0.006	13
2007	44	0.069	1.921	0.002	0.456	46

2008	116	0.074	2.080	0.002	0.558	118
2009	170	0.193	5.404	0.004	1.169	176
2010	241	0.233	6.514	0.006	1.613	249
2011	86	0.217	6.087	0.004	1.037	93
2012	0	0.132	3.696	0.002	0.466	4
2013	NO	NO	NO	NO	NO	NO
2014	NO	NO	NO	NO	NO	NO
2015	NO	NO	NO	NO	NO	NO
2016	NO	NO	NO	NO	NO	NO
2017	NO	NO	NO	NO	NO	NO
2018	NO	NO	NO	NO	NO	NO
2019	NO	NO	NO	NO	NO	NO
2020	NO	NO	NO	NO	NO	NO
2021	NO	NO	NO	NO	NO	NO
2022	NO	NO	NO	NO	NO	NO

3.2.9.2. *Methodological issues*

Assessment method

The IPCC "Tier 1" sectoral approach was used to calculate emissions. Due to the absence of specialized laboratories and relevant data, it is not feasible to perform higher-tier emission calculations.

Activity data

The fuel consumption data for the Non-Specified subsectors from 1990 to 2022 were obtained from the National Statistics Office of Georgia (Geostat) and the International Energy Agency.

Table 3-31. Activity data in unspecified subsector

Year/ gas	Gas/Diesel Oil (TJ)	Residual fuel oil (TJ)	Other bituminous coal (TJ)	Lignite (TJ)	Natural gas (dry) (TJ)	Wood/wood waste (TJ)
1990	NO	NO	NO	NO	NO	3760.00
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	298	NO	NO	NO	1178.00	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	128	NO	700	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	NO	NO	NO	NO	490.00	NO
2002	NO	NO	NO	NO	410.00	NO
2003	NO	NO	NO	NO	465.00	NO
2004	NO	NO	NO	NO	545.00	NO
2005	NO	NO	NO	NO	NO	NO

2006	NO	NO	NO	NO	226.00	NO
2007	NO	NO	450	141.00	NO	209.00
2008	NO	NO	800	NO	715.00	209.00
2009	NO	NO	1325	NO	791.00	586.00
2010	NO	9.7	NO	2172.88	363.65	696.70
2011	NO	NO	NO	736.95	201.25	696.77
2012	NO	NO	NO	NO	NO	440.00
2013	NO	NO	NO	NO	NO	NO
2014	NO	NO	NO	NO	NO	NO
2015	NO	NO	NO	NO	NO	NO
2016	NO	NO	NO	NO	NO	NO
2017	NO	NO	NO	NO	NO	NO
2018	NO	NO	NO	NO	NO	NO
2019	NO	NO	NO	NO	NO	NO
2020	NO	NO	NO	NO	NO	NO
2021	NO	NO	NO	NO	NO	NO
2022	NO	NO	NO	NO	NO	NO

3.2.9.3. *Uncertainties and Consistency of time series*

Uncertainty assessment

See information in Annex II.

Consistency of time series

The same sources for activity data were used across time periods.

3.2.9.4. *Category-appropriate quality control and assurance and verification*

Quality control procedures for the general inventory were conducted in accordance with the 2006 IPCC Guidelines. These procedures focused on verifying activity data parameters, emission factors, and archiving reference materials. Quality assurance measures, also aligned with IPCC guidelines, involved reviewing text structure, completeness, clarity, and ensuring the accuracy and consistency of calculations, emission factors, and activity data over time. A summary of quality assurance and quality control activities is provided in Chapter 1.

3.2.9.5. *A category-specific, explained and justified recalculation, a description of changes related to the inspection process and their impact on the emission trend.*

Recalculations were performed for data from the previous report (1990-2017) for several reasons:

In Category 1.A.5.a – Stationary:

- Wood and wood products were not included in the previous inventory report. They have now been added, leading to data updates for 1990 and 2007-2012.

- Data for 1997, 1998, 2000, and 2005 were not previously estimated. The missing values were restored using interpolation methodology.

*Table 3-32 Results of GHG recalculation from category 1.A.4.**

Year	GHG emissions before conversion (Gg CO_2 eq.)	GHG emissions after conversion (Gg CO_2 eq.)	Difference (Gg CO_2 eq.)
1990	28.34	36	7.66 (23.81%)
1991	NO	NO	NO
1992	NO	NO	NO
1993	NO	NO	NO
1994	NO	NO	NO
1995	NO	NO	NO
1996	88.36	88	0.36 (0.41%)
1997	0.00	84	84 (200%)
1998	0.00	80	80 (200%)
1999	76.18	76	-0.18 (0.24%)
2000	0.00	52	52 (200%)
2001	27.53	28	0.47 (1.69%)
2002	23.06	23	-0.06 (0.26%)
2003	26.13	26	-0.13 (0.5%)
2004	30.64	31	0.36 (1.17%)
2005	0.00	22	22 (200%)
2006	12.70	13	0.30 (2.33%)
2007	46.06	46	-0.06 (0.13%)
2008	117.97	118	0.03 (0.03%)
2009	175.01	176	0.99 (0.56%)
2010	247.37	249	1.63 (0.66%)
2011	91.52	93	1.48 (1.6%)
2012	3.39	4	0.61 (16.51%)
2013	NO	NO	NO
2014	NO	NO	NO
2015	NO	NO	NO
2016	NO	NO	NO
2017	NO	NO	NO

* Emissions were recalculated using updated global warming potential (GWP) values. Instead of the previous values of 21 for methane (CH_4) and 310 for nitrous oxide (N_2O), the revised values of 28 and 265, respectively, were applied.

3.2.10. *Emissions in order to receive energy from the combustion of waste*

Incinerating waste for energy recovery is not carried out in Georgia.

3.3. Fugitive emissions from fuel (1.B.)

Fugitive emissions include all intentional or unintentional release of greenhouse gases (mainly methane) during the extraction, processing, and transportation of fossil fuels to the point of final use. Fugitive emissions were calculated from the following categories and sub-categories:

1.B.1. Solid fuels (coal mining and handling, underground mines)

- Coal mining;
- Post-mining seam gas emissions;
- Abandoned underground mines.

1.B.2. Oil and natural gas

1.B.2a Oil

- Venting;
- Flaring;
- Oil production and upgrading;
- Oil transportation;

1.B.2a Natural gas

- Venting;
- Flaring;
- Production;
- Trasmission and storage;
- Distribution;

GHG emissions trend from the fugitive emissions in subsectors are provided in the Table 3-33.

Table 3-33. Fugitive emissions (Gg)

Year /category	1B1 Solid fuel total in CO_{2eq}	CO_2	CH_4 in CO_{2eq}	1B2a Oil Total in CO_{2eq}	CO_2	CH_4 in CO_{2eq}	N_2O in CO_{2eq}	1B2b Natural gas total in CO_{2eq}.	CO_2	CH_4 in CO_{2eq}	N_2O in CO_{2eq}	Total Fugitive Emissions in CO_{2eq}
1990	1,009.64	54.91	954.73	208.28	11.37	196.87	0.05	6,915.73	0.27	6,915.46	0.0004	8,134
1991	409.68	20.92	388.76	210.28	11.50	198.73	0.05	7,277.00	0.30	7,276.70	0.0004	7,897
1992	168.42	7.37	161.04	146.55	8.08	138.44	0.03	6,550.41	0.26	6,550.14	0.0003	6,865
1993	128.12	5.28	122.85	46.41	2.55	43.85	0.01	5,576.35	0.23	5,576.12	0.0003	5,751
1994	139.56	6.09	133.47	51.22	2.82	48.39	0.01	1,874.45	0.05	1,874.40	0.0000	2,065
1995	51.40	1.17	50.24	55.01	3.04	51.96	0.01	1,598.04	0.04	1,598.00	0.0001	1,704
1996	38.78	0.55	38.23	135.91	3.03	132.87	0.01	2,087.36	0.06	2,087.29	0.0000	2,262
1997	30.61	0.17	30.44	147.35	8.14	139.18	0.03	1,892.50	0.09	1,892.41	0.0000	2,070
1998	35.23	0.51	34.72	130.86	7.23	123.60	0.03	1,908.62	0.12	1,908.50	0.0000	2,075
1999	34.66	0.55	34.11	100.08	5.53	94.53	0.02	1,001.66	0.12	1,001.54	0.0000	1,136
2000	30.43	0.36	30.06	122.17	6.75	115.40	0.03	1,340.50	0.15	1,340.35	0.0005	1,493
2001	26.15	0.17	25.98	108.87	6.01	102.84	0.02	966.60	0.08	966.52	0.0003	1,102
2002	25.92	0.21	25.71	81.38	4.49	76.87	0.02	2,729.29	0.11	2,729.19	0.0001	2,837
2003	26.36	0.27	26.09	153.96	8.50	145.42	0.03	3,375.21	0.13	3,375.08	0.0001	3,556
2004	25.72	0.27	25.45	107.79	5.95	101.81	0.02	3,480.59	0.12	3,480.47	0.0001	3,614
2005	23.18	0.17	23.01	74.42	4.11	70.29	0.02	1,619.58	0.07	1,619.51	0.0001	1,717
2006	25.12	0.31	24.81	70.38	3.89	66.48	0.02	3,389.49	0.12	3,389.37	0.0001	3,485
2007	32.96	0.79	32.17	67.83	3.48	64.33	0.01	3,024.96	0.12	3,024.83	0.0001	3,126
2008	37.86	1.10	36.76	64.39	3.23	61.14	0.01	1,842.22	0.10	1,842.11	0.0001	1,944
2009	91.81	4.22	87.59	63.74	3.12	60.60	0.01	1,341.30	0.08	1,341.22	0.0000	1,497
2010	172.37	8.87	163.50	64.8	3.18	61.60	0.01	2,035.47	0.10	2,035.37	0.0001	2,273
2011	221.17	11.69	209.48	62.39	3.09	59.29	0.01	2,631.96	0.11	2,631.85	0.0000	2,916

2012	260.57	13.97	246.60	55.65	2.73	52.91	0.01	2,840.12	0.11	2,840.00	0.0000	3,156
2013	250.04	13.39	236.65	59.84	2.96	56.87	0.01	1,802.54	0.10	1,802.44	0.0000	2,112
2014	189.20	9.91	179.28	54.35	2.64	51.70	0.01	1,719.89	0.11	1,719.78	0.0001	1,963
2015	192.68	10.13	182.55	51.71	2.49	49.21	0.01	2,436.29	0.13	2,436.16	0.0001	2,681
2016	186.97	9.82	177.15	49.73	2.39	47.33	0.01	2,535.95	0.13	2,535.82	0.0000	2,773
2017	169.56	8.88	160.68	42.34	1.98	40.35	0.01	1,817.65	0.10	1,817.55	0.0001	2,030
2018	94.18	4.57	89.61	40.36	1.88	38.48	0.01	2,090.80	0.12	2,090.68	0.0001	2,225
2019	23.18	0.51	22.67	45.31	2.17	43.13	0.01	1,730.33	0.12	1,730.21	0.0001	1,799
2020	71.46	3.29	68.17	40.53	1.94	38.59	0.01	1,796.09	0.13	1,795.96	0.0001	1,908
2021	99.31	4.90	94.41	44.96	2.19	42.76	0.01	1,826.09	0.17	1,825.92	0.0001	1,970
2022	98.22	4.85	93.37	46.24	2.26	43.97	0.01	1,925.94	0.19	1,925.75	0.0001	2,070

As can be seen from the table, natural gas is the dominant subsector, where high emissions are caused by high losses of natural gas in the process of transportation and distribution. Over the years, emissions from the mining and processing of coal also increased, as a result of intensification of mining of this fuel in Georgia. Below all source subcategories are described separately.

3.3.1. *Solid fuel (1.B.1.)*

3.3.1.1. *Source category description and calculated emissions*

Although underground coal mining in Georgia was well developed during the Soviet period, it has subsequently declined significantly. Since 2009, coal mining has started to increase again, and consequently, Fugitive Emissions from this subcategory have increased. However, since 2017, the volume of these operations has significantly decreased due to fatal accidents at the workplace following a technical inspection of miners' safety standards. Emission data are presented in Table 3-34.

Table 3-34. Methane emissions from underground mines during coal mining and processing (Gg)

Source	1.B.1. Solid fuel total CO_{2eq}.	1.B.1.a.i.1 Mining Total CO_{2eq}	1.B.1.a.i.2 Post-mining seam gas emissions total CO_{2eq}	1.B.1.a.i.3 Abandoned underground mines total CO_{2eq}
1990	**1,009.64**	832.51	124.42	52.71
1991	**409.68**	317.23	47.41	45.05
1992	**168.42**	111.77	16.70	39.95
1993	**128.12**	79.97	11.95	36.20
1994	**139.56**	92.39	13.81	33.36
1995	**51.40**	17.66	2.64	31.10
1996	**38.78**	8.33	1.24	29.21
1997	**30.61**	2.60	0.39	27.62
1998	**35.23**	7.80	1.17	26.27
1999	**34.66**	8.33	1.24	25.09
2000	**30.43**	5.52	0.83	24.08
2001	**26.15**	2.60	0.39	23.16
2002	**25.92**	3.13	0.47	22.32
2003	**26.36**	4.16	0.62	21.58
2004	**25.72**	4.16	0.62	20.94
2005	**23.18**	2.51	0.38	20.29
2006	**25.12**	4.67	0.70	19.75
2007	**32.96**	11.96	1.79	19.21
2008	**37.86**	16.63	2.49	18.74

2009	**91.81**	63.95	9.56	18.30
2010	**172.37**	134.42	20.09	17.86
2011	**221.17**	177.200	26.48	17.49
2012	**260.57**	211.79	31.65	17.12
2013	**250.04**	202.96	30.33	16.75
2014	**189.20**	150.29	22.46	16.45
2015	**192.68**	153.58	22.95	16.14
2016	**186.97**	148.88	22.25	15.84
2017	**169.56**	134.62	20.12	14.82
2018	**94.18**	69.24	10.35	14.59
2019	**23.18**	7.68	1.15	14.35
2020	**71.46**	49.86	7.45	14.15
2021	**99.31**	74.26	11.10	13.95
2022	**98.22**	73.46	10.98	13.78

Coal deposits in Georgia are mainly located in three regions where coal extraction is underway for 158 years: in Tkibuli-Shaori since 1847; in Tkvarcheli since 1929 and in Akhaltsikhe since 1947[30]. Surface mining of coal is only carried out in Tkvarcheli. However, information about the volume, technology and manufacturers is not available since the entire region is occupied by Russia.[31]

In addition to the occupied Tkvarcheli, there are 6 abandoned mines in Georgia: 2 in Tkibuli and 4 in Akhaltsikhe. Currently, 2 mines are operational, in Tkibuli-Shaori and Akhaltsikhe.

3.3.1.2. *Methodological issues*

Evaluation methods

In all sub-sectors of solid fuel fugitive emissions were calculated using the IPCC Tier 1 sectoral approach. The Tier 1 approach requires that countries choose from the global average range of Emission Factors and use country-specific Activity Data to calculate total emissions.

Below is the general form of the equation for estimating emissions for Tier 1 approach, based on coal production Activity Data from underground coal mining and post-mining emissions:

Estimating emissions from underground coal mines for tier 1 and tier 2 approaches without adjustment for methane utilization or flaring

Greenhouse gas emissions = Raw coal production x Emission factor x Unit conversion factor

The basic equation for estimating emissions from abandoned underground coal mines is shown below:

[30] Coal Production and its Development Perspective – Green Alternative
[31] Surface mining of coal in Georgia and Related Problems – Green Alternative

General equation for estimating fugitive emissions from abandoned underground coal mines

CH_4emission= Emissions from abandoned mines – CH_4recovered emissions.

Emission factors

Tier 1 Emission Factors for underground mining are shown below.

Tier 1: Global Average Method – Underground Mining – prior to Adjustment for Any Methane Utilization or Flaring

$$CH_4\text{emission} = CH_4 \text{ emission factor} \times \text{underground coal production} \times \text{conversion factor}$$

where the units are:
Methane Emissions (Gg/year)
CH_4 Emission Factor (m^3/tons)
Underground Coal Production (tons/year)

Emission factor:
Low CH_4 Emission Factor = 10 m^3/tons
Average CH_4 Emission Factor =18 m^3/tons
High CH_4 Emission Factor = 25 m^3/tons

Conversion factor:

This is the density of CH_4 and converts volume of CH_4 to mass of CH_4. The density is taken at 20°C and 1 atmosphere pressure and has a value of 0.67×10^{-6} Gg/m^3.

Countries using the Tier 1 approach should consider country-specific variables such as the depth of major coal seams to determine the emission factor to be used. As gas content of coal usually grows with increase of the depth, the low end of the range should be chosen for average mining depths <200 m, whereas the high value is appropriate for depths > 400 m. For intermediate depths, average values can be used. In Georgia, average mining depths is about 800-1200m, based on the information provided by Georgian Industrial Group (GIG), therefore High CH_4 Emission Factor = 25 m^3/tons were stated.
For a Tier 1 approach the post-mining emissions factors are shown below together with the estimation method:

TIER 1: GLOBAL AVERAGE METHOD – POST-MINING EMISSIONS – UNDERGROUND MINES

$$\text{Methane emissions} = CH_4 \text{ emission} \times \text{underground coal production} \times \text{conversion factor}$$

where the units are:
Methane Emissions (Gg/year)
CH_4 Emission Factor (m^3/tons)
Underground Coal Production (tons/year)

Emission factor:
Low CH_4 Emission Factor = 0.9 m^3/tons
Average CH_4 Emission Factor = 2.5 m^3/tons
High CH_4 Emission Factor = 4.0 m^3/tons

Conversion Factor:

This is the density of CH_4 and converts volume of CH_4 to mass of CH_4. The density is taken at 20°C and 1 atmosphere pressure and has a value of 0.67×10^{-6} Gg/m^3.

Developing emissions estimates from abandoned underground coal mines requires historical records. The two key parameters used to estimate abandoned mine emissions for each mine (or group of mines) are the time (in years) elapsed since the mine was abandoned, relative to the year of the emissions inventory, and Emission Factors that take into account the mine's gassiness. Tier 1 approach includes default values and broader time intervals. For a Tier 1 approach, the emissions for a given inventory year can be calculated from the Equation below:

Tier 1 approach for abandoned underground mines

$$Methane\ Emissions = Number\ of\ Abandoned\ Coal\ Mines\ remaining\ unflooded \times Fraction\ of gassy \times Coal\ Mines\ Emission\ Factor \times Conversion\ Factor$$

Where units are:

Methane emissions (Gg/year)
Emission factor (m^3/year)

Note: The Emission Factor has different units here compared with the definitions for underground, surface, and post-mining emissions. The reason for this is that the different method is applied for estimating emissions from abandoned mines compared with underground or surface mining.

This equation is applied for each time interval, and emissions from each time interval are added to calculate the total emissions.

Conversion factor:

This is the density of CH_4 and converts volume of CH_4 to mass of CH_4. The density is taken at 20°C and 1 atmosphere pressure and has a value of 0.67×10-6 Gg/m^3.

A Tier 1 approach for determining emissions from abandoned underground mines is described below and is largely based on methods developed by the USEPA (Franklin et al, 2004).

Since six underground mines were abandoned in Georgia during 1976-2000 period, default values - percentage of coal mines that are gassy were assumed to be 30%, selected from the range 8%-100% (IPCC 2006, volume 2, table 4.1.5). As for the Emission Factors, they are obtained from the table 4.1.6 of IPCC 2006, volume 2.

Activity data

Information about coal mining and its specificities were obtained from the National Statistics Office of Georgia (GEOSTAT).
The IPCC “Tier 1” sectoral approach was used to calculate emissions.

Table 3-35. Activity data on coal

Year/gas	Amount of coal produced (tons)
1990	1658,000.00
1991	631,773.90
1992	222,588.20
1993	159,272.40
1994	184,000.00
1995	35,176.47
1996	16,588.24
1997	5,176.47
1998	15,529.41
1999	16,588.24
2000	11,000.00
2001	5,176.47
2002	6,235.29
2003	8,294.12
2004	8,294.12
2005	5,000.00
2006	9,294.12
2007	23,823.53
2008	33,117.65
2009	127,352.90
2010	267,700.00
2011	352,900.00
2012	421,800.00
2013	404,200.00
2014	299,314.00
2015	305,870.10
2016	296,500.00
2017	268,100.00
2018	137,900.00
2019	15,300.00
2020	99,300.00
2021	147,900.00
2022	146,300.00

3.3.1.3. *Uncertainties and Consistency of time series*

Uncertainty assessment

See information in Annex II.

Consistency of time series

The same sources for activity data were used across time periods.

3.3.1.4. *Category-appropriate quality control and assurance and verification*

Quality control procedures for the general inventory were conducted in accordance with the 2006 IPCC Guidelines. These procedures focused on verifying activity data parameters, emission factors, and archiving reference materials. Quality assurance measures, also aligned with IPCC guidelines, involved reviewing text structure, completeness, clarity, and ensuring the accuracy and consistency of calculations, emission factors, and activity data over time. A summary of quality assurance and quality control activities is provided in Chapter 1.

3.3.1.5. *A category-specific, explained and justified recalculation, a description of changes related to the inspection process and their impact on the emission trend.*

Recalculations were performed for data from the previous report (1990-2017) for several reasons:

- The National Statistics Office's energy balance was updated with revised data for 2013-2017, and new data for 2018-2022 was added.
- In category 1.B.1.a.i.1 (Mining, total CO_2 equivalent), data for 1991-1993 and 2017 was not previously estimated; therefore, missing fields were restored.
- In category 1.B.1.a.i.2 (Post-Mining Emissions, total CO_2 equivalent), data for 1991-1993 and 2017 was also restored due to previous omissions.
- In category 1.B.1.a.i.3 (Abandoned Underground Mines, total CO_2 equivalent), methane (CH_4) emission values were erroneously applied, leading to a million-fold discrepancy in emission factors for the 1990-2017 period. As a result, values were recalculated based on recommendations, and data for 2018-2022 was also added.

*Table 3-36. Results of GHG recalculation from category 1.B.1.**

Years	GHG emissions before recalculation (Gg CO_{2eq})	GHG emissions after recalculation (Gg CO_{2eq})	Difference (Gg CO_{2eq})
1990	738.70	1,009.64	270.94 (30.99%)
1991	23.70	409.68	385.98 (178.13%)
1992	8.35	168.42	160.07 (181.11%)
1993	5.98	128.12	122.14 (182.16%)
1994	81.98	139.56	57.58 (51.98%)
1995	15.66	51.40	35.74 (106.59%)

1996	7.38	38.78	31.4 (136.05%)
1997	2.32	30.61	28.29 (171.82%)
1998	6.93	35.23	28.3 (134.25%)
1999	7.38	34.66	27.28 (129.78%)
2000	4.89	30.43	25.54 (144.62%)
2001	2.32	26.15	23.83 (167.4%)
2002	2.78	25.92	23.14 (161.25%)
2003	3.69	26.36	22.67 (150.88%)
2004	3.69	25.72	22.03 (149.81%)
2005	2.23	23.18	20.95 (164.9%)
2006	4.15	25.12	20.97 (143.29%)
2007	10.62	32.96	22.34 (102.52%)
2008	14.77	37.86	23.09 (87.74%)
2009	56.73	91.81	35.08 (47.23%)
2010	119.26	172.37	53.11 (36.42%)
2011	157.24	221.17	63.93 (33.79%)
2012	187.92	260.57	72.65 (32.4%)
2013	184.32	250.04	65.72 (30.26%)
2014	133.36	189.2	55.84 (34.62%)
2015	136.28	192.68	56.4 (34.29%)
2016	132.10	186.97	54.87 (34.39%)
2017	10.06	169.56	159.5 (177.6%)

* Emissions were recalculated using updated global warming potential (GWP) values. Instead of the previous values of 21 for methane (CH_4) and 310 for nitrous oxide (N_2O), the revised values of 28 and 265, respectively, were applied.

3.3.2. *Fugitive emissions from oil and natural gas (CRT 1.B.2.)*

3.3.2.1. *Source category description and calculated emissions*

The sources of fugitive emissions in oil and gas systems include, but are not limited to, equipment leaks, evaporation and flashing losses, venting, flaring, incineration, and accidental releases. While some of these emission sources are engineered or intentional and therefore relatively well characterized, the quantity and composition of the emissions is generally subject to significant uncertainty due to the limited use of measurement systems. in these cases.

Fugitive emissions are calculated from the following sub-categories:

CRT 1B2a. Oil

- Venting - Emissions from venting of associated gas and waste gas/vapor streams at oil facilities;
- Flaring - Emissions from flaring of natural gas and waste gas/vapor streams at oil facilities;
- Oil production and upgrading - Fugitive emissions from oil production (excluding venting and flaring) occur at the oil wellhead through to the starting

point of the oil transmission system. This includes fugitive emissions related to well servicing, transportation of untreated production to treating or extraction facilities, activities at extraction and upgrading facilities, associated gas re-injection systems, and produced water disposal systems. Fugitive emissions from upgraders are grouped with those from production sites rather than those from refining facilities since the upgraders are often integrated with extraction facilities and their relative emission contributions are difficult to be established;

- Oil transportation - Fugitive emissions (excluding venting and flaring) related to the transportation of marketable crude oil to upgraders and refineries. The transportation systems may comprise pipelines, marine tankers, tank trucks and rail cars. Evaporation losses from storage, filling and unloading activities, as well as fugitive equipment leaks are the primary sources of these emissions.

1B2b. Natural gas

- Venting - Emissions from venting of natural gas and waste gas/vapor streams at gas facilities;
- Flaring - Emissions from flaring of natural gas and waste gas/vapor streams at gas facilities;
- Production - Fugitive emissions (excluding venting and flaring) from the gas wellhead through to the inlet of gas processing plants, or, where processing is not required, to the tie-in points on gas transmission systems. This includes fugitive emissions related to well servicing, gas gathering, processing and associated waste water and acid gas disposal activities;
- Transmission and storage - Fugitive emissions from systems used to transport processed natural gas to market. Fugitive emissions from natural gas storage systems should also be included in this category;
- Distribution - Fugitive emissions (excluding venting and flaring) during the distribution of natural gas to end users.

Table 3-37. GHG Emissions from Oil and Natural Gas Related Activities (Gg)

Year	1B2 Oil and natural gas total CO_{2eq}.	1B2ai Oil venting total CO_{2eq}	1B2aii Flaring of oil, total CO_{2eq}	1B2aiii2 Oil production and upgrading	1B2aiii3 Oil transport total CO_{2eq}	1B2aiii4 Oil refining total CO_{2eq}	1B2bi Natural gas venting total CO_{2eq}	1B2bii Natural gas flaring total CO_{2eq}	1B2biii2 Natural gas production	1B2biii4 Natural gas transmission and storage	1B2biii5 Natural gas distribution total CO
1990	7,124	5.580	11.129	189.812	NO	1.764	59.824	0.084	20.130	1,968	4,868
1991	7,487	5.644	11.249	191.976	NO	1.406	55.822	0.084	20.133	1,341	5,860
1992	6,697	3.950	7.908	134.366	NO	0.328	55.119	0.070	16.630	1,326	5,153
1993	5,623	1.247	2.499	42.428	NO	0.236	44.408	0.070	16.630	1,080	4,435
1994	1,926	1.380	2.760	46.942	NO	0.138	21.312	0.004	0.877	701	1,151
1995	1,653	1.485	2.970	50.520	NO	0.037	13.058	0.015	3.503	926	655
1996	2,223	3.802	2.760	129.331	NO	0.017	11.437	0.005	1.103	376	1,699
1997	2,040	3.980	7.968	135.377	NO	0.029	9.8270	0.032	7.613	323	1,552
1998	2,039	3.535	7.075	120.229	NO	0.023	10.020	0.059	14.123	330	1,555
1999	1,102	2.703	5.409	91.938	NO	0.031	9.654	0.086	20.633	318	654
2000	1,463	3.300	6.603	112.255	NO	0.016	12.658	0.114	27.143	416	884
2001	1,075	2.941	5.880	100.030	NO	0.018	10.670	0.057	13.489	351	591
2002	2,811	2.198	4.395	74.770	NO	0.021	8.925	0.024	5.705	294	2,421
2003	3,529	4.159	8.319	141.456	NO	0.026	10.132	0.026	6.251	333	3,026
2004	3,588	2.911	5.820	99.028	NO	0.027	11.870	0.017	4.049	391	3,074
2005	1,694	2.010	4.024	68.370	NO	0.015	13.939	0.026	6.251	459	1,141

2006	3,460	1.901	3.803	64.666	NO	0.014	18.100	0.026	6.251	596	2,770
2007	3,093	1.693	3.392	57.584	5.128	0.031	53.347	0.023	5.510	599	2,367
2008	1,907	1.574	3.141	53.543	6.085	0.042	86.686	0.018	4.408	467	1,284
2009	1,405	1.515	3.031	51.530	7.650	0.011	84.550	0.011	2.574	469	785
2010	2,100	1.543	3.091	52.499	7.657	0.009	80.539	0.012	2.765	393	1,559
2011	2,694	1.498	3.00	50.966	6.916	0.007	78.095	0.008	1.980	612	1,940
2012	2,896	1.323	2.649	45.005	6.664	0.004	77.213	0.008	1.844	647	2,114
2013	1,862	1.436	2.875	48.844	6.682	0.002	88.262	0.008	1.810	73	1,639
2014	1,774	1.279	2.559	43.506	7.007	0.000	110.55	0.014	3.448	307	1,299
2015	2,488	1.206	2.413	41.022	7.061	0.005	114.86	0.016	3.824	480	1,837
2016	2,586	1.157	2.314	39.347	6.862	0.047	114.97	0.009	2.219	423	1,996
2017	1,860	0.965	1.920	32.644	6.790	0.018	117.68	0.012	2.868	619	1,078
2018	2,131	0.907	1.814	30.834	6.790	0.018	125.64	0.014	3.414	524	1,438
2019	1,776	1.053	2.107	35.819	6.302	0.028	155.49	0.014	3.278	560	1,012
2020	1,837	0.939	1.879	31.945	5.743	0.028	176.33	0.013	3.039	452	1,165
2021	1,871	1.064	2.130	36.206	5.526	0.037	240.02	0.023	5.463	452	1,129
2022	1,972	1.098	2.197	37.351	5.562	0.032	282.55	0.021	4.985	596	1,042

3.3.2.2. *Methodological issues*

Evaluation method

Fugitive emissions from oil and natural gas systems are often difficult to quantify accurately. This is largely due to the diversity of the industry, the large number and variety of potential emission sources, the wide variations in emission-control levels and the limited availability of emission-source data.

In Georgia, oil and natural gas are extracted at a small scale, and this fact has been considered in the process of the methodology selection. For assessing fugitive emissions in the course of oil extraction, the Tier 1 method was used; Tier 1 method implies the application of appropriate default Emission Factors to a representative activity parameter (usually throughput) for each applicable segment or subcategory of a country's oil and natural gas industry. Tier 1 approach is performed using equations presented below:

Tier 1: ESTIMATING FUGITIVE EMISSIONS FROM AN INDUSTRY SEGMENT

$$E_{gas,\ industry\ segment} = A_{industry\ segment} \times EF_{gas,\ industry\ segement}$$

Tier 1: TOTAL FUGITIVE EMISSIONS FROM INDUSTRY SEGMENTS

$$E_{gas} = \sum_{industry\ segments} E_{gas,industry\ segment}$$

Where:

$E_{gas,industry\ segment}$ = **Annual emissions (Gg)**

$EF_{gas,industry\ segment}$= **Emission factor (Gg/unit of activity)**

$A_{industry\ segment}$= **Activity value (units of activity)**

Emissions during natural gas transmission and distribution were calculated using the value of losses in the transmission and distribution systems, based on the following formula:

$$CH_4Emissions(Gg) = Gas\ Loss(10^6\ m^3) \times Methan\ Content\ in\ Gas(\%) \times Conversion\ Factor(t\frac{CH_4}{m^3 CH_4}) \times 1000$$

This methodology corresponds to the one recommended for the calculation of emissions from natural gas losses under the Clean Development Mechanism (CDM). In the formula, a conversion factor, methane density (ρ), converts methane volume into weight. A value (0.64512 Gg CH_4/mln. m^3) accepted in the CDM Methodology in standard conditions (at 0°C temperature and 101.3 kPa pressure conditions), ρ= 0.0007168 (t CH_4/m^3 CH_4) was used. In total 90% was taken as the value of methane content in natural gas[32].

Emission coefficients

The available Tier 1 default Emission Factors are presented in table Table 3-38[33]. All the presented Emission Factors are expressed in units of mass emissions per unit volume of oil or gas throughput. Furthermore, throughput statistics are the most consistently available Activity Data to be used in Tier 1 calculations. The Emission Factors apply to systems in developing countries and countries with economies in transition where there are much greater amounts of fugitive emissions per unit of activity (often by an order of magnitude or more). The reasons for the greater emissions in these cases may include less stringent design standards, use of lower quality components, restricted access to natural gas markets, and, in some cases, artificially low energy pricing resulting in reduced energy conservation.

Table 3-38. Emission Factors for Fugitive Emissions (Including Venting and Flaring) From Oil and Gas Operations Category

Category	Subcategory	Emission Source	CH_4 volume	CO_2 volume	N_2O volume	Units of measurement
Gas production	All	Fugitive	1.2E-02	9.7E-05	-	GG / MILLION M^3 ON GAS PRODUCTION
		Flaring	8.8E-07	1.4E-03	2.5E-08	GG / MILLION M^3 ON GAS PRODUCTION
Gas transmission and storage	TRANSMISSION	Fugitive	0.64512	5.04E-06	-	GG / MILLION M^3 ON GAS TRANSPORTATION
		Fugitives	3.9E-04	5.2E-06	-	GG / MILLION M^3 ON MARKET GAS
Gas distributon	All	All	0.64512	5.73E-04	-	GG / MILLION M^3 ON DISTRIBUTED GAS
Oil Production	Fossil fuel	Fugitive	3.0E-02	2.0E-03	-	GG / 10^3 m^3 on fossil fuel extraction
		Venting	8.5E-04	1.1E-04	-	GG / 10^3 m^3 on fossil fuel extraction

[32] Project 2404: Reduction of leakage from aboveground gas distribution facilities in the Kaztransgaz-Tbilisi gas distribution system - Tbilisi, Georgia

[33] IPCC 2006, volume 2, table 4.2.5

		Flaring	2.95E-05	4.8E-02	7.6E-07	GG / 10^3 m^3 on fossil fuel extraction
Oil transport	Pipes	All	5.4E-06	4.9E-07	-	GG / 10^3 M^3 ON OIL TRANSPORTED IN PIPELINES
	Truck and rail transportation	Venting	2.5E-05	2.3E-06	-	GG / 10^3 M^3 ON OIL TRANSPORTED BY TRUCKS

Activity data

Information on the production, transmission and distribution of oil and natural gas was obtained from the National Statistics Office of Georgia and the Georgian Oil and Gas Corporation.

In Georgia, natural gas losses in distribution systems are quite large. These losses consist of operational (technology-related and accident-related) and commercial losses. The magnitude of losses in gas pipelines depends on various factors – natural gas pressure, pipeline diameter and length, technical condition, number of natural gas control points, etc. It is almost impossible to obtain the above data in Georgia.

Natural gas losses were estimated based on the annual reports of the Georgian National Energy and Water Regulatory Commission34. According to the information received, in 2022, losses in the natural gas transportation system amounted to 1.09% of local supply. In previous years, based on expert assessments, losses in natural gas transportation were assumed to be 2% of local supply.

The Georgian Energy and Water Supply Regulatory Commission, through its Resolution N26 dated November 18, 2010, approved the "Rule for Calculating the Amount of Normative Losses in the Natural Gas Distribution Network". This rule is based on statistical data, expert assessments, and the principles of natural gas dynamics. According to this regulation, a normative loss rate was established for natural gas supply license holders.

In the annual reports of the Georgian National Energy and Water Supply Regulatory Commission (2012 and 2013), natural gas losses during the distribution process were estimated at approximately 9% of the total natural gas distributed in Georgia. This figure was used to calculate natural gas distribution losses in prior years for the greenhouse gas emissions inventory. Emissions were calculated using the IPCC "Tier 1" sectoral approach.

Information on other subsectors was obtained from the National Statistics Office of Georgia (Geostat) and the International Energy Agency.

Table 3-39. Activity data in the oil and natural gas subsector

Year	Oil extraction and transportation (truck and rail	Oil transportation (pipelines) (1000 m^3)	Oil refining (1000 m^3)	Natural gas transmission and storage -	Natural gas production - flaring	Natural gas transportation (10^6 Sm^3)	Natural gas distribution (10^6

[34] https://www.geostat.ge/ka/modules/categories/308/sakmianobis-angarishi

	transportation) (1000 m^3)			ventilation (10^6 Sm^3)	(10^6 S m^3)		m^3)
1990	225.43	NO	2889.41	5,447.85	58.96	108.96	269.46
1991	228.00	NO	2303.88	5,083.37	58.97	74.26	324.38
1992	159.58	NO	537.56	5,019.43	48.71	73.40	285.25
1993	50.39	NO	386.39	4,043.97	48.71	59.80	245.52
1994	55.75	NO	225.43	1,940.73	2.57	38.81	63.73
1995	60.00	NO	60.00	1,189.14	10.26	51.29	36.26
1996	153.60	NO	27.61	1,041.54	3.23	20.83	94.03
1997	160.78	NO	46.80	894.86	0.00	17.90	85.90
1998	142.79	NO	38.38	912.43	0.00	18.25	86.07
1999	109.19	NO	51.59	879.11	0.00	17.58	36.19
2000	133.32	NO	25.452	1,152.66	79.50	23.05	48.95
2001	118.80	NO	30.03	971.66	39.51	19.43	32.74
2002	88.80	NO	33.59	812.74	16.71	16.25	134.03
2003	168.00	NO	42.01	922.66	18.31	18.45	167.49
2004	117.61	NO	44.40	1,080.94	11.86	21.62	170.18
2005	81.20	NO	24.24	1,269.33	18.31	25.39	63.15
2006	76.80	NO	22.81	1,648.31	18.31	32.97	153.32
2007	68.39	33,803.40	50.39	4,858.00	16.14	33.16	131.04
2008	63.59	40,115.70	69.58	7,894.06	12.91	25.88	71.06
2009	61.20	50,434.80	17.99	7,699.49	7.54	25.99	43.44
2010	62.35	50,476.19	NO	7,334.23	8.10	21.78	86.29
2011	60.53	45,595.24	NO	7,111.69	5.80	33.86	107.41
2012	53.45	43,928.57	NO	7,031.40	5.40	35.81	117.04
2013	58.01	44,047.62	NO	8,037.60	5.30	4.04	90.76
2014	51.67	46,190.48	0.02	10,067.40	10.10	17.00	71.90
2015	48.72	46,547.62	17.57	10,459.90	11.20	26.60	101.70
2016	46.73	45,238.10	76.93	10,470.20	6.50	23.40	110.50
2017	38.77	44,761.90	30.29	10,716.80	8.40	34.25	59.70
2018	36.62	44,761.90	28.72	11,442.10	10.00	29.00	79.60
2019	42.54	41,547.62	45.57	14,160.40	9.60	31.00	56.00
2020	37.94	37,857.14	45.21	16,057.70	8.90	25.00	64.50
2021	43.00	36,428.57	60.96	21,858.20	16.00	25.00	62.50
2022	44.36	36,666.67	51.99	25,731.00	14.60	33.00	57.70

3.3.2.3. *Uncertainties and Consistency of time series*

Uncertainty assessment

See information in Annex II.

Consistency of time series

Two different sources of activity data were used (National Statistics Office of Georgia and Georgian Oil and Gas Corporation) for the time periods.

3.3.2.4. *Category-appropriate quality control and assurance and verification*

Quality control procedures for the general inventory were conducted in accordance with the 2006 IPCC Guidelines. These procedures focused on verifying activity data parameters, emission factors, and archiving reference materials. Quality assurance measures, also aligned with IPCC guidelines, involved reviewing text structure, completeness, clarity, and ensuring the accuracy and consistency of calculations, emission factors, and activity data over time. A summary of quality assurance and quality control activities is provided in Chapter 1.

3.3.2.5. *A category-specific, explained and justified recalculation, a description of changes related to the inspection process and their impact on the emission trend.*

Recalculations were performed for data from the previous report (1990-2017) for the following reasons:

- The National Statistics Office energy balance was updated with revised data for 2013-2017, and new data for 2018-2022 was added.
- Data from the Georgian Oil and Gas Corporation was revised, and figures for 2018-2022 were incorporated.
- Annual reports from the Georgian Energy and Water Regulatory Commission were supplemented with 2018-2022 data, from which the necessary information was collected.

In category 1.B.2.a.iii.2 (Petroleum Extraction and Upgrading):

- Based on recommendations, the CH_4 emission factor for 1991 was adjusted. Instead of 0.00000059, a value of 0.03—consistent with other years—was used.

In category 1.B.2.a.iii.4 (Oil Processing):

- Data for 2010-2013 was previously unassessed; these missing values were restored.
- Following recommendations, CH_4 emission factors for the entire time series were corrected. The previous value of 0.00004 was replaced with 0.0000218.

In category 1.B.2.b.ii (Natural Gas Flaring):

- Data for 1997-1999 was not previously assessed, so these missing values were restored.

In category 1.B.2.b.iii.2 (Natural Gas Extraction):

- Data for 1997-1999 was unassessed and has now been restored.

*Table 3-40. Results of GHG recalculation from category 1.B.2.**

Years	GHG emissions before recalculation (Gg CO_{2eq})	GHG emissions after recalculation (Gg CO_{2eq})	Difference (Gg CO_{2eq})
1990	5,347	7,124	1777 (28.5%)
1991	5,476	7,487	2011 (31.03%)
1992	5,025	6,697	1672 (28.53%)
1993	4,218	5,623	1405 (28.55%)
1994	1,445	1,926	481 (28.54%)
1995	1,241	1,653	412 (28.47%)
1996	1,668	2,223	555 (28.53%)
1997	1,526	2,040	514 (28.83%)
1998	1,521	2,039	518 (29.1%)

1999	812	1,102	290 (30.3%)
2000	1,099	1,463	364 (28.42%)
2001	808	1,075	267 (28.36%)
2002	2,109	2,811	702 (28.54%)
2003	2,649	3,529	880 (28.49%)
2004	2,693	3,588	895 (28.5%)
2005	1,272	1,694	422 (28.46%)
2006	2,596	3,460	864 (28.53%)
2007	2,321	3,093	772 (28.52%)
2008	1,431	1,907	476 (28.52%)
2009	1,055	1,405	350 (28.46%)
2010	1,574	2,100	526 (28.63%)
2011	2,023	2,694	671 (28.45%)
2012	2,175	2,896	721 (28.44%)
2013	1,370	1,862	492 (30.45%)
2014	1,355	1,774	419 (26.78%)
2015	1,896	2,488	592 (27.01%)
2016	1,971	2,586	615 (26.99%)
2017	1,417	1,860	443 (27.04%)

* Emissions were recalculated using updated global warming potential (GWP) values. Instead of the previous values of 21 for methane (CH_4) and 310 for nitrous oxide (N_2O), the revised values of 28 and 265, respectively, were applied.

3.3.3. *Fugitive emissions related to other (geothermal) energy generation (1.B.3.)*

In Georgia, electricity is not produced through geothermal energy generation and, therefore, there are no associated fugitive emissions (NO).

3.4. CO2 transportation and storage (1.C.)

CO_2 transport and storage do not take place in Georgia.

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

4.1. Sector overview and general information

Chapter 4 presents methodologies for calculating greenhouse gas emissions from industrial processes and information on activity data and emission factors for 1990-2022 within the CRF Sector 2—Industrial Processes and Product Use.

Greenhouse gas emissions from this sector include emissions from the following categories: mineral industry (2A), chemical industry (2B), metal production (2C), non-energy products from fuels and solvent use (2D), electronics industry (2E), product uses as substitutes for ozone-depleting substances (2F), other product manufacture and use (2G), and other such as paper, beverage, and food production (2H).

The tables present comparative information by category and greenhouse gas to the extent that confidentiality allows.

Table 4-1. Greenhouse gas emissions from industrial processes and product use sectors by category (in Gg CO2 eq.) 1990-2022

Year	Mineral industry	Chemical industry	Metal production	Non-energy products from fuels and solvents use	Electronics Industry	Product Uses as Substitutes for Ozone Depleting Substances	Other Product Manufacture and Use	Other	Total
	2 A	2B	2C	2D	2 E	2F	2G	2H	
1990	576.03	C	347.75	C	NA	NA	NO	NO	1,641.52
1991	360.55	C	248.04	C	NA	NA	NO	NO	1,340.15
1992	221.68	C	123.70	C	NA	NA	NO	NO	852.74
1993	117.09	C	80.64	C	NA	NA	NO	NO	655.25
1994	48.01	C	53.77	C	NA	NA	NO	NO	387.33
1995	33.53	C	46.62	C	NA	NA	NO	NO	399.06
1996	49.47	C	36.29	C	NA	NA	NO	NO	491.95
1997	43.18	C	49.56	C	NA	NA	NO	NO	441.40
1998	84.67	C	80.71	C	NA	NA	NO	NO	467.63
1999	138.34	C	58.15	C	NA	NA	NO	NO	693.00
2000	142.50	C	46.51	C	NA	NA	NO	NO	708.72
2001	145.96	C	71.14	C	NA	0.24	NO	NO	433.41
2002	160.57	C	60.70	C	NA	0.94	NO	NO	576.35
2003	163.16	C	111.01	C	NA	2.85	NO	NO	685.57
2004	190.08	C	186.88	C	NA	5.18	NO	NO	834.90
2005	228.26	C	200.39	C	NA	9.44	NO	NO	941.52
2006	378.76	C	213.90	C	NA	9.21	NO	NO	1,165.70
2007	489.45	C	207.09	C	NA	9.66	NO	NO	1,266.72
2008	643.25	C	235.32	C	NA	14.90	NO	NO	1,424.74
2009	339.81	C	223.84	C	NA	22.29	NO	NO	1,090.66
2010	437.27	C	360.96	C	NA	59.36	0.55	NO	1,445.33
2011	622.23	C	437.67	C	NA	70.06	0.62	NO	1,768.68
2012	648.16	C	472.63	C	NA	98.79	0.68	NO	1,875.86
2013	662.83	C	465.32	C	NA	109.13	0.68	NO	1,885.55

Year	Mineral industry	Chemical industry	Metal production	Non-energy products from fuels and solvents use	Electronics Industry	Product Uses as Substitutes for Ozone Depleting Substances	Other Product Manufacture and Use	Other	Total
	2 A	2B	2C	2D	2 E	2F	2G	2H	
2014	776.09	C	475.36	C	NA	125.35	0.74	NO	2,021.91
2015	775.04	C	425.20	C	NA	144.82	0.79	NO	2,029.22
2016	717.96	C	367.50	C	NA	154.16	0.83	NO	1,917.53
2017	728.42	C	436.22	C	NA	192.21	0.87	NO	2,070.40
2018	632.66	C	391.92	C	NA	244.92	0.93	NO	2,019.17
2019	718.47	C	418.11	C	NA	299.47	1.00	NO	2,235.78
2020	778.50	C	443.72	C	NA	443.62	1.06	NO	2,452.39
2021	727.59	C	468.91	C	NA	383.55	1.12	NO	2,304.78
2022	819.17	C	493.67	C	NA	479.59	1.14	NO	2,571.47

Table 4-2. Greenhouse gas emissions from industry and product consumption sectors by gas in 1990-2022

Year	CO2	CH4		N2O		HFC-32		HFC-125		HFC- 134a		HFC-143a		HFC-227ea		SF6	
	GG	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG .	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,
1990	1,514.22	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
1991	1,213.13	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
1992	765.04	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
1993	567.12	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
1994	349.13	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
1995	349.38	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
1996	409.64	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
1997	367.38	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
1998	401.85	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
1999	578.45	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2000	588.73	C	C	C	C	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2001	385.26	C	C	C	C	0.00	0.00	0.00	0.05	0.00	0.11	0.00	0.07	NO	NO	NO	NO
2002	476.06	C	C	C	C	0.00	0.01	0.00	0.21	0.00	0.46	0.00	0.25	NO	NO	NO	NO
2003	572.87	C	C	C	C	0.00	0.08	0.00	0.72	0.00	1.46	0.00	0.59	NO	NO	NO	NO
2004	710.44	C	C	C	C	0.00	0.18	0.00	1.60	0.00	2.15	0.00	1.25	NO	NO	NO	NO
2005	790.56	C	C	C	C	0.00	0.28	0.00	2.63	0.00	4.35	0.00	2.18	NO	NO	NO	NO
2006	993.89	C	C	C	C	0.00	0.28	0.00	2.52	0.00	4.48	0.00	1.93	NO	NO	NO	NO
2007	1,095.23	C	C	C	C	0.00	0.28	0.00	2.42	0.00	5.14	0.00	1.83	NO	NO	NO	NO
2008	1,246.67	C	C	C	C	0.00	0.31	0.00	3.50	0.01	7.66	0.00	3.43	NO	NO	NO	NO
2009	903.43	C	C	C	C	0.00	0.40	0.00	4.61	0.01	12.71	0.00	4.56	NO	NO	NO	NO
2010	1,193.58	C	C	C	C	0.00	0.93	0.00	14.56	0.02	26.30	0.00	17.57	NO	NO	0.00002	0.55
2011	1,489.85	C	C	C	C	0.00	1.89	0.01	19.54	0.02	30.34	0.00	18.29	NO	NO	0.00003	0.62
2012	1,570.10	C	C	C	C	0.00	2.27	0.01	21.41	0.04	56.33	0.00	18.78	NO	NO	0.00003	0.68
2013	1,565.97	C	C	C	C	0.00	2.71	0.01	23.61	0.05	63.94	0.00	18.88	NO	NO	0.00003	0.68
2014	1,686.51	C	C	C	C	0.01	4.64	0.01	33.81	0.05	66.22	0.00	20.68	NO	NO	0.00003	0.74
2015	1,662.47	C	C	C	C	0.01	6.13	0.01	41.39	0.06	75.63	0.00	21.67	NO	NO	0.00003	0.79
2016	1,592.40	C	C	C	C	0.01	7.34	0.01	44.66	0.06	73.34	0.01	28.82	NO	NO	0.00004	0.83

Year	CO2	CH4		N2O		HFC-32		HFC-125		HFC- 134a		HFC-143a		HFC-227ea		SF6	
	GG	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,	GG.	Gg, CO2 eq,
2017	1,681.53	C	C	C	C	0.01	8.89	0.02	53.61	0.06	82.60	0.01	47.03	0.00002	0.07	0.00004	0.87
2018	1,563.37	C	C	C	C	0.02	10.40	0.02	66.44	0.07	95.40	0.02	72.38	0.00009	0.31	0.00004	0.93
2019	1,710.03	C	C	C	C	0.02	11.96	0.03	79.43	0.09	115.42	0.02	92.56	0.00003	0.10	0.00004	1.00
2020	1,785.26	C	C	C	C	0.02	14.45	0.04	122.91	0.12	153.60	0.03	152.04	0.00018	0.61	0.00004	1.06
2021	1,718.44	C	C	C	C	0.02	16.59	0.04	117.49	0.10	126.94	0.03	122.14	0.00012	0.39	0.00005	1.12
2022	1,868.15	C	C	C	C	0.02	14.82	0.04	121.06	0.16	207.04	0.03	136.20	0.00014	0.47	0.00005	1.14

In the Industrial Processes and Product Use sector, only emissions related to non-energy production activities are considered. Emissions related to fuel combustion are described in subcategory 1A2: Fuel combustion activities - manufacturing and construction (see Chapter 3).

The IPPU sector has 13 % of total emissions (excluding LULUCF) across Georgia.

Emissions of CO2, CH4, and N2O from the Industrial Processes and Product Use sector have decreased by 53% compared to 1990. Emissions of hydrofluorocarbons, perfluorocarbons, and SF6 from this sector have increased by 712 compared to 2001.

Since 1990, the main factor driving the reduction in emissions in this sector has been the decline in steel production as a result of economic change. However, emissions of hydrofluorocarbons have increased significantly as a result of the use of Product Uses as Substitutes for Ozone Depleting Substances. Methodological levels used in the Industrial Processes and Product Use sector are presented in the table.

Table 4-3. Methodological levels used in the Industrial Processes and Product Use

		Mineral industry	Chemical industry	Metal production	Non-energy products from fuels and solvents use	Electronics Industry	Product Uses as Substitutes for Ozone Depleting Substances	Production and use of other products	Other industrial processes, such as paper, beverage, and food manufacturing
		2 A	**2B**	**2C**	**2D**	**2 E**	**2F**	**2G**	**2H**
CO2	**Method used**	T2,T3	T3	T1,T2	T1	NA		NO, NO	NO
	Emission factor	D, CS	D, CS	D	D	NA		NO, NO	NO
CH4	**Method used**			T1	NO,NO	NA		NO,NO	NO
	Emission factor			D	NO, NO	NA		NO, NO	NO
N2O	**Method used**		T2	NO,NO	NO,NO	NA		NO,NO	NO
	Emission factor		D	NO, NO	NO, NO	NA		NO, NO	NO
HFC-32	**Method used**					NA	T1	NO, NO	NO
	Emission factor					NA	D	NO, NO	NO
HFC-	**Method used**					NA	T1	NO, NO	NO

		Mineral industry	Chemical industry	Metal production	Non-energy products from fuels and solvents use	Electronics Industry	Product Uses as Substitutes for Ozone Depleting Substances	Production and use of other products	Other industrial processes, such as paper, beverage, and food manufacturing
		2 A	2B	2C	2D	2 E	2F	2G	2H
125	Emission factor					NA	D	NO, NO	NO
HFC-134a	Method used					NA	T1	NO, NO	NO
	Emission factor					NA	D	NO, NO	NO
HFC-143a	Method used					NA	T1	NO, NO	NO
	Emission factor					NA	D	NO, NO	NO
HFC-227ea	Method used					NA	NE	T1	NO
	Emission factor					NA	NE	D	NO
SF6	Method used					NA		T1	NO
	Emission factor					NA		D	NO

4.2. Mineral industry (CRT 2A)

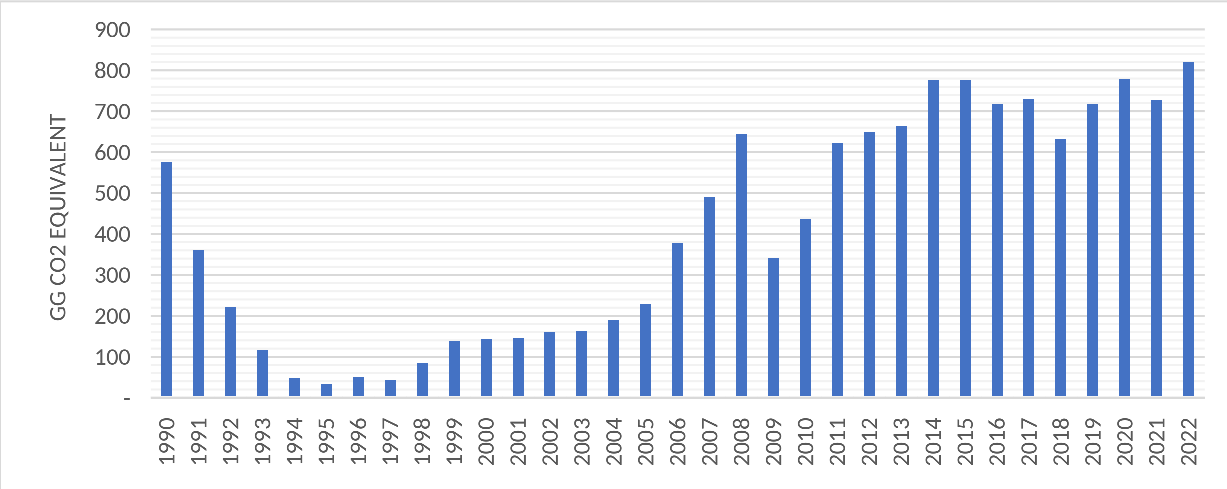
The mineral industry category in Georgia includes cement (2A1), lime (2A2), and glass production (2A3). In 1990, CO_2 emissions from the mineral industry category were at a high level (»576 Gg). In the early 90s, its amount decreased sharply and in 1995 reached a historical minimum (»34 Gg), which is associated with the difficult economic transformation of the country since the restoration of Georgia's independence. Since 1996, the amount of CO_2 emissions has begun to increase slightly, which is mainly due to very limited activity in the construction sector. Since 2005, along with the increase in cement production, CO_2 emissions have also increased sharply. In 2008, 2014 and 2020, CO2 emissions peaked (»643 Gg, »776 Gg and »779 Gg, respectively). Its sharp decline in 2009 is largely due to the economic crisis in the country. In 2022, the highest CO2 emissions from the mineral industry category were recorded during the entire accounting period (»819 Gg).

Table 4-4. CO2 emissions from the mineral industry (Gg) 1990-2022

Year	CO2 emissions (Gg)	Year	CO2 emissions (Gg)	Year	CO2 emissions (Gg)	Year	CO2 emissions (Gg)
1990	576.03	1999	138.34	2007	489.45	2015	775.04
1991	360.55	2000	142.50	2008	643.25	2016	717.96
1992	221.68	2001	145.96	2009	339.81	2017	728.42
1993	117.09	2002	160.57	2010	437.27	2018	632.66
1994	48.01	2003	163.16	2011	622.23	2019	718.47

Year	CO2 emissions (Gg)	Year	CO2 emissions (Gg)	Year	CO2 emissions (Gg)	Year	CO2 emissions (Gg)
1995	33.53	2004	190.08	2012	648.16	2020	778.50
1996	49.47	2005	228.26	2013	662.83	2021	727.59
1997	43.18	2006	378.76	2014	776.09	2022	819.17
1998	84.67						

Diagram 1. CO2 emissions from the mineral industry (Gg) 1990-2022.



4.2.1. *Cement production (CRT 2A1)*

4.2.1.1. *Category description*

Only JSC HeidelbergCement Georgia produces Clinker in Georgia. It has factories in Rustavi and Kaspi. Clinker is an intermediate product of cement. Since 2019, clinker has been produced only using the dry method at the Rustavi and Kaspi cement plants, although until 2019, clinker was also produced using the wet method at the Rustavi cement plant. Carbon dioxide (CO_2) is produced during the calcination of limestone during the production of clinker.

In 1990, CO2 emissions from the cement production source category were at a high level . In the early 1990s, its amount decreased sharply and reached a historical minimum in 1995, which is associated with the difficult economic transformation of the country since the restoration of Georgia's independence. In 1992-2004, CO2 emissions were at a low level, which is associated with very limited activity in the construction sector. Since 2005, along with the increase in cement production, CO2 emissions have also been increasing. In 2008, 2014 and 2020, CO2 emissions peaked. Its sharp decline in 2009 is largely due to the economic crisis in the country. In 2022, the highest CO2 emissions from the cement production source category were recorded during the entire accounting period.

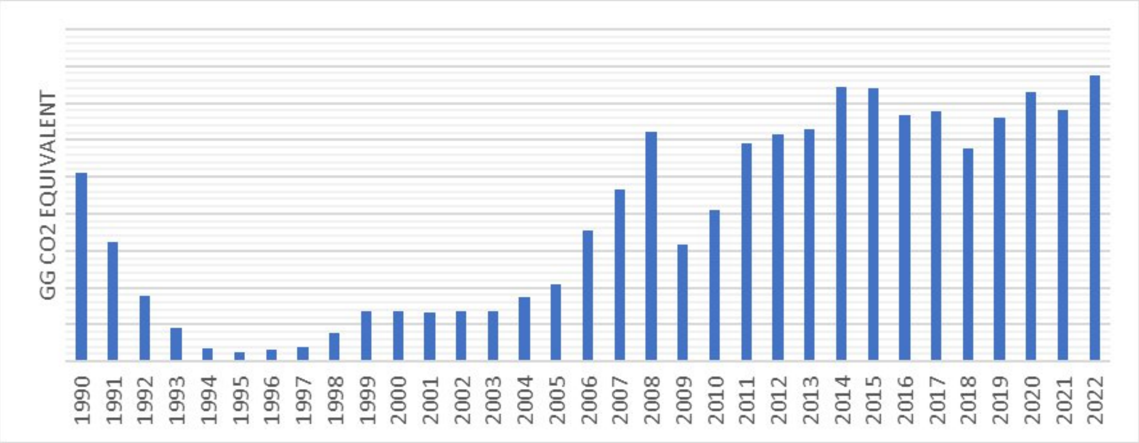
Cement production (2A1) has been the key source category of CO_2 emissions since 1990, without any interruption.

Table 4-5. CO2 Emissions from cement production based on consumed lime (Gg) 1990-2022

Year	Amount of limestone raw material (T)	Emission factor (t CO2/t calcite used)	Emission factor (t CO2/t magnesite used)	Calcite fraction share	Magnesite fraction share	CO2 emission (T)	CO2 emission (GG)
1990	C	0.43971	0.52197	0.96[35]	0.01[36]	C	C
1991	C	0.43971	0.52197	0.96	0.01	C	C
1992	C	0.43971	0.52197	0.96	0.01	C	C
1993	C	0.43971	0.52197	0.96	0.01	C	C
1994	C	0.43971	0.52197	0.96	0.01	C	C
1995	C	0.43971	0.52197	0.96	0.01	C	C
1996	C	0.43971	0.52197	0.96	0.01	C	C
1997	C	0.43971	0.52197	0.96	0.01	C	C
1998	C	0.43971	0.52197	0.96	0.01	C	C
1999	C	0.43971	0.52197	0.96	0.01	C	C
2000	C	0.43971	0.52197	0.96	0.01	C	C
2001	C	0.43971	0.52197	0.96	0.01	C	C
2002	C	0.43971	0.52197	0.96	0.01	C	C
2003	C	0.43971	0.52197	0.96	0.01	C	C
2004	C	0.43971	0.52197	0.96	0.01	C	C
2005	C	0.43971	0.52197	0.96	0.01	C	C
2006	C	0.43971	0.52197	0.96	0.01	C	C
2007	C	0.43971	0.52197	0.96	0.01	C	C
2008	C	0.43971	0.52197	0.96	0.01	C	C
2009	C	0.43971	0.52197	0.96	0.01	C	C
2010	C	0.43971	0.52197	0.96	0.01	C	C
2011	C	0.43971	0.52197	0.96	0.01	C	C
2012	C	0.43971	0.52197	0.96	0.01	C	C
2013	C	0.43971	0.52197	0.96	0.01	C	C
2014	C	0.43971	0.52197	0.96	0.01	C	C
2015	C	0.43971	0.52197	0.96	0.01	C	C
2016	C	0.43971	0.52197	0.96	0.01	C	C
2017	C	0.43971	0.52197	0.96	0.01	C	C
2018	C	0.43971	0.52197	0.96	0.01	C	C
2019	C	0.43971	0.52197	0.96	0.01	C	C
2020	C	0.43971	0.52197	0.96	0.01	C	C
2021	C	0.43971	0.52197	0.96	0.01	C	C
2022	C	0.43971	0.52197	0.96	0.01	C	C

[35] For the Kaspi plant, this value is equal to 0.90.
[36] For the Kaspi factory, this value is equal to 0.00.

Figure 4-1. CO2 emissions from cement production (Gg) 1990 – 2022



According to paragraph 50 of Georgia's Nationally Determined Contribution, information on sulfur dioxide (SO2) emissions is presented in a table in accordance with the Georgian Air Pollutant Emissions Inventory (https://www.ceip.at/status-of-reporting-and-review-results/2024-submission).

Table 4-6. SO2 Emissions from Cement Production (Gg) 1990-2022

Year	SO2 emissions (Gg)	Year	SO2 emissions (Gg)	Year	SO2 emissions (Gg)	Year	SO2 emissions (Gg)
1990	0.77	1999	0.12	2007	0.41	2015	0.66
1991	0.52	2000	0.14	2008	0.40	2016	0.62
1992	0.48	2001	0.17	2009	0.13	2017	0.66
1993	0.30	2002	0.18	2010	0.24	2018	0.60
1994	0.14	2003	0.20	2011	0.42	2019	0.70
1995	0.08	2004	0.24	2012	0.50	2020	0.73
1996	0.07	2005	0.34	2013	0.51	2021	0.71
1997	0.08	2006	0.33	2014	0.63	2022	0.63
1998	0.09						

4.2.1.2. *Methodological issues*

Estimation method

CO2 emissions from cement production are estimated using the IPCC 2006 Tier 3 approach. According to the Tier 3 approach, CO2 emissions from clinker production are calculated as follows:

$$CO_{2Emissions} = \sum_{i} (EF_i \times M_i \times F_i) - M_d \times C_d \times (1 - F_d) \times EF_d + \sum_{k} (M_k \times X_k \times EF_k)$$

Where:

$CO_{2Emissions}$ – carbon dioxide emissions from cement production;
EF_i – emission factor for carbonate i;
M_i – mass of carbonate consumed in the furnace;
F_i – calcination fraction;
M_d – mass of unprocessed calciner dust;
C_d – fraction of unrefined carbonate;
F_d – a fraction of calcined dust;
EF_d – emission factor of uncalcined carbonate;
M_k – mass of non-combustible organic raw materials;
X_k – fraction of non-combustible organic raw materials
EF_k – emission factor for non-combustible organic raw materials

According to information from clinker-producing plants, unrefined calciner kiln dust is generated in negligible quantities and is fully recycled into the production process. According to the methodological issues of the IPCC 2006 Guidelines, Volume 3, Chapter 2 (pp. 2-10), $M_d \times C_d \times (1 - F_d) \times EF_d$ is considered to be zero. In addition, since the mass of non-combustible organic raw materials is not indicated in the raw material, $\sum_k (M_k \times X_k \times EF_k)$ is considered to be zero.

Emission factor

CO2 emissions from cement production using the IPCC 2006 Tier 3 approach, the emission factor is taken from Table 2.1 of Chapter 2, Volume 3 of the IPCC 2006 Guidelines. Non-energy emissions from cement production are estimated from clinker production. Since the limestone used for clinker production contains calcite and magnesite from this production, emission factors of 0.43971 and 0.52197, respectively (uncertainty ±2 %) have been used to estimate CO2 emissions.

Initial data

In Georgia, only JSC HeidelbergCement Georgia produces clinker at its Kaspi and Rustavi plants. Carbon dioxide emissions from 2008 to 2022 are estimated based on data provided by the plants, while data for 1990–2007 are reconstructed using the overlap method. Initial data are provided separately for each plant.

According to available data, the raw materials used in clinker production are limestone, sand, iron-containing materials, and clay, rarely - small amounts of gypsum and granulated slag. Of the described raw materials, the carbonate content is high only in limestone and gypsum. Since the amount of gypsum used in production is insignificant (2,485 tons in 28 years) and fragmentary (in 2010, 2011, 2012, and 2017), only limestone was considered from the raw materials for the assessment of CO_2 emissions.

JSC HeidelbergCement Georgia extracts limestone for the production of clinker at the Kaspi plant from the Kavtiskhevi deposit, in which the calcite content »is 90% (uncertainty ±3 %), while the Rustavi plants are supplied with limestone from the Dedoplistskaro deposit. The chemical composition of the limestone extracted from the Dedoplistskaro deposit is:

Calcite as CaCO3 - maximum 96.00%
Silica as SiO2 - maximum 1.00%
Iron as Fe2O3 - maximum 0.30%
Aluminum as Al2O3 - maximum 0.35%
Magnesium as MgCO3 - maximum 1.25%
Below is the total amount of limestone consumed by all factories by year.

Table 4-7. Amount of limestone consumed (tons) in 1990 - 2022

Year	Limestone consumed (t)	Year	Limestone consumed (t)	Year	Limestone consumed (t)	Year	Limestone consumed (t)
1990	1,183,615	1999	313,245	2007	1,159,575	2015	1,802,294
1991	753,201	2000	319,025	2008	1,507,837	2016	1,632,066
1992	413,348	2001	307,556	2009	764,534	2017	1,657,111
1993	208,830	2002	318,108	2010	1,002,235	2018	1,405,149
1994	81,385	2003	316,365	2011	1,444,539	2019	1,636,834
1995	54,134	2004	405,090	2012	1,506,099	2020	1,808,057
1996	77,990	2005	485,833	2013	1,540,131	2021	1,687,360
1997	86,340	2006	898,083	2014	1,813,183	2022	1,915,512
1998	182,222						

4.2.1.3. *Description of the flexibility used*

Flexibility not applied

4.2.1.4. *Uncertainty assessment and time series consistency*

Uncertainty assessment

See information in Annex II.

Time series consistency

An overlap method was used to reconstruct the baseline data required for the years 1990-2007 estimating CO_2 emissions from cement production under the IPCC 2006 Tier 3 approach for the full reporting period (1990-2022).

In the case of cement production, the overlap method involves reconstructing the amount of limestone used as raw material for the years 1990–2007. The relationship between limestone used as raw material and cement produced in Georgia is estimated for the period 2008–2015 when both quantities were available. The data on limestone used for clinker production in Georgia is reconstructed using the following formula:

$$y_0 = x_0 \times \left[\frac{1}{(n - m + 1)} \times \sum_{i=m}^{n} \frac{y_i}{x_i}\right]$$

Where,

y_0 – recalculated data using the overlap method;

x_0 – estimate developed using the previously used method;

y_i x_i – estimates prepared using the new and previously used methods over an overlapping period, denoted by years m to n.

According to the data of the National Statistics Service of Georgia, the amount of cement consumed in Georgia is described for the reporting period 1990 - 2015, and the initial data provided by the enterprise for all factories for the years 2008 - 2022. Accordingly, the relationship between limestone used as raw material and cement produced in Georgia is estimated for the period 2008 - 2015, when both values were available.

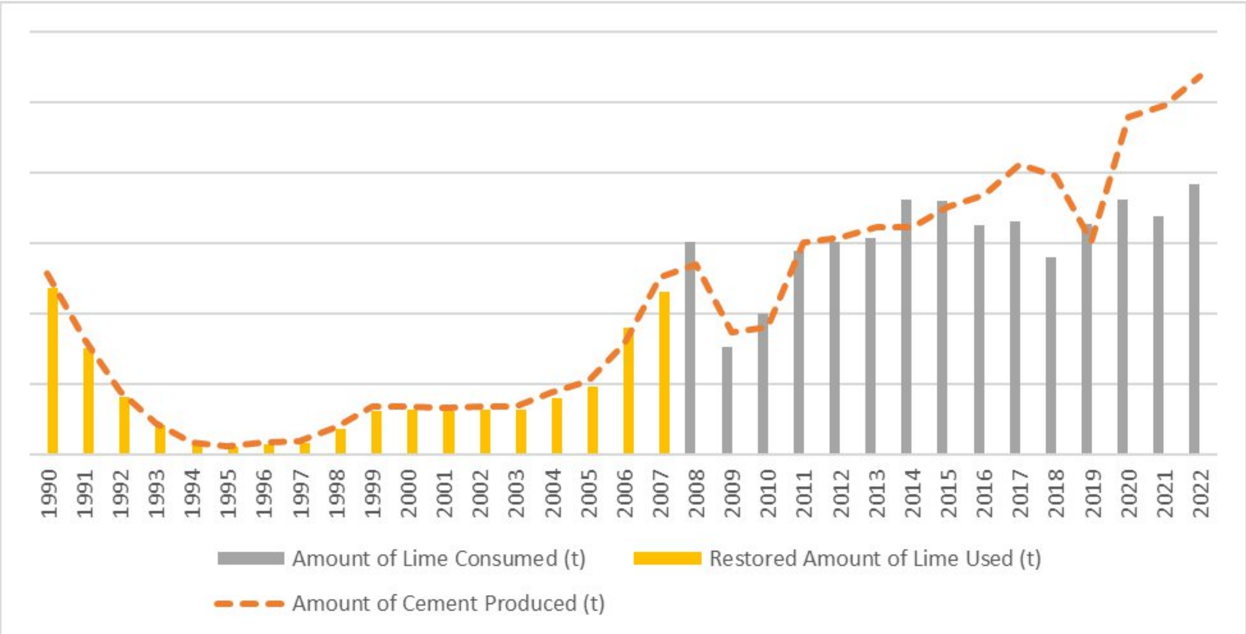
Thus, n = 2015, m = 2008

The available data is given in the table:

Table 4-8. The mass of limestone used as raw material calculated by the overlap method (tons) 1990 - 2007

Year	Amount of cement produced (t)	Amount of limestone used as raw material (t)	Year	Amount of cement produced (t)	Amount of limestone used as raw material (t)	Year	Amount of cement produced (t)	Amount of limestone used as raw material (t)
1990	1,290,000.0		2001	335,200.0		2012	1,545,500.0	1,506,099.0
1991	820,900.0		2002	346,700.0		2013	1,618,700.0	1,540,131.0
1992	450,500.0		2003	344,800.0		2014	1,618,700.0	1,813,183.0
1993	227,600.0		2004	441,500.0		2015	1,758,600.0	1,802,294.0
1994	88,700.0		2005	529,500.0		2016	1,844,000.0	1,632,066.0
1995	59,000.0		2006	789,500.0		2017	2,057,802.1	1,657,111.0
1996	85,000.0		2007	1,263,800.0		2018	1,980,499.9	1,405,149.0
1997	94,100.0		2008	1,351,000.0	1,507,837.0	2019	1,514,710.3	1,636,834.0
1998	198,600.0		2009	870,400.0	764,534.0	2020	2,392,312.1	1,808,057.0
1999	341,400.0		2010	907,000.0	1,002,235.0	2021	2,479,262.6	1,687,360.0
2000	347,700.0		2011	1,502,000.0	1,444,539.0	2022	2,682,932.4	1,915,512.0

Figure 4-2. Overlap method



The calculated amount of limestone used as raw material in the production of clinker by the overlap method is given in the table.

Table 4-9. The mass of limestone used as raw material calculated by the overlap method (t) 1990-2007

Year	Amount of cement produced (t)	Amount of limestone used as raw material (t)	Year	Amount of cement produced (t)	Amount of limestone used as raw material (t)	Year	Amount of cement produced (t)	Amount of limestone used as raw material (t)
1990	1,290,000.0	C	2001	335,200.0	C	2012	1,545,500.0	C
1991	820,900.0	C	2002	346,700.0	C	2013	1,618,700.0	C
1992	450,500.0	C	2003	344,800.0	C	2014	1,618,700.0	C
1993	227,600.0	C	2004	441,500.0	C	2015	1,758,600.0	C
1994	88,700.0	C	2005	529,500.0	C	2016	1,844,000.0	C
1995	59,000.0	C	2006	789,500.0	C	2017	2,057,802.1	C
1996	85,000.0	C	2007	1,263,800.0	C	2018	1,980,499.9	C
1997	94,100.0	C	2008	1,351,000.0	C	2019	1,514,710.3	C
1998	198,600.0	C	2009	870,400.0	C	2020	2,392,312.1	C
1999	341,400.0	C	2010	907,000.0	C	2021	2,479,262.6	C
2000	347,700.0	C	2011	1,502,000.0	C	2022	2,682,932.4	C

4.2.1.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.2.1.6. *Category-specific explained, and justified recalculation, description of changes related to the verification process and impact on emission trends.*

For the full reporting period (1990-2022), CO2 emissions from cement production are estimated using the IPCC 2006 Tier 3 approach. The previous inventory report covered the reporting period (1990-2017), while greenhouse gas emissions were estimated using the IPCC 2006 Tier 2 approach. In accordance with the principle of time consistency, as the assessment approach improves, greenhouse gas emissions have been recalculated for the entire previous reporting period (1990-2017). The differences in CO2 emissions between the approaches are given in the table below.

Table 4-10. Differences among CO2 emissions (Gg)

Year	IPCC 2006 "Level 3" CO2 emission (Gg)	IPCC 2006 "Level 2 " CO2 emission (Gg)	Difference CO2 emission (Gg)	Year	IPCC 2006 "Level 3" CO2 emission (Gg)	IPCC 2006 "Level 2 " CO2 emission (Gg)	Difference CO2 emission (Gg)
1990	C	C	**4.34**	2004	C	C	**1.48**
1991	C	C	**2.76**	2005	C	C	**1.78**
1992	C	C	**1.51**	2006	C	C	**46.36**
1993	C	C	**0.77**	2007	C	C	**-29.94**
1994	C	C	**0.30**	2008	C	C	**73.78**
1995	C	C	**0.19**	2009	C	C	**29.09**
1996	C	C	**0.29**	2010	C	C	**30.76**
1997	C	C	**0.31**	2011	C	C	**17.04**
1998	C	C	**0.67**	2012	C	C	**23.37**

Year	IPCC 2006 "Level 3" CO_2 emission (Gg)	IPCC 2006 "Level 2 " CO_2 emission (Gg)	Difference CO_2 emission (Gg)	Year	IPCC 2006 "Level 3" CO_2 emission (Gg)	IPCC 2006 "Level 2 " CO_2 emission (Gg)	Difference CO_2 emission (Gg)
1999	C	C	**1.15**	2013	C	C	**25.98**
2000	C	C	**1.17**	2014	C	C	**29.59**
2001	C	C	**1.13**	2015	C	C	**32.56**
2002	C	C	**1.16**	2016	C	C	**25.00**
2003	C	C	**1.16**	2017	C	C	**17.54**

4.2.1.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission estimation within the category is linked to the establishment of a common national transparency system.

4.2.2. *Lime production (CRT 2A2)*

4.2.2.1. *Category description*

Several companies produce lime in Georgia, including “Industria Lime LLC”, “Gwirgvini LLC”, “Agari Sugar Company LLC”, and “Elba Export LLC”. Lime is produced by processing raw materials obtained from limestone deposits.

Lime production (2A2) is a source of carbon dioxide (CO_2) emissions. Carbon dioxide is produced during the calcination of limestone in the production of lime.

In 1990, CO_2 emissions from the lime production source category were at a high level (»38 Gg). In the early 1990s, its amount decreased sharply and reached a historical minimum (»0.08 Gg) in 1995, which is associated with the difficult economic transformation of the country since the restoration of Georgia's independence. During the entire decade of 1991-2000, CO_2 emissions were at a low level, which is associated with very limited activity in the construction sector. Since 2001, along with the increase in lime production, CO_2 emissions have also increased. In 2003 and 2013, CO_2 emissions peaked (»21 Gg and »31 Gg, respectively). In 2019, the highest CO_2 emissions from the lime production source category were recorded over the entire accounting period (»48 Gg). Emissions decreased by 24% in 2020-21, which may be largely due to pandemic-related restrictions. In 2022, CO_2 emissions increased by 3%, along with a slight increase in production.

Since 1990Lime production (2A2) has not been a key source category.

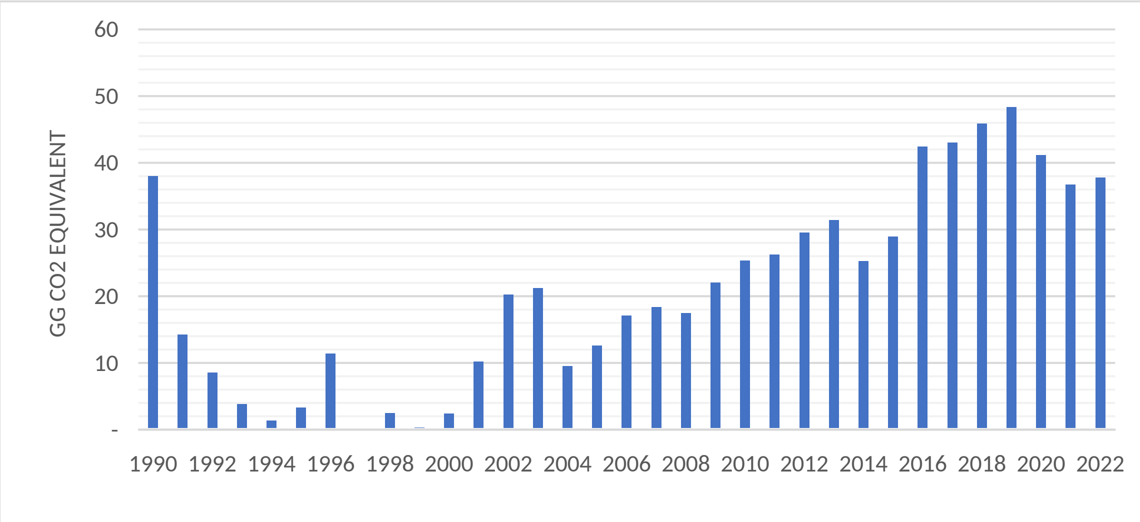
Table 4-11. CO_2 emissions from lime production (Gg) 1990 - 2022

Year	Amount of lime produced (T)	Emission factor (t CO_2 / t lime produced)	Calciner-bell kiln dust (LKD) correction factor	Hydrated lime correction factor[37]	CO_2 emission (T)	CO_2 emission (Gg)
1990	51,230.62	0.75	1.02	0.97	38,015.68	38.02
1991	19,185.56	0.75	1.02	0.97	14,236.64	14.24
1992	11,511.33	0.75	1.02	0.97	8,541.99	8.54
1993	5,185.29	0.75	1.02	0.97	3,847.74	3.85
1994	1,866.70	0.75	1.02	0.97	1,385.19	1.39
1995	4,459.35	0.75	1.02	0.97	3,309.06	3.31
1996	15,348.45	0.75	1.02	0.97	11,389.31	11.39
1997	103.71	0.75	1.02	0.97	76.95	0.08
1998	3,318.58	0.75	1.02	0.97	2,462.55	2.46
1999	414.82	0.75	1.02	0.97	307.82	0.31

[37] The hydrated lime correction factor for LLC Industry lime is different and equals 0.986, which is taken into account in the calculation.

Year	Amount of lime produced (T)	Emission factor (t CO_2 / t lime produced)	Calciner-bell kiln dust (LKD) correction factor	Hydrated lime correction factor[37]	CO_2 emission (T)	CO_2 emission (Gg)
2000	3,214.88	0.75	1.02	0.97	2,385.60	2.39
2001	13,792.86	0.75	1.02	0.97	10,234.99	10.23
2002	27,274.60	0.75	1.02	0.97	20,239.12	20.24
2003	28,622.78	0.75	1.02	0.97	21,239.53	21.24
2004	12,859.51	0.75	1.02	0.97	9,542.40	9.54
2005	17,007.74	0.75	1.02	0.97	12,620.59	12.62
2006	23,022.67	0.75	1.02	0.97	17,083.97	17.08
2007	22,161.59	0.75	1.02	0.97	18,338.28	18.34
2008	829.74	0.75	1.02	0.97	17,504.85	17.50
2009	4,430.22	0.75	1.02	0.97	22,037.72	22.04
2010	5,598.35	0.75	1.02	0.97	25,308.99	25.31
2011	6,766.47	0.75	1.02	0.97	26,208.70	26.21
2012	8,699.86	0.75	1.02	0.97	29,508.06	29.51
2013	10,633.24	0.75	1.02	0.97	31,395.11	31.40
2014	12,566.63	0.75	1.02	0.97	25,271.91	25.27
2015	14,500.02	0.75	1.02	0.97	28,968.57	28.97
2016	30,109.92	0.75	1.02	0.97	42,413.51	42.41
2017	13,976.14	0.75	1.02	0.97	43,006.37	43.01
2018	61,493.91	0.75	1.02	0.97	45,902.18	45.90
2019	64,674.04	0.75	1.02	0.97	48,354.70	48.35
2020	55,002.92	0.75	1.02	0.97	41,120.92	41.12
2021	49,344.77	0.75	1.02	0.97	36,730.67	36.73
2022	50,934.73	0.75	1.02	0.97	37,796.12	37.80

Diagram 4. CO2 emissions from lime production (Gg) 1990 - 2022.



4.2.2.2. *Methodological issues*

Evaluation method

CO_2 emissions from lime production are estimated using the IPCC 2006 Tier 2 approach. According to the Tier 2 method, CO_2 emissions from lime production are calculated as follows:

$$CO_2 Emissions = \sum_i \left(EF_{lime,i} \times M_{l,i} \times CF_{lkd,i} \times C_{h,i}\right)$$

Where,

CO_2 Emissions – Carbon dioxide emissions from lime production, t;

$EF_{lime,i}$ – emission factor for type i of lime produced, t CO_2 / t lime;
$CF_{lkd,i}$ – LKD correction factor for the type of lime produced i;
$C_{h,i}$ – correction factor for hydrated lime produced according to type i of lime;
i – a type of lime produced.

Emission factor

CO2 emissions from lime production using the IPCC 2006 Tier 2 approach, the emission factor is taken in accordance with Table 2.4 of Volume 3, Chapter 2 of the IPCC 2006 Guidelines. Since lime production in Georgia is carried out using the hydration method, an emission factor of 0.75 has been used to estimate CO2 emissions from this production.

Initial data

In Georgia, "Industria Lime LLC", "Gwirgvini LLC", "Agari Sugar Company LLC" and "Elba Export LLC" produce lime. Carbon dioxide emissions from 2007 to 2022 are estimated for "Industria Lime LLC", and from 2018 to 2022 are estimated based on data provided by the remaining factories, since data from the factories is available from the mentioned years. Accordingly, data for 1990–2017 were obtained from the Statistics Service of Georgia. Initial data for each factory are provided separately.

In addition, the correction factors for LKD and hydrated lime are selected as 1.02 and 0.97, respectively, in accordance with the same IPCC manual, Volume 3, Chapter 2, Paragraph 2.3.1.3 (selection of initial data, pp. 2.23-2.24). Except for LLC "Industria Kirisa", for which the factory's hydrated lime correction factor of 0.986 was used.

Table 4-12. Amount of lime produced (t) in 1990 - 2022

Year	Consumed Limestone (t)	Year	Consumed Limestone (t)	Year	Consumed Limestone (t)	Year	Consumed Limestone (t)
1990	51,230.62	1999	414.82	2007	22,161.59	2015	14,500.02
1991	19,185.56	2000	3,214.88	2008	829.74	2016	30,109.92
1992	11,511.33	2001	13,792.86	2009	4,430.22	2017	13,976.14
1993	5,185.29	2002	27,274.60	2010	5,598.35	2018	61,493.91
1994	1,866.70	2003	28,622.78	2011	6,766.47	2019	64,674.04
1995	4,459.35	2004	12,859.51	2012	8,699.86	2020	55,002.92
1996	15,348.45	2005	17,007.74	2013	10,633.24	2021	49,344.77
1997	103.71	2006	23,022.67	2014	12,566.63	2022	50,934.73
1998	3,318.58						

4.2.2.3. *Description of the flexibility used*

Flexibility not applied

4.2.2.4. *Uncertainty assessment and time series consistency*

Uncertainty assessment

See information in Annex II.

Time series consistency

For the entire reporting period (1990-2022), carbon dioxide emissions are estimated using the same IPCC 2006 “Level 2” approach. During this period, there were two sources of initial data providers: 1. The National Statistics Office of Georgia (1990-2017) and 2. The factories themselves (Ltd. “Industria Kiri” 2007-2022, and the remaining factories 2017-2022).

It is recommended to use the plant data source for CO2 emissions from lime production for the full reporting period. Given this, a surrogate method has been used to restore the initial data corresponding to the plant data source for the years 1990 - 2017 (including the years 2007 - 2017 for Industry Lime LLC) to ensure consistency of the time series.

In the case of lime production, the surrogate method involves reconstructing the amount of limestone used as raw material according to the data of the factories for the years 1990-2017. The data of the National Statistics Office of Georgia on the amount of lime consumed for the years 1990-2017 are a surrogate value. Limestone data in Georgia are reconstructed using the following formula:

$$y_0 = y_t \times \frac{s_0}{s_t}$$

Where,

y – initial data in year 0 and t ;

s – surrogate data in years 0 and t.

According to the data of the National Statistics Office of Georgia, the amount of limestone consumed in Georgia is described for the reporting period 1990 - 2017, and the initial data provided by the enterprise for all factories is for the years 2017 - 2022. Accordingly, the initial data close to the factory data is estimated for the period 1990 - 2017.

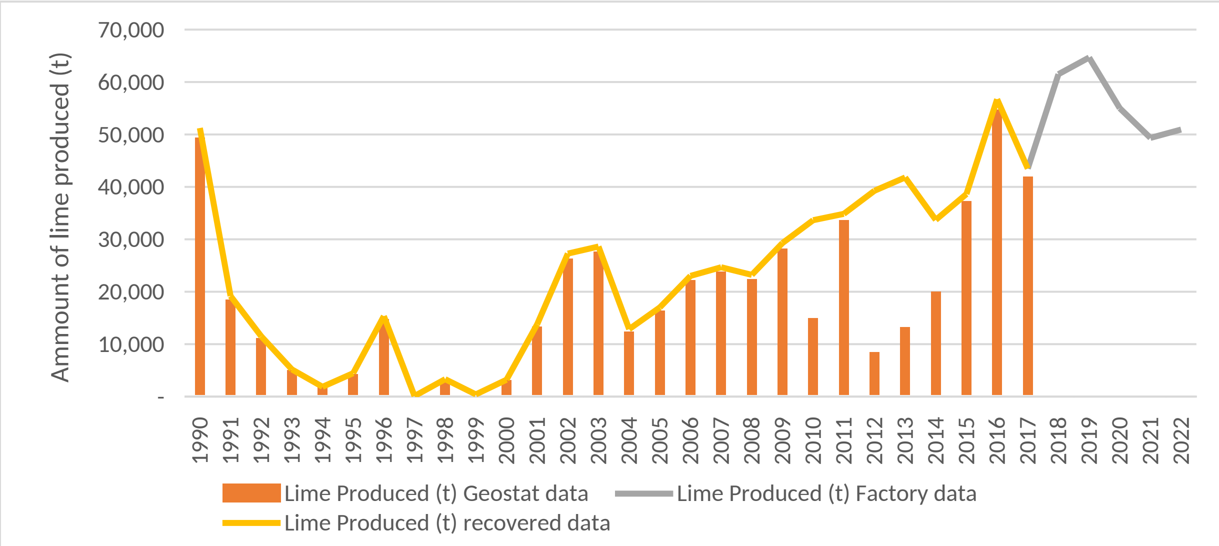
The available data on limestone consumption by source are given in the table:

Table 4-13. Data on limestone consumption by the source before using the surrogate method (t) 1990-2022

Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)	Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)	Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)
1990	49,400.00		2001	13,300.00		2012	8,438.37	
1991	18,500.00		2002	26,300.00		2013	13,238.62	
1992	11,100.00		2003	27,600.00		2014	20,058.47	
1993	5,000.00		2004	12,400.00		2015	37,259.64	
1994	1,800.00		2005	16,400.00		2016	54,691.60	
1995	4,300.00		2006	22,200.00		2017	41,939.00	43,493.14
1996	14,800.00		2007	23,790.00		2018		61,493.91
1997	100.00		2008	22,390.78		2019		64,674.04
1998	3,200.00		2009	28,241.83		2020		55,002.92
1999	400.00		2010	14,954.11		2021		49,344.77

Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)	Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)	Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)
2000	3,100.00		2011	33,610.48		2022		50,934.73

Figure 4-3. Surrogate method



The amount of lime produced corresponding to the factory data calculated using the surrogate method is given in the table.

Table 4-14. The mass of limestone used as raw material calculated by the surrogate method (t) 19990 - 2016

Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)	Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)	Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)
1990	49,400.00	5,185.29	2001	13,300.00	13,792.86	2012	8,438.37	39,261.49
1991	18,500.00	1,866.70	2002	26,300.00	27,274.60	2013	13,238.62	41,794.62
1992	11,100.00	4,459.35	2003	27,600.00	28,622.78	2014	20,058.47	33,708.16
1993	5,000.00	15,348.45	2004	12,400.00	12,859.51	2015	37,259.64	38,640.38
1994	1,800.00	103.71	2005	16,400.00	17,007.74	2016	54,691.60	56,718.32
1995	4,300.00	3,318.58	2006	22,200.00	23,022.67	2017	41,939.00	43,493.14
1996	14,800.00	414.82	2007	23,790.00	24,671.59	2018		61,493.91
1997	100.00	3,214.88	2008	22,390.78	23,220.52	2019		64,674.04
1998	3,200.00	5,185.29	2009	28,241.83	29,288.39	2020		55,002.92

Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)	Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)	Year	Geostat data: Amount of limestone used as raw material (t)	Total data of factories: Amount of limestone used as raw material (t)
1999	400.00	1,866.70	2010	14,954.11	33,644.24	2021		49,344.77
2000	3,100.00	4,459.35	2011	33,610.48	34,855.99	2022		50,934.73

4.2.2.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.2.2.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

For the full reporting period (1990-2022), CO2 emissions from lime production are estimated using the IPCC 2006 Tier 2 approach. The previous inventory report covered the reporting period (1990-2017), and greenhouse gas emissions were estimated based on data provided by the National Statistics Service of Georgia, while for the years 2018-2022, baseline data from factories were used to estimate greenhouse gas emissions. In accordance with the principle of timeliness, as the baseline data sources improved, greenhouse gas emissions were recalculated for the entire previous reporting period (1990-2017). The differences in CO2 emissions between the approaches are given in the table below.

Table 4-15. Difference of CO2 Emissions (Gg)

Year	Estimated CO2 emissions (Gg) according to Geostat data	Estimated CO2 emissions from factories (Gg)	Difference CO2 emission (Gg)	Year	Estimated CO2 emissions (Gg) according to Geostat data	Estimated CO2 emissions from factories (Gg)	Difference CO2 emission (Gg)
1990	36.66	38.02	**-1.36**	2004	9.20	9.54	**-0.34**
1991	13.73	14.24	**-0.51**	2005	12.17	12.62	**-0.45**
1992	8.24	8.54	**-0.31**	2006	16.47	17.08	**-0.61**
1993	3.71	3.85	**-0.14**	2007	19.55	18.34	**1.21**
1994	1.34	1.39	**-0.05**	2008	33.50	17.50	**16.00**
1995	3.19	3.31	**-0.12**	2009	39.71	22.04	**17.67**
1996	10.98	11.39	**-0.41**	2010	32.25	25.31	**6.94**
1997	0.07	0.08	**-0.00**	2011	46.13	26.21	**19.92**
1998	2.37	2.46	**-0.09**	2012	29.31	29.51	**-0.19**
1999	0.30	0.31	**-0.01**	2013	33.33	31.40	**1.93**
2000	2.30	2.39	**-0.09**	2014	30.83	25.27	**5.56**
2001	9.87	10.23	**-0.37**	2015	45.86	28.97	**16.89**
2002	19.52	20.24	**-0.72**	2016	60.65	42.41	**18.24**
2003	20.48	21.24	**-0.76**	2017	53.39	43.01	**10.38**

4.2.2.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission assessment within the category is linked to the establishment of a common national transparency system.

4.2.3. *Glass production (CRT 2A3)*

4.2.3.1. *Category description*

The mineral industry sub-sector includes production and technologies related to the thermal processing of carbonates, one of which is used in glass production. Therefore, CO_2 emissions from glass production are included in this source category.

In Georgia, only JSC "Mina" produces glass. The JSC "Mina" factory is located in Ksani. According to 2022 data, the enterprise uses two 100 t/day capacity furnaces with appropriate infrastructure to produce glass containers. CO_2 is generated during the calcination process of limestone, dolomite, and soda during the production of glass containers.

In 1990, CO2 emissions from the glass production source category were at a high level, and in 1992 they reached a peak. In the following years, its amount decreased sharply and for almost two decades it was stable at a low level. In 2009, CO2 emissions reached a historical minimum, which is associated with the economic crisis in Georgia. Since 2010, CO2 emissions have also increased along with the increase in glass production. In 2016, a peak of CO2 emissions was noted. In 2017-2022, glass production was stable and CO2 emissions were also characterized by stability.

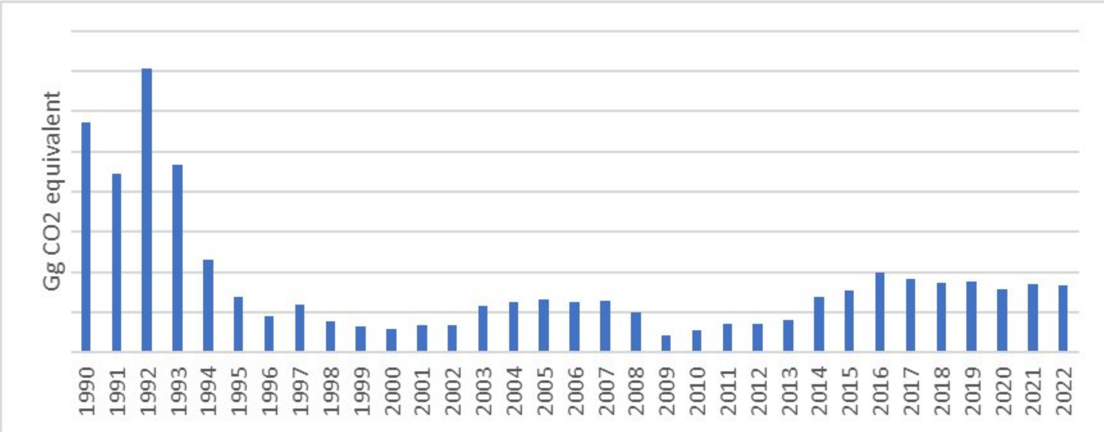
Glass production (2A3) has not been a major source category of CO_2 emissions since 1990, without any interruption.

Table 4-16. CO2 Emissions from glass production (Gg) in 1990 - 2022

Year	Glass containers produced (tons)	Glass production emission factor (t CO2 / t glass)	Share of cullet used	CO2 emission (T)	CO2 emission (GG)
1990	C	0.21	0.70	C	C
1991	C	0.21	0.70	C	C
1992	C	0.21	0.70	C	C
1993	C	0.21	0.70	C	C
1994	C	0.21	0.70	C	C
1995	C	0.21	0.70	C	C
1996	C	0.21	0.70	C	C
1997	C	0.21	0.70	C	C
1998	C	0.21	0.70	C	C
1999	C	0.21	0.70	C	C
2000	C	0.21	0.70	C	C
2001	C	0.21	0.70	C	C
2002	C	0.21	0.70	C	C
2003	C	0.21	0.70	C	C
2004	C	0.21	0.65	C	C
2005	C	0.21	0.65	C	C
2006	C	0.21	0.70	C	C
2007	C	0.21	0.65	C	C
2008	C	0.21	0.70	C	C
2009	C	0.21	0.70	C	C
2010	C	0.21	0.70	C	C
2011	C	0.21	0.65	C	C
2012	C	0.21	0.70	C	C
2013	C	0.21	0.65	C	C
2014	C	0.21	0.65	C	C
2015	C	0.21	0.65	C	C
2016	C	0.21	0.91	C	C
2017	C	0.21	0.91	C	C
2018	C	0.21	0.91	C	C
2019	C	0.21	0.91	C	C
2020	C	0.21	0.91	C	C

Year	Glass containers produced (tons)	Glass production emission factor (t CO_2 / t glass)	Share of cullet used	CO_2 emission (T)	CO_2 emission (GG)
2021	C	0.21	0.91	C	C
2022	C	0.21	0.91	C	C

Figure 4-4. CO 2 - of Emissions from glass production (Gg) 1990-2022



4.2.3.2. *Methodological issues*

Evaluation method

CO_2 emissions from glass production are estimated using the IPCC 2006 Tier 2 approach. According to the Tier 2 method, CO_2 emissions from glass production are calculated as follows:

$$CO_{2Emissions} = \sum_i [M_{g,i} \times EF_i \times (1 - CR_i)]$$

Where:

$CO_{2Emissions}$ – carbon dioxide emissions from cement production;

EF_i – emission factor for glass type i, t CO_2/t glass;

M_{gi} – mass of produced glass, t;

CR_i – share of glass waste in glass production, t;

Emission factor

CO_2 emissions from glass production using the IPCC 2006 Tier 2 approach, the emission factor is taken from Table 2.6 of Volume 3, Chapter 2 of the IPCC 2006 Guidelines. Since glass containers are produced in Georgia from this production, an emission factor of 0.21 was used to estimate CO_2 emissions.

Initial data

In Georgia, only JSC Mina in the village of Ksani produces glass containers. Carbon dioxide emissions from 2003 to 2022 are estimated based on data provided by the factory, while data for 1990–2002 are reconstructed using the overlap method.

Below is the factory's initial data - the number of glass containers by year is presented in a tabular format.

Table 4-17. Quantity of glass containers produced (t) in 1990 - 2022

Year	Glass containers produced (tons)	Year	Glass containers produced (tons)	Year	Glass containers produced (tons)	Year	Glass containers produced (tons)
1990	195,303.57	1999	22,093.67	2007	46,440.00	2015	56,352.00
1991	151,095.30	2000	19,306.36	2008	33,943.00	2016	67,742.60
1992	239,965.57	2001	23,024.25	2009	14,077.00	2017	62,104.90
1993	159,098.23	2002	23,457.04	2010	18,985.00	2018	58,813.80
1994	78,973.15	2003	39,356.00	2011	26,082.00	2019	59,874.30
1995	47,113.42	2004	45,618.00	2012	23,722.00	2020	53,429.70
1996	30,741.94	2005	48,283.00	2013	28,968.00	2021	57,441.10
1997	40,473.86	2006	42,655.00	2014	50,877.00	2022	56,759.00
1998	25,814.86						

4.2.3.3. *Description of the flexibility used*

Flexibility not applied

4.2.3.4. *Uncertainty assessment and time series consistency*

Uncertainty assessment

See information in Annex II.

Time series consistency

In the case of glass production, the overlap method involves reconstructing the quantity of glass containers produced for the years 1990–2002. The relationship between glass containers produced in Georgia and bottled alcoholic beverages is estimated for the period 2003–2018 when both quantities were available. Data on glass containers produced in Georgia for the years 1990–2002 are reconstructed using the following formula:

$$y_0 = x_0 \times \left[\frac{1}{(n - m + 1)} \times \sum_{i=m}^{n} \frac{y_i}{x_i} \right]$$

Where,

y_o – recalculated data using the overlap method;

x_o – estimate developed using the previously used method;

$y_i x_i$ – estimates prepared using the new and previously used methods over the overlap period, as denoted by years m through n.

According to the data of the National Statistics Office of Georgia, the volume of bottled alcoholic beverages (red wine, sparkling wine, and beer) in Georgia is described for the reporting period 1990-2018, while the initial data provided by the enterprise is for the years 2003-2022. Accordingly, the relationship between glass containers produced and bottled alcoholic beverages in Georgia is estimated for the period 2003-2018, when both values were available.

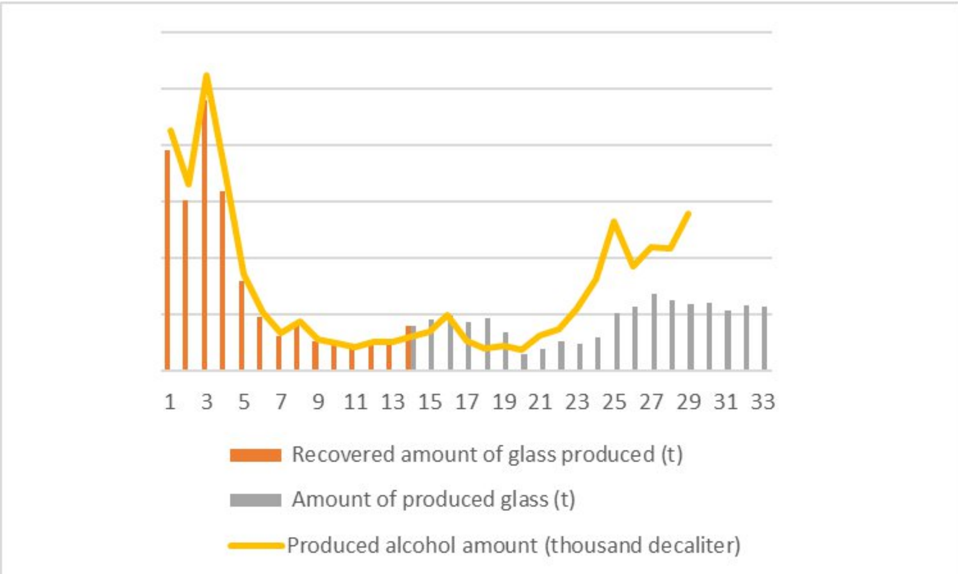
Thus, n = 2018, m = 2003

The available data is given in the table:

Table 4-18. Data for the overlap method 1990 - 2022

Year	Amount of alcohol bottled (thousand decaliters)	Quantity of glass containers produced (tons)	Year	Amount of alcohol bottled (thousand decaliters)	Quantity of glass containers produced (tons)	Year	Amount of alcohol bottled (thousand decaliters)	Quantity of glass containers produced (tons)
1990	C		2001		C	2012	C	C
1991	C		2002		C	2013	C	C
1992	C		2003	C	C	2014	C	C
1993	C		2004	C	C	2015	C	C
1994	C		2005	C	C	2016	C	C
1995	C		2006	C	C	2017	C	C
1996	C		2007	C	C	2018	C	C
1997	C		2008	C	C	2019		C
1998	C		2009	C	C	2020		C
1999	C		2010	C	C	2021		C
2000	C		2011	C	C	2022		C

Figure 4-5. Overlap method to restore the quantity of glass containers produced



The calculated quantity of glass containers produced by the overlap method is given in the table:

Table 4-19. Amount of glass containers produced calculated by the overlap method (t) in 1990 - 2003

Year	Amount of alcohol bottled (thousand decaliters)	Quantity of glass containers produced (tons)	Year	Amount of alcohol bottled (thousand decaliters)	Quantity of glass containers produced (tons)	Year	Amount of alcohol bottled (thousand decaliters)	Quantity of glass containers produced (tons)
1990	C	C	2001	C	C	2012	C	C
1991	C	C	2002	C	C	2013	C	C
1992	C	C	2003	C	C	2014	C	C
1993	C	C	2004	C	C	2015	C	C
1994	C	C	2005	C	C	2016	C	C
1995	C	C	2006	C	C	2017	C	C
1996	C	C	2007	C	C	2018	C	C
1997	C	C	2008	C	C	2019		C
1998	C	C	2009	C	C	2020		C
1999	C	C	2010	C	C	2021		C
2000	C	C	2011	C	C	2022		C

4.2.3.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.2.3.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

For the full reporting period (1990-2022), CO2 emissions from glass production are estimated using the IPCC 2006 Tier 2 approach. The previous inventory report covered the reporting period (1990-2017), while greenhouse gas emissions were estimated using the IPCC 2006 Tier 1 approach. In accordance with the principle of time consistency, as the assessment approach improves, greenhouse gas emissions have been recalculated for the full reporting period (1990-2017). The differences in CO2 emissions between the approaches are given in the table below.

Table 4-20. Difference between CO2 emissions in glass production by assessment levels

Year	IPCC 2006 "Level 2" CO2 emission (Gg)	IPCC 2006 "Level 1" CO2 emission (Gg)	Difference CO2 emission (Gg)	Year	IPCC 2006 "Level 2" CO2 emission (Gg)	IPCC 2006 "Level 1" CO2 emission (Gg)	Difference CO2 emission (Gg)
1990	C	C	-1.59	2004	C	C	-
1991	C	C	0.24	2005	C	C	-
1992	C	C	8.39	2006	C	C	-
1993	C	C	5.96	2007	C	C	-

Year	IPCC 2006 "Level 2" CO2 emission (Gg)	IPCC 2006 "Level 1" CO2 emission (Gg)	Difference CO2 emission (Gg)	Year	IPCC 2006 "Level 2" CO2 emission (Gg)	IPCC 2006 "Level 1" CO2 emission (Gg)	Difference CO2 emission (Gg)
1994	C	C	2.92	2008	C	C	-
1995	C	C	1.44	2009	C	C	-
1996	C	C	0.88	2010	C	C	-
1997	C	C	0.98	2011	C	C	-
1998	C	C	0.10	2012	C	C	-
1999	C	C	-0.38	2013	C	C	-
2000	C	C	-1.72	2014	C	C	-
2001	C	C	-1.81	2015	C	C	-
2002	C	C	-1.97	2016	C	C	-2.99
2003	C	C	-	2017	C	C	-5.99

4.2.3.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission assessment within the category is linked to the establishment of a common national transparency system.

4.2.4. *Other production that uses carbonates (CRT 2A4)*

This source category does not occur in Georgia.

4.2.5. *Other (CRT 2A5)*

The mentioned source category does not occur in Georgia.

4.3. Chemical industry (CRT 2B)

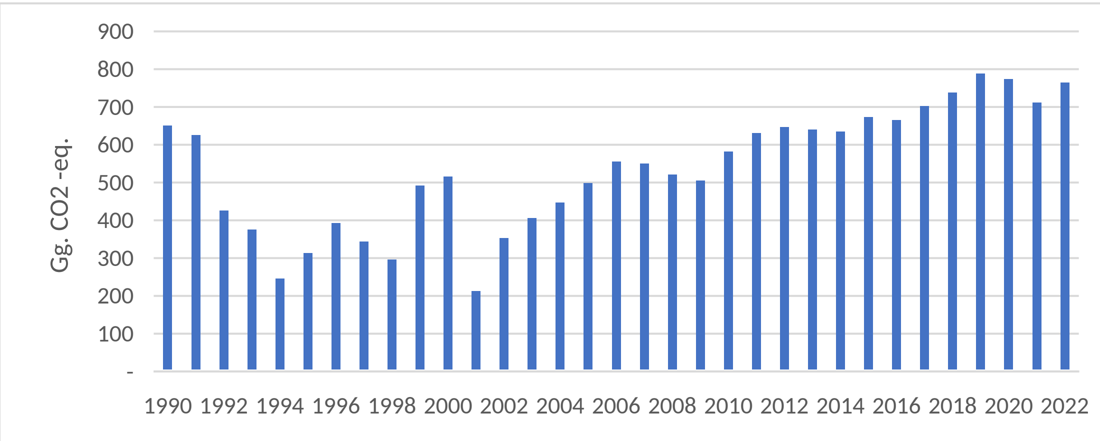
In Georgia, the chemical production category includes the production of ammonia (2B1) and nitric acid (2B2). In 1990, CO2 eq. emissions from the chemical production category were at a high level. In the early 90s, its amount decreased sharply and in 1994 reached one of the lowest levels, and in 2001, a historical minimum was recorded, which is associated with the difficult economic transformation of the country since the restoration of Georgia's independence. Since 2002, the amount of greenhouse gas emissions has increased, which is mainly associated with the restoration-activation of chemical production. In 2007-2010, a halt in the growth of emissions was observed, which is a result of the global economic crisis and the 2008 war. From 2011-2019, greenhouse gas emissions were characterized by a high growth rate. In 2019, the highest greenhouse gas emissions were recorded from the chemical production category during the entire accounting period. In 2020-2022, emissions decreased slightly, which is largely due to the restrictions caused by the pandemic.

Table 4-21. GHG emissions from the chemical industry (Gg) in 1990 - 2022

Year	CO2 emissions (Gg)	N2O emissions (Gg)	Greenhouse gas emissions (Gg CO2 eq.)	Year	CO2 emissions (Gg)	N2O emissions (Gg)	Greenhouse gas emissions (Gg CO2 eq.)
1990	C	C	C	2007	C	C	C
1991	C	C	C	2008	C	C	C
1992	C	C	C	2009	C	C	C
1993	C	C	C	2010	C	C	C

Year	CO2 emissions (Gg)	N2O emissions (Gg)	Greenhouse gas emissions (Gg CO2 eq.)	Year	CO2 emissions (Gg)	N2O emissions (Gg)	Greenhouse gas emissions (Gg CO2 eq.)
1994	C	C	C	2011	C	C	C
1995	C	C	C	2012	C	C	C
1996	C	C	C	2013	C	C	C
1997	C	C	C	2014	C	C	C
1998	C	C	C	2015	C	C	C
1999	C	C	C	2016	C	C	C
2000	C	C	C	2017	C	C	C
2001	C	C	C	2018	C	C	C
2002	C	C	C	2019	C	C	C
2003	C	C	C	2020	C	C	C
2004	C	C	C	2021	C	C	C
2005	C	C	C	2022	C	C	C
2006	C	C	C				

Figure 4-6. GHG emissions from the chemical industry 1990 - 2022



4.3.1. *Ammonia production (CRT 2B1)*

4.3.1.1. *Category description*

In Georgia, ammonia is produced only by JSC "Rustavi Azoti". It is the largest chemical enterprise producing mineral fertilizers and industrial chemicals in the South Caucasus. The factory is located in the city of Rustavi. Several workshops operate at the JSC "Rustavi Azoti" chemical enterprise, including 1) an ammonia workshop, in which ammonia synthesis is carried out and 2) a cold workshop, in which evaporated ammonia is condensed, stored, and distributed to consumers, as well as ammonia water is received;

According to the conclusion of the ecological expertise No. 43 of December 11, 2008, and the corresponding environmental impact assessment report, two conversion units were located in the ammonia workshop, and the annual capacity of each was 200,000 t/y, while the total capacity of both units was 400,000 t/y.

In fact, out of the two units located in the ammonia workshop, only one conversion unit is in working condition, which has undergone rehabilitation, and after rehabilitation, its annual capacity has increased from 200,000 tons to 240,000 tons, which amounts to 720 tons/day.

The starting raw materials for ammonia production are natural gas and nitrogen from atmospheric air. In the plant, ammonia production takes place under high pressure and temperature conditions, through the interaction of gaseous hydrogen (H_2) and nitrogen (N_2).

Methane conversion is expressed by the following equation:

$$CH_4 + H_2O = CO + 3H_2 - Q$$
$$CO + H_2O = CO_2 + H_2 + Q$$

After the removal of carbon monoxide and dioxide, nitrogen and hydrogen react under high pressure and temperature, according to the following equation:

$$3H_2 + N_2 = 2NH_3 + Q$$

Carbon dioxide from ammonia production is used to make dry ice. Given that carbon is released into the atmosphere almost immediately after the use of dry ice, the intermediate retention of CO_2 in the production process and products is not taken into account.

In 1990, CO_2 emissions from the ammonia production source category were at a high level (»525 Gg). In the early 90s, its amount decreased and in 1994 it reached one of the lowest levels (»208 Gg), in 2001 a historical minimum (»165 Gg) was noted, which is associated with the difficult economic transformation of the country since the restoration of Georgia's independence. In 2002-2007, the amount of CO_2 emissions increased, which is associated with the restoration of the sector and the expansion of production. In 2007-2009, the growth of CO_2 emissions stopped due to the global economic crisis and the war in Georgia. CO_2 emissions increased again between 2010 and 2019, with ammonia production accounting for the highest CO_2 emissions of the entire period (»563 Gg). Emissions fell by 10% in 2020-21, likely due in large part to pandemic-related restrictions. In 2022, CO_2 emissions increased by 6%, despite a slight increase in production.

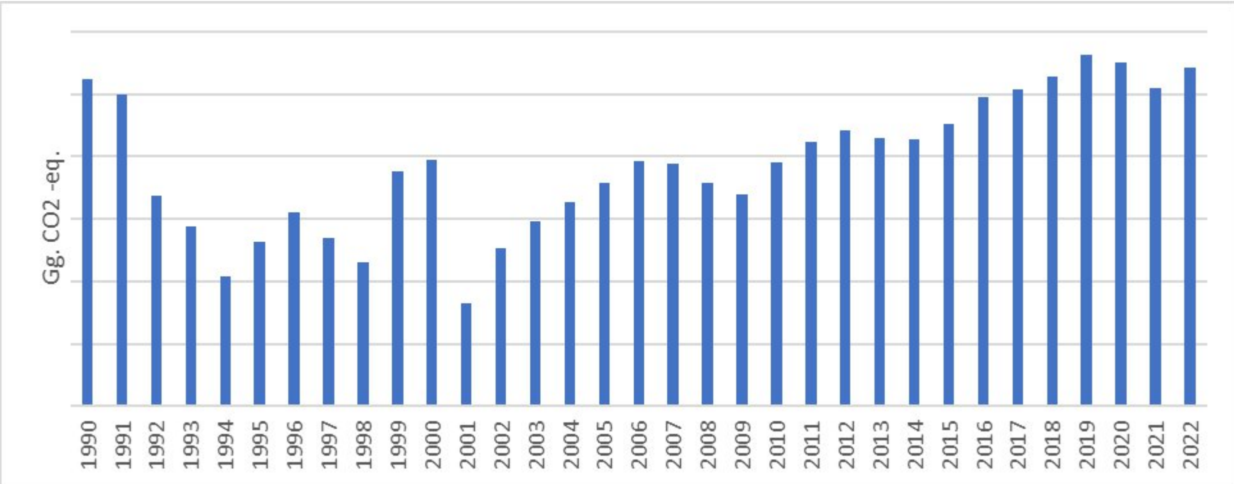
Ammonia Production (2B1) has been a key source category of CO_2 emissions since 1990, without any interruption.

Table 4-22. CO2 emissions from ammonia production by natural gas consumed (Gg) 1990 - 2022

Year	Natural gas consumed (GJ)	C content in natural gas (kg C/GJ)	Oxidation factor of C	44/12	CO2 emission (T)	CO2 emission (Gg)
1990	C	C	1.00	44/12	C	C
1991	C	C	1.00	44/12	C	C
1992	C	C	1.00	44/12	C	C
1993	C	C	1.00	44/12	C	C
1994	C	C	1.00	44/12	C	C
1995	C	C	1.00	44/12	C	C
1996	C	C	1.00	44/12	C	C
1997	C	C	1.00	44/12	C	C
1998	C	C	1.00	44/12	C	C
1999	C	C	1.00	44/12	C	C
2000	C	C	0.99	44/12	C	C
2001	C	C	1.00	44/12	C	C
2002	C	C	1.00	44/12	C	C
2003	C	C	1.00	44/12	C	C
2004	C	C	1.00	44/12	C	C
2005	C	C	1.00	44/12	C	C
2006	C	C	1.00	44/12	C	C

Year	Natural gas consumed (GJ)	C content in natural gas (kg C/GJ)	Oxidation factor of C	44/12	CO2 emission (T)	CO2 emission (Gg)
2007	C	C	0.99	44/12	C	C
2008	C	C	0.99	44/12	C	C
2009	C	C	0.98	44/12	C	C
2010	C	C	0.98	44/12	C	C
2011	C	C	0.98	44/12	C	C
2012	C	C	1.00	44/12	C	C
2013	C	C	0.99	44/12	C	C
2014	C	C	0.98	44/12	C	C
2015	C	C	0.99	44/12	C	C
2016	C	C	0.98	44/12	C	C
2017	C	C	0.99	44/12	C	C
2018	C	C	0.98	44/12	C	C
2019	C	C	0.98	44/12	C	C
2020	C	C	0.98	44/12	C	C
2021	C	C	0.98	44/12	C	C
2022	C	C	0.98	44/12	C	C

Figure 4-7. CO2 emissions from ammonia production (Gg) 1990-2022



According to paragraph 50 of the Nationally Determined Contribution of Georgia, information on the emission of atmospheric pollutants is presented in the form of a table in accordance with the Georgian Air Pollutant Emissions Inventory (https://www.ceip.at/status-of-reporting-and-review-results/2024-submission).

Table 4-23. Emissions of NOx, CO, NMVOC, and SOx from ammonia production (Gg) 1990 - 2022

Year	NO_x Spraying (GG)	CO emission (GG)	NMVOC emissions (GG)	SO_x Spray (GG)	Year	NO_x Spraying (GG)	CO emission (GG)	NMVOC emissions (GG)	SO_x Spray (GG)
1990	0.22	0.02	NE	NE	2007	0.18	0.02	NE	NE
1991	0.19	0.02	NE	NE	2008	0.20	0.02	NE	NE
1992	0.12	0.01	NE	NE	2009	0.21	0.02	NE	NE
1993	0.09	0.01	NE	NE	2010	0.19	0.02	NE	NE
1994	0.05	0.01	NE	NE	2011	0.22	0.02	NE	NE
1995	0.07	0.01	NE	NE	2012	0.22	0.02	NE	NE
1996	0.09	0.01	NE	NE	2013	0.22	0.02	NE	NE
1997	0.10	0.01	NE	NE	2014	0.22	0.02	NE	NE
1998	0.08	0.01	NE	NE	2015	0.24	0.02	NE	NE
1999	0.13	0.01	NE	NE	2016	0.18	0.02	NE	NE
2000	0.14	0.01	NE	NE	2017	0.21	0.02	NE	NE
2001	0.06	0.01	NE	NE	2018	0.23	0.02	NE	NE

Year	NO_x Spraying (GG)	CO emission (GG)	NMVOC emissions (GG)	SO_x Spray (GG)	Year	NO_x Spraying (GG)	CO emission (GG)	NMVOC emissions (GG)	SO_x Spray (GG)
2002	0.11	0.01	NE	NE	2019	0.24	0.02	NE	NE
2003	0.12	0.01	NE	NE	2020	0.24	0.02	NE	NE
2004	0.13	0.01	NE	NE	2021	0.22	0.02	NE	NE
2005	0.15	0.02	NE	NE	2022	0.24	0.02	NE	NE
2006	0.16	0.02	NE	NE					

4.3.1.2. *Methodological issues*

Evaluation method

CO2 emissions from ammonia production are estimated using the IPCC 2006 Tier 3 approach. According to the Tier 3 method, CO2 $_{emissions}$ from ammonia production are calculated as follows:

$$CO_{2Emissions} = \sum_i \left(TFR_i \times CCF_i \times COF_i \times \frac{44}{12} \right) - R_{CO2}$$

Where:

$CO_{2Emissions}$ – carbon dioxide emissions from ammonia production, kg;

TFR_i – the amount of fuel consumed by fuel type i, GJ;

CCF_i – carbon content coefficient for fuel type i, kg C/GJ;

COF_i – carbon oxidation coefficient for fuel type i;

R_{CO2} – amount of recovered CO2, kg;

Since the carbon dioxide released from ammonia production is used to produce dry ice, and after the dry ice is used, the carbon is released into the atmosphere almost immediately, the intermediate retention of CO2 in the production process and products is not taken into account. The value of the coefficient R_{CO2} is assumed to be zero.

Emission factor

CO2 emissions from ammonia production using the IPCC 2006 Tier 3 approach, the carbon content factor (CCF) is taken from the plant and is equal to 15.3 kg/GJ, which corresponds to the data in IPCC 2006 Guideline, Volume 3, Chapter 3, Table 3.1 (uncertainty ± 5%). 1998-2022 Carbon Oxidation Factor (COF) It is obtained from the factory and ranges from 0.98 to 1.00 (uncertainty ± 2%), while for 1990-1997 the same coefficient is taken from IPCC 2006 Manual, Volume 3, Chapter 3, Table 3.1 and is 1.00 (uncertainty ± 5%).

Initial data

In Georgia, only JSC Rustavi Azoti in Rustavi produces ammonia. Carbon dioxide emissions from 1990 to 2022 are estimated based on data provided by the plants.

According to the available data, natural gas and nitrogen from atmospheric air are used as raw materials in the production of ammonia. Of the described raw materials, carbon dioxide is produced only from the conversion of natural gas. Accordingly, only natural gas from the raw materials was considered for the assessment of CO_2 emissions. The uncertainty of the initial data is ± 2%.

Below is the total amount of natural gas consumed by year.

Table 4-24. Amount of natural gas consumed (m^3) in 1990 - 2022

Year	Consumed Natural gas (m3)	Year	Consumed Natural gas (m3)	Year	Consumed Natural gas (m3)	Year	Consumed Natural gas (m3)
1990	C	1999	C	2007	C	2015	C
1991	C	2000	C	2008	C	2016	C
1992	C	2001	C	2009	C	2017	C
1993	C	2002	C	2010	C	2018	C
1994	C	2003	C	2011	C	2019	C
1995	C	2004	C	2012	C	2020	C
1996	C	2005	C	2013	C	2021	C
1997	C	2006	C	2014	C	2022	C
1998	C						

4.3.1.3. *Description of the flexibility used*

Flexibility not applied

4.3.1.4. *Uncertainty assessment and time series consistency*

Uncertainty assessment

See information in Annex II.

Time series consistency

For the entire reporting period, greenhouse gas emissions from the source category are estimated using the same method, and the initial data are obtained from a single source.

4.3.1.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.3.1.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

During the current inventory period, greenhouse gas emissions from the source category were not recalculated.

4.3.1.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission assessment within the category is linked to the establishment of a common national transparency system.

4.3.2. *Nitric acid production (CRT 2B2)*

4.3.2.1. *Category description*

In Georgia, nitric acid (HNO_3) is produced only by JSC Rustavi Azoti. It is the largest chemical enterprise producing mineral fertilizers and industrial chemicals in the South Caucasus. The factory is located in the city of Rustavi. Several facilities operate at the JSC "Rustavi Azoti" chemical enterprise, including a nitric acid facility, where nitric acid synthesis is carried out.

Nitric acid is obtained by catalytic oxidation of ammonia with air oxygen at a pressure of 0.2 - 0.37 MPa (2–3.7 kg/cm^2) and absorption of the formed nitrogen oxides by water vapor at a pressure of 0.65 - 1.16 MPa. Nitrogen oxides, including nitrous oxide (N_2O), are emitted into the atmosphere during production. The exhaust gases are cleaned of nitrogen oxides by their recovery with natural gas in a reactor using a two-layer catalyst: the first layer is APK-2, and the second is AL203. These catalysts contribute to the removal of nitrogen oxides from exhaust gases, which pollute the atmospheric air but are less effective in terms of removing nitrous oxide. Currently, JSC Rustavi Azoti is a member of NACAG and is developing catalyst replacement technology to reduce nitrogen oxide emissions.

In 1990, N2O emissions from the nitric acid production source category were at a high level. In the early 1990s, its amount decreased and reached a historical minimum in 1994. Also, low N2O emissions in 2001, which is associated with the difficult economic transformation of Georgia since its independence. From 2002-2019, the amount of N2O emissions increased, which is associated with the recovery of the sector and the expansion of production. During this period, the peak of N2O emissions was noted in 2015 and 2019. In 2019, nitric acid production had the highest N2O emissions from the source category over the entire accounting period. Emissions decreased by 11% in 2020-21, which may be largely due to pandemic-related restrictions. In 2022, N2O emissions increased by 9%, along with a slight increase in production.

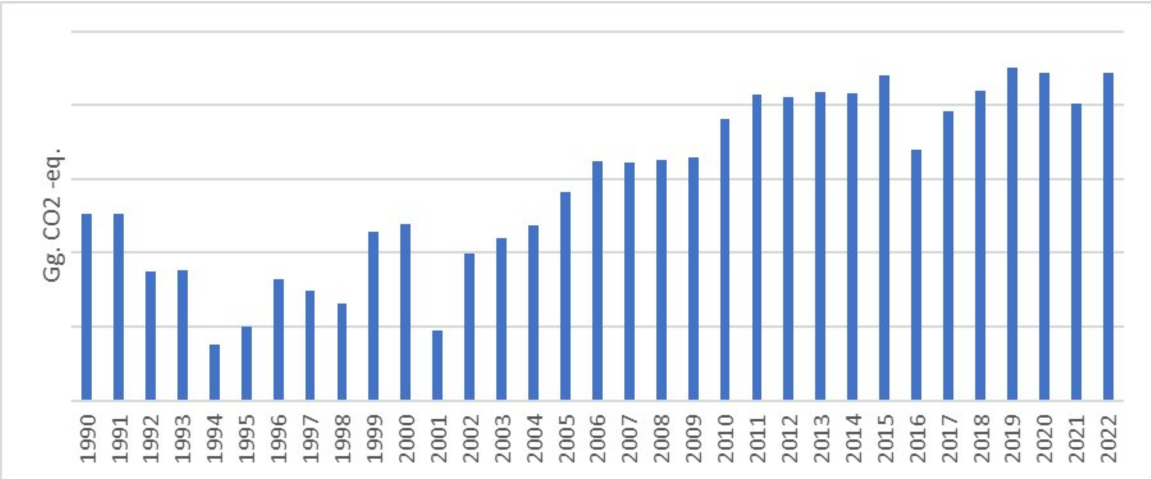
Nitric Acid production is the key category according to the level and trend assessment.

Table 4-25. N2O emissions from nitric acid production (Gg) in 1990 - 2022

Year	Amount of nitric acid produced (T)	N2 O emission factor (kg N2 O /t)	N_2O spraying (T)	N_2O spraying (GG)	CO_2 - equivalent emission (Gg)
1990	C	2	C	C	C
1991	C	2	C	C	C
1992	C	2	C	C	C
1993	C	2	C	C	C
1994	C	2	C	C	C
1995	C	2	C	C	C
1996	C	2	C	C	C
1997	C	2	C	C	C
1998	C	2	C	C	C
1999	C	2	C	C	C
2000	C	2	C	C	C
2001	C	2	C	C	C
2002	C	2	C	C	C
2003	C	2	C	C	C
2004	C	2	C	C	C
2005	C	2	C	C	C
2006	C	2	C	C	C
2007	C	2	C	C	C
2008	C	2	C	C	C
2009	C	2	C	C	C
2010	C	2	C	C	C
2011	C	2	C	C	C
2012	C	2	C	C	C
2013	C	2	C	C	C
2014	C	2	C	C	C
2015	C	2	C	C	C
2016	C	2	C	C	C
2017	C	2	C	C	C

Year	Amount of nitric acid produced (T)	N2 O emission factor (kg N2 O /t)	N ₂O spraying (T)	N ₂O spraying (GG)	CO ₂- equivalent emission (Gg)
2018	C	2	C	C	C
2019	C	2	C	C	C
2020	C	2	C	C	C
2021	C	2	C	C	C
2022	C	2	C	C	C

Table 4-26. N2O emissions from nitric acid production (Gg) 1990-2022



According to paragraph 50 of the Nationally Determined Contribution of Georgia, information on the emission of atmospheric pollutants is presented in the form of a table in accordance with the Georgian Air Pollutant Emissions Inventory (https://www.ceip.at/status-of-reporting-and-review-results/2024-submission).

Table 4-27. NOx emissions form nitric acid production (Gg) 1990 - 2022

Year	NOx emission (GG)	Year	NOx emission (GG)	Year	NOx emission (GG)
1990	NO	2001	0.90	2012	3.87
1991	NO	2002	1.87	2013	3.94
1992	NO	2003	2.07	2014	3.92
1993	NO	2004	2.24	2015	4.15
1994	NO	2005	2.26	2016	3.21
1995	0.94	2006	2.73	2017	3.69
1996	1.55	2007	3.08	2018	3.96
1997	1.69	2008	1.96	2019	4.25
1998	1.24	2009	3.62	2020	4.20
1999	2.16	2010	3.80	2021	3.80
2000	2.26	2011	3.91	2022	4.20

4.3.2.2. *Methodological issues*

Evaluation method

N_2O emissions from nitric acid production are estimated using the IPCC 2006 Tier 2 approach. According to the Tier 2 method, N_2O emissions from nitric acid production are calculated as follows:

$$N_2O_{Emissions} = \sum_{i,j} \left(EF_i \times NAP_i \times \left(1 - DF_j \times ASUF_j\right)\right)$$

Where:
$N_2O_{\ Emissions}$ – nitrous oxide emissions from nitric acid production, kg;
EF_i – N_2O emission factor for technology type i, kg N_2O/t ;
NAP_i - amount of nitric acid produced, t;
DF_j – dissipation factor according to filter type j;
$ASUF_i$ – filter utilization coefficient by filter type j;
Since the reference value (see below) is used as the emission factor when estimating N_2O emissions from nitric acid production, the multiplier (1-DF_j * $ASUF_j$) is not taken into account (=1).

Emission factor

N2O emissions from nitric acid production using the IPCC 2006 Tier 2 approach, the $_{N2O}$ emission factor (EF) is taken from the data in IPCC 2006 Guideline Volume 3, Chapter 3, Table 3.3 and is 2.00 (uncertainty ± 10%), as the plant uses non-selective catalysts APK-2 and AL203 throughout the year.

Initial data

In Georgia, only JSC Rustavi Azoti in Rustavi produces nitric acid. Nitrogen oxide emissions from 1990 to 2022 are estimated based on data provided by the plants. The uncertainty of the initial data is ± 2%.

Below is the total amount of nitric acid produced by year.

Table 4-28. Amount of nitric acid produced (t) in 1990 - 2022

Year	Amount of nitric acid produced (t)	Year	Amount of nitric acid produced (t)	Year	Amount of nitric acid produced (t)	Year	Amount of nitric acid produced (t)
1990	C	1999	C	2007	C	2015	C
1991	C	2000	C	2008	C	2016	C
1992	C	2001	C	2009	C	2017	C
1993	C	2002	C	2010	C	2018	C
1994	C	2003	C	2011	C	2019	C
1995	C	2004	C	2012	C	2020	C
1996	C	2005	C	2013	C	2021	C
1997	C	2006	C	2014	C	2022	C
1998	C						

4.3.2.3. *Description of the flexibility used*

No flexibility was used.

4.3.2.4. *Uncertainty assessment and time series consistency*

Uncertainty assessment

See information in Annex II.

Time series consistency

For the entire reporting period, greenhouse gas emissions from the source category are estimated using the same method, and the initial data are obtained from a single source.

4.3.2.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.3.2.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

During the current inventory period, greenhouse gas emissions from the source category were not recalculated.

4.3.2.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission assessment within the category is linked to the establishment of a common national transparency system.

4.3.3. *Adipic acid production (CRT 2B3)*

This source category does not occur in Georgia.

4.3.4. *Production of caprolactam, glyoxal, and glyoxylic acid (CRT 2B4)*

This source category does not occur in Georgia.

4.3.5. *Carbides production (CRT 2B5)*

This source category does not occur in Georgia.

4.3.6. *Titanium dioxide production (CRT 2B6)*

This source category does not occur in Georgia.

4.3.7. *Soda production (CRT 2B7)*

This source category does not occur in Georgia.

4.3.8. *Petrochemical industry and ash production (CRT 2B8)*

This source category does not occur in Georgia.

4.3.8.1. *Ethylene production (CRT 2B8b)*

This source category does not occur in Georgia.

4.3.8.2. *Production of ethylene dichloride and vinyl dichloride (2B8c)*

This source category does not occur in Georgia.

4.3.8.3. *Ethylene oxide production (2B8d)*

This source category does not occur in Georgia.

4.3.8.4. *Acrylonitrile production (2B8e)*

This source category does not occur in Georgia.

4.3.8.5. *Ash production (2B8f)*

This source category does not occur in Georgia.

4.3.9. *Production of fluorinated compounds (CRT 2B9)*

This source category does not occur in Georgia.

4.3.9.1. *Spraying of similar products*

4.3.9.2. *Fugitive sprays*

4.3.10. *Other (CRT 2B10)*

This source category does not occur in Georgia.

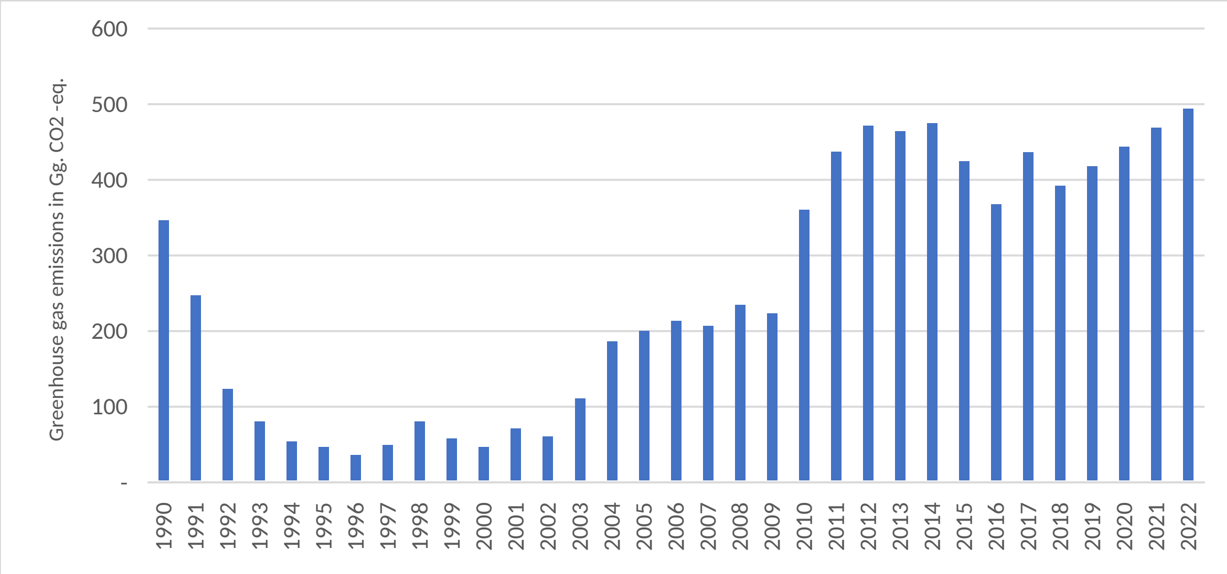
4.4. Metallurgy (CRT 2C)

In Georgia, the metallurgy category includes only the production of steel and cast iron (2C1) and ferroalloys (2C2). In 1990, greenhouse gas emissions from the metallurgy category were at a high level (»392 Gg. CO_2 eq.). In the early 90s, its amount decreased sharply and in 1996 reached a historical minimum (»44 Gg. CO_2 eq.), which is associated with the difficult economic transformation of the country since the restoration of Georgia's independence. Based on the above, from 1993-2003, greenhouse gas emissions were at a low level throughout the decade. Since 2003, greenhouse gas emissions have also increased along with the increase in metal production. In 2012, 2014, and 2017, greenhouse gas emissions peaked (»614, »616, and »448 Gg CO2 eq. respectively), which corresponds to high levels of ferroalloy production. In 2014, the highest greenhouse gas emissions from the metallurgy category were recorded during the entire accounting period (»616 Gg CO2 eq.). In 2018, emissions decreased by 10%, which is associated with a decrease in ferroalloy production. From 2019 to 2022, greenhouse gas emissions increased steadily, by 5-6% per year. At the end of the accounting period, greenhouse gas emissions from the metallurgy category amounted to 507 Gg CO2 eq.

Table 4-29. GHG emissions from metallurgy (Gg) 1990 - 2022

Year	CO2 emissions (Gg)	CH4 emissions (Gg)	Greenhouse gas emissions (Gg CO2 eq.)	Year	CO2 emissions (Gg)	CH4 emissions (Gg)	Greenhouse gas emissions (Gg CO2 eq.)
1990	524.78	0.48	650.86	2007	388.65	0.61	550.04
1991	498.86	0.48	625.00	2008	358.13	0.61	520.79
1992	338.20	0.33	425.44	2009	340.26	0.62	504.72
1993	287.71	0.33	375.58	2010	390.46	0.72	581.52
1994	207.92	0.14	245.97	2011	423.25	0.78	630.48
1995	263.14	0.19	312.75	2012	440.86	0.77	646.15
1996	309.77	0.31	392.02	2013	430.41	0.79	639.22
1997	269.80	0.28	343.73	2014	426.68	0.79	635.01
1998	229.86	0.25	295.47	2015	452.03	0.83	672.30
1999	376.53	0.43	490.96	2016	495.33	0.64	665.40
2000	395.36	0.45	515.25	2017	506.72	0.74	702.44
2001	165.24	0.18	212.99	2018	527.83	0.79	737.71
2002	253.07	0.37	352.29	2019	563.23	0.85	788.44
2003	295.86	0.41	405.46	2020	550.52	0.84	772.88
2004	327.11	0.45	445.99	2021	510.04	0.76	711.63
2005	356.76	0.53	497.85	2022	541.85	0.84	764.33
2006	392.45	0.61	554.58				

Figure 4-8. Emissions from metal production (Gg CO2 eq.)



4.4.1. *Iron and steel production (CRT 2C1)*

4.4.1.1. *Category description*

In Georgia, steel is produced using an electric arc furnace at three main factories: Rustavi Steel LLC, Geosteel LLC, and Kutaisi Automechanical Factory LLC. In the recent past, steel was produced at only one enterprise - the Rustavi Metallurgical Factory. In 1990, the factory operated several technological lines that produced slag, pig iron, and steel using an open-hearth furnace. In 1993, pig iron production was discontinued. The following year, slag production was discontinued, and in 1999, the use of the open-hearth furnace was also discontinued. From 2000-2010, steel was produced at the factory using the pig iron melting method, which is not characterized by non-energy greenhouse gas emissions.

Steel production (2C1) is a source of carbon dioxide (CO2) emissions. "In most electric arc furnaces, where metal is melted, CO2 emissions are mainly associated with the consumption of carbon electrodes. All carbon used in electric arc furnaces and other steelmaking processes should be considered as process emissions from industrial processes and product consumption[38]." Since 1990, steel production (2C1) has not been a key source category for CO2 and CH4 emissions. Before the start of the reporting period and then from 1990 to 1994, sinter was produced at the Rustavi Metallurgical Plant. The amount of greenhouse gases emitted from sinter produced in Georgia can be seen in the table below.

Table 4-30. CO2 and CH4 emissions from sinter production (Gg) in 1990 - 1994

Year	The produced agglomerate R - Ba (t)	CO2 emission factor (t CO_2 / t sinter)	CH_4 emission factor (kg CH_4 /t sinter)	The amount of CO2 emitted (T)	The amount of CO2 emitted (GG)	The amount of CH_4 emitted (T)	The amount of CH_4 emitted (GG)	The amount of CH_4 emitted (Gg CO2 equivalent)	of greenhouse gases (Gg CO2 eq .)
1990	460,710.00	0.20	0.07	92,142.00	92.14	32.25	0.03	0.90	93.04

[38] IPCC 2006 Year textbook, Tribe 3, Chapter 4: Metal Production, p. 4.12.

1991	340,301.70	0.20	0.07	68,060.34	68.06	23.82	0.02	0.67	68.73
1992	187,117.53	0.20	0.07	37,423.51	37.42	13.10	0.01	0.37	37.79
1993	77,065.92	0.20	0.07	15,413.18	15.41	5.39	0.01	0.15	15.56
1994	42,570.71	0.20	0.07	8,514.14	8.51	2.98	0.00	0.08	8.60

In 1990, greenhouse gas emissions from the steel production source category were at a high level (»205 Gg). In the early 90s, its amount decreased sharply, and in 2000 it completely stopped, which is associated with the difficult economic transformation of the country since the restoration of Georgia's independence. From 2010 to 2015, the amount of CO2 emissions gradually increased, which is associated with the restoration of the production of steel products by the electric arc method in Georgia. Since 2015, CO2 emissions have decreased by 30% and reached their recent minimum (»14.5 Gg) in 2019. In 2020-2022, emissions increased by 20%, which is largely associated with the increase in production.

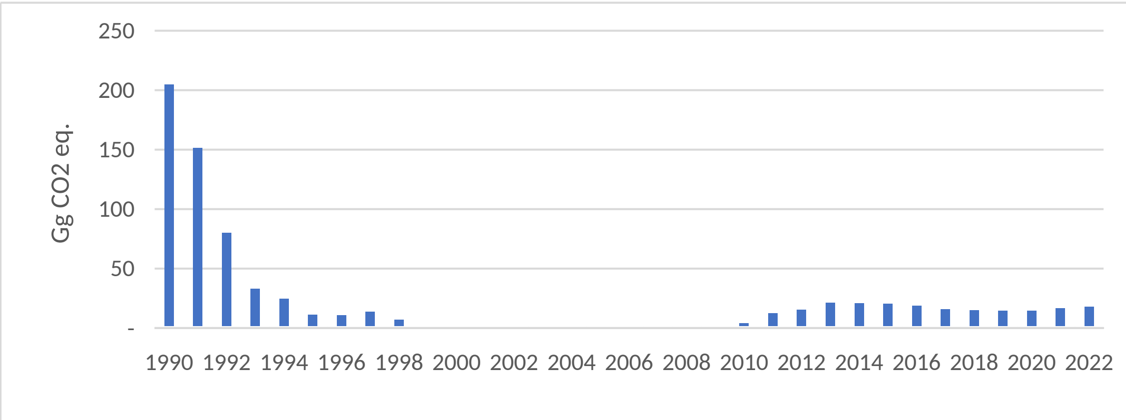
The amount of greenhouse gases emitted during steel production over the entire inventory period is presented in the table below.

Table 4-31. CO2 emissions from steel production (Gg) 1990 - 2022

Year	- Ba (t) of produced steel	Coke used R - Ba (t)	Graphite used R-Ba (t)	Amount of lime used (t)	Used ferrosilicon scrap R - Ba (t)	Used silicon manganese R - Ba (t)	Sinter R - Ba (t)	Used scrap metal (tons)	Used cast iron R - Ba (T)	CO2 emitted (t)	CO2 emitted (Gg)
1990	1,296,400.00	1,296.40	1,944.60	139,363.00	3,889.20	12,964.00	460,710.00	648,200.00	N O	111,743.32	111.74
1991	957,750.00	957.70	1,436.60	102,957.00	2,873.30	9,577.50	340,301.70	478,790.00	N O	82,550.75	82.55
1992	526,510.00	526.50	789.80	56,600.00	1,578.50	5,265.10	187,117.53	26,326.00	N O	42,342.26	42.34
1993	216,850.00	216.80	325.30	21,685.00	650.60	2,168.50	77,065.92	108,430.00	N O	17,498.75	17.50
1994	119,800.00	119.80	179.70	11,980.00	359.40	1,198.00	42,570.71	N O	59,900.00	15,816.98	15.82
1995	87,410.00	87.40	131.10	8,741.00	262.20	874.10	N O	N O	43,710.00	11,313.30	11.31
1996	82,650.00	82.60	123.90	8,265.00	247.90	826.50	N O	N O	41,330.00	10,696.91	10.70
1997	104,240.00	104.20	156.40	10,424.00	312.70	102.40	N O	N O	52,120.00	13,447.92	13.45
1998	56,400.00	56.40	84.60	5,640.00	169.20	564.00	N O	N O	28,200.00	6,966.47	6.97
1999	7,036.00	7.00	10.60	703.60	21.10	70.36	N O	N O	3,520.00	869.20	0.87
2000	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2001	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2002	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2003	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2004	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2005	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2006	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2007	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2008	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2009	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O	N O
2010	87,963.00	620.00	364.00	N O	106,244.00	2,119.00	N O	N O	N O	3,875.84	3.88
2011	112,926.00	2,993.00	700.00	N O	134,473.00	1,039.00	N O	N O	N O	12,322.10	12.32
2012	141,277.00	3,627.90	775.20	410.30	159,875.40	1,450.10	N O	3,042.00	1,956.00	15,174.79	15.17
2013	183,879.00	4,567.80	1,221.80	2,140.90	177,851.20	2,600.40	N O	15,876.00	5,638.00	21,373.93	21.37
2014	202,211.50	4,153.30	1,175.32	3,246.90	176,385.74	2,662.66	N O	24,077.00	7,949.40	20,928.06	20.93
2015	219,540.00	3,735.90	1,124.85	4,287.50	174,915.69	2,714.92	N O	31,794.00	10,124.79	20,399.18	20.40

2016	225,110.50	3,283.10	1,027.37	4,563.90	173,212.73	2,649.58	N O	33,843.00	10,700.19	18,890.86	18.89
2017	226,398.00	2,817.30	912.99	4,556.40	171,566.31	2,540.54	N O	11,782.12	1,563.01	15,700.38	15.70
2018	209,447.64	2,549.87	896.78	4,585.09	152,425.09	2,969.44	N O	25,670.00	1,578.67	15,040.59	15.04
2019	209,146.61	2,415.48	865.49	5,107.13	132,845.76	2,911.42	N O	13,892.00	1,604.87	14,530.36	14.53
2020	213,002.05	2,379.62	881.00	5,599.70	130,912.44	3,034.08	N O	7,365.00	1,671.03	14,681.93	14.68
2021	239,241.83	2,797.19	992.07	5,713.81	178,217.64	3,574.63	N O	8,199.43	1,910.47	16,781.98	16.78
2022	258,848.24	3,103.18	1,075.15	5,839.84	174,884.26	3,575.57	N O	17,486.00	2,050.12	18,024.32	18.02

Figure 4-9. Greenhouse gas emissions from steel production (Gg) 1990-2022



4.4.1.2. *Methodological issues*

Evaluation method

CO2 emissions from steel production are estimated using the IPCC 2006 Tier 2 approach. According to the Tier 2 method, CO2 emissions from steel production are calculated as follows:

$$E_{CO2,non-energy} = \left[PC \times C_{PC} + \sum_a (COB_a \times C_a) + CI \times C_{CI} + L \times C_L + D \times C_D + CE \times C_{CE} + \sum_b (O_b \times C_b) + COG \times C_{COG} - S \times C_s - IP \times C_{IP} - BG \times C_{BG} \right] \times \frac{44}{12}$$

Where:

$E_{CO2,non-energy}$ – carbon dioxide emissions from steel production, t;
PC – amount of coke consumed, t;
COB_a – the amount of product equivalent to the firing furnace, t;
CI – amount of coal added directly to the furnace for combustion, t;
L – the amount of limestone consumed in steel production, t;
D – amount of dolomite consumed in steel production, t;
CE – amount of graphite spent in the electric arc furnace, t;
O_b – amount of other carbon-containing materials consumed in steel production, t;
COG – the amount of coke oven gas consumed in the combustion furnace, m^3;
S – quantity of steel produced, t;
IP – amount of raw material from which steel was not produced, t;
BG – amount of flue gas removed from the production site, m^3;
C_x – carbon content;

Since steel production in Georgia is carried out by processing steel scrap and ferroalloys in an electric arc furnace, $\Sigma(COB_{a} * C_{a})$, $COG * C_{COG}$, and $BG * C_{BG}$ are assumed to be zero.

CO_2 and CH_4 emissions from sinter production are estimated using the IPCC 2006 Tier 1 approach. According to the Tier 1 method, CO_2 and CH_4 emissions from sinter production are calculated as follows:

$$E_{CO2,\ non-energy} = SI \times EF_{SI}$$

Where,
$E_{CO2,non-energy}$ – amount of carbon dioxide emissions, t;
SI – amount of agglomerate produced in the country, t;
EF_{SI} – carbon dioxide emission factor, t CO_2/t sinter;

$$E_{CH4,\ non-energy} = SI \times EF_{SI}$$

Where,
$E_{CH4,non-energy}$ – amount of methane emissions, kg;
SI – amount of agglomerate produced in the country, t;
EF_{SI} – methane emission factor, kg CH_4/t sinter;

Emission factor

CO_2 emissions from steel production using the IPCC 2006 Tier 2 approach, the carbon content coefficients: for coke (C_{PC}) – 0.83, for coal (C_{CL}) -0.9, for lime (C_{L}) – 0.20, for graphite (C_{CE}) – 0.99, for various scrap (C_{b}) – from 0.0125 to 0.004 were obtained depending on the raw material (uncertainty ± 10%).

CO_2 and CH_4 emissions from sinter production using the IPCC 2006 Tier 1 approach, the emission factors for carbon dioxide (0.2 t CO_2/t sinter) and methane (0.07 kg CH_4/t sinter) are taken from Tables 4.1 and 4.2 of the IPCC 2006 Guidelines, Volume 3, Chapter 4. The uncertainty of the emission factors for carbon dioxide and methane is ± 25% according to Table 4.4 of the same IPCC Guidelines.

Initial data

In Georgia, Rustavi Steel LLC, Geosteel LLC, and Kutaisi Automechanical Factory LLC produce steel. Carbon dioxide and methane emissions from 1990 to 2022 are estimated based on data provided by the factories.

According to available data, sinter was produced in Georgia at the Rustavi Metallurgical Plant from 1990 to 1994. Information about the sinter produced is provided below.

Table 4-32. Amount of agglomerate produced in Georgia (t) in 1990 - 1994

Year	Amount of agglomerate produced (t)
1990	460,710.00
1991	340,301.70
1992	187,117.53
1993	77,065.92

Year	Amount of agglomerate produced (t)
1994	42,570.71

Data on the amount of steel produced in Georgia for 1990 – 1999 and 2010 – 2022 are provided below in aggregate form.

Table 4-33. Amount of steel produced in Georgia (t) in 1990 - 2022

Year	Amount of steel produced (t)	Year	Amount of steel produced (t)	Year	Amount of steel produced (t)	Year	Amount of steel produced (t)
1990	1,296,400.00	1999	7,036.00	2007	N O	2015	219,540.00
1991	957,750.00	2000	N O	2008	N O	2016	225,110.50
1992	526,510.00	2001	N O	2009	N O	2017	226,398.00
1993	216,850.00	2002	N O	2010	87,963.00	2018	209,447.64
1994	119,800.00	2003	N O	2011	112,926.00	2019	209,146.61
1995	87,410.00	2004	N O	2012	141,277.00	2020	213,002.05
1996	82,650.00	2005	N O	2013	183,879.00	2021	239,241.83
1997	104,240.00	2006	N O	2014	202,211.50	2022	258,848.24
1998	56,400.00						

Since information on steel production is provided by the mills, the uncertainty of the initial data is ± 10 %, according to Table 4.4 of the same IPCC manual.

4.4.1.3. *Description of the flexibility used*

Flexibility not applied

4.4.1.4. *Uncertainty assessment and time series consistency*

Uncertainty assessment

See information in Annex II.

Time series consistency

For the entire reporting period, greenhouse gas emissions from the source category are estimated using the same method, and the initial data are obtained from a single source.

4.4.1.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.4.1.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

No recalculation took place.

4.4.1.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission assessment within the category is linked to the establishment of a common national transparency system.

4.4.2. *Ferroalloy production (CRT 2C2)*

4.4.2.1. *Category description*

Ferroalloys are produced in Georgia in several factories, including Georgian Manganese LLC, Chiaturmanganum Georgia LLC, Geo Enterprise LLC, Georgian Alloys Group LLC, Russelloys LLC, GTM Group LLC, etc. Ferrosilicomanganese, ferrosilicon, and ferromanganese (7% C) are the goods that are mainly produced in Georgia. Carbon dioxide (CO_2) is produced during the reduction of metal in an electric arc furnace during the production of ferroalloys, and methane (CH_4) is produced during the production of ferrosilicon.

In 1990, greenhouse gas emissions from the ferroalloy production source category were at a high level (»187 Gg CO_2 eq.). In the early 1990s, its amount decreased sharply and reached a historical minimum (»34 Gg CO_2 eq.) in 1996, which is associated with the difficult economic transformation of the country since the restoration of Georgia's independence. Based on the above, during the entire decade of 1992-2002, greenhouse gas emissions were at a low level. Since 2003, greenhouse gas emissions have also increased along with the increase in ferroalloy production. In 2012, 2014, and 2017, greenhouse gas emissions peaked (»599, »595, and »432 Gg CO2 eq. respectively). In 2012, the highest greenhouse gas emissions from the ferroalloys production source category were recorded during the entire accounting period (»599 Gg CO2 eq.). In 2018, emissions decreased by 10%, which is associated with a decrease in production. From 2019 to 2022, greenhouse gas emissions increased steadily, by 5-7% per year. At the end of the accounting period, greenhouse gas emissions from the ferroalloys source category amounted to 489 Gg CO2 eq.

Ferroalloy production is a key source category in accordance with level and trend assessment.

Table 4. 30. CO2 emissions from ferrosilicon manganese production (Gg) 1990-2022.

Year	Amount of ferrosilicon manganese produced (T)	Emission factor (t CO2/t product produced)	CO2 emission (T)	CO2 emission (GG)
1990	67,363.08	1.4	94,308.32	94.31
1991	45,595.15	1.4	63,833.22	63.83
1992	20,529.38	1.4	28,741.13	28.74
1993	22,420.23	1.4	31,388.32	31.39
1994	13,834.60	1.4	19,368.44	19.37
1995	16,639.51	1.4	23,295.31	23.30
1996	12,061.00	1.4	16,885.40	16.89
1997	17,015.20	1.4	23,821.28	23.82
1998	34,751.24	1.4	48,651.73	48.65
1999	26,992.13	1.4	37,788.99	37.79
2000	21,919.03	1.4	30,686.65	30.69
2001	33,522.59	1.4	46,931.63	46.93
2002	28,604.73	1.4	40,046.62	40.05
2003	52,313.87	1.4	73,239.42	73.24
2004	88,061.73	1.4	123,286.42	123.29
2005	94,429.53	1.4	132,201.34	132.20
2006	100,797.33	1.4	141,116.26	141.12
2007	97,589.48	1.4	136,625.28	136.63

Year	Amount of ferrosilicon manganese produced (T)	Emission factor (t CO2/t product produced)	CO2 emission (T)	CO2 emission (GG)
2008	110,892.34	1.4	155,249.27	155.25
2009	105,479.87	1.4	147,671.82	147.67
2010	168,270.23	1.4	235,578.32	235.58
2011	200,435.37	1.4	280,609.52	280.61
2012	215,569.21	1.4	301,796.90	301.80
2013	209,200.26	1.4	292,880.36	292.88
2014	214,141.24	1.4	299,797.74	299.80
2015	190,757.43	1.4	267,060.40	267.06
2016	239,700.55	1.4	335,580.77	335.58
2017	289,142.04	1.4	404,798.86	404.80
2018	259,135.14	1.4	362,789.19	362.79
2019	277,492.94	1.4	388,490.12	388.49
2020	295,000.74	1.4	413,001.03	413.00
2021	310,875.71	1.4	435,225.99	435.23
2022	327,048.75	1.4	457,868.25	457.87

Figure 4-10. Greenhouse gas emissions from ferroalloys (Gg CO2 eq.) 1990 -2022

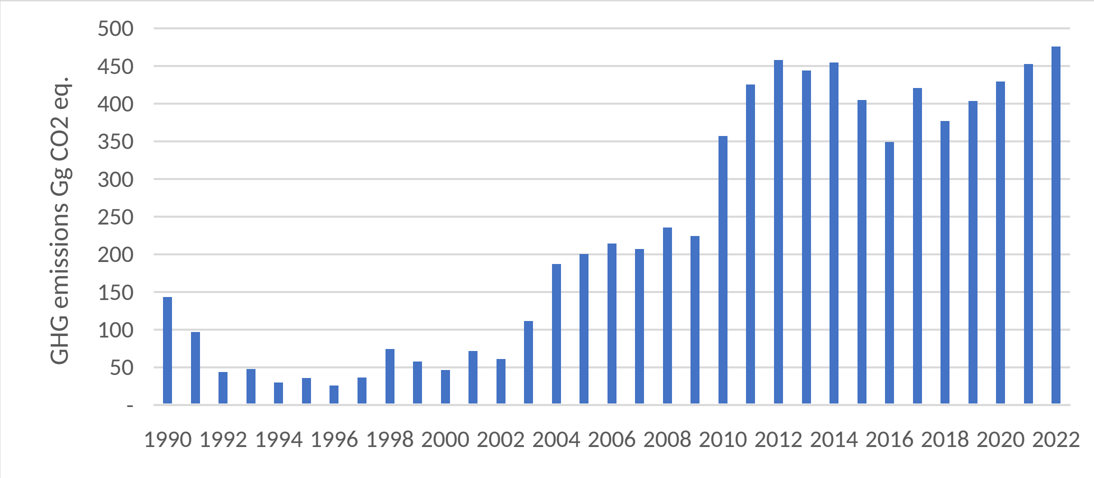


Table 4-34. CO2 emissions from ferromanganese production (Gg) in 1990 - 2022

Year	Amount of ferromanganese produced (T)	Emission factor (t CO2/t product produced)	CO2 emission (T)	CO2 emission (Gg)
1990	3,165.42	1.3	4,115.05	4.12
1991	2,142.54	1.3	2,785.30	2.79
1992	964.68	1.3	1,254.09	1.25
1993	1,053.54	1.3	1,369.60	1.37
1994	650.09	1.3	845.12	0.85
1995	781.90	1.3	1,016.47	1.02
1996	566.75	1.3	736.78	0.74
1997	799.55	1.3	1,039.42	1.04
1998	1,632.98	1.3	2,122.87	2.12
1999	1,268.37	1.3	1,648.88	1.65
2000	1,029.98	1.3	1,338.98	1.34
2001	1,575.24	1.3	2,047.81	2.05
2002	1,344.15	1.3	1,747.39	1.75
2003	2,458.25	1.3	3,195.73	3.20
2004	4,138.06	1.3	5,379.48	5.38
2005	4,437.28	1.3	5,768.47	5.77
2006	4,736.51	1.3	6,157.46	6.16

Year	Amount of ferromanganese produced (T)	Emission factor (t CO2/t product produced)	CO2 emission (T)	CO2 emission (Gg)
2007	4,585.77	1.3	5,961.50	5.96
2008	5,210.88	1.3	6,774.14	6.77
2009	4,956.54	1.3	6,443.51	6.44
2010	7,907.09	1.3	10,279.22	10.28
2011	9,418.54	1.3	12,244.11	12.24
2012	10,129.69	1.3	13,168.60	13.17
2013	9,830.41	1.3	12,779.53	12.78
2014	10,062.59	1.3	13,081.37	13.08
2015	8,963.77	1.3	11,652.91	11.65
2016	2,445.92	1.3	3,179.70	3.18
2017	2,950.43	1.3	3,835.56	3.84
2018	2,644.24	1.3	3,437.51	3.44
2019	2,831.56	1.3	3,681.03	3.68
2020	3,010.21	1.3	3,913.28	3.91
2021	3,172.20	1.3	4,123.86	4.12
2022	3,337.23	1.3	4,338.40	4.34

Table 4-35. CO2 and CH4 emissions form ferrosilicon production (Gg) in 1990 - 2022

Year	Quantity of ferrosilicon produced (t)	Emission factor (t CO2/ t product produced)	CO2 emission (t)	CO2 emission (Gg)	Emission factor (t CH4 /t product produced)	CH_4 dispersion (t)	CH_4 dispersion (Gg)	CH_4 dispersion (Gg CO_2 eq.)
1990	11,054.50	4.00	44,217.99	44.22	0.001	11.05	0.011	44.53
1991	7,482.31	4.00	29,929.24	29.93	0.001	7.48	0.007	30.14
1992	3,368.94	4.00	13,475.75	13.48	0.001	3.37	0.003	13.57
1993	3,679.23	4.00	14,716.93	14.72	0.001	3.68	0.004	14.82
1994	2,270.30	4.00	9,081.21	9.08	0.001	2.27	0.002	9.14
1995	2,730.60	4.00	10,922.38	10.92	0.001	2.73	0.003	11.00
1996	1,979.25	4.00	7,916.99	7.92	0.001	1.98	0.002	7.97
1997	2,792.25	4.00	11,168.99	11.17	0.001	2.79	0.003	11.25
1998	5,702.79	4.00	22,811.15	22.81	0.001	5.70	0.006	22.97
1999	4,429.50	4.00	17,717.98	17.72	0.001	4.43	0.004	17.84
2000	3,596.98	4.00	14,387.93	14.39	0.001	3.60	0.004	14.49
2001	5,501.16	4.00	22,004.66	22.00	0.001	5.50	0.006	22.16
2002	4,694.13	4.00	18,776.51	18.78	0.001	4.69	0.005	18.91
2003	8,584.87	4.00	34,339.49	34.34	0.001	8.58	0.009	34.58
2004	14,451.21	4.00	57,804.84	57.80	0.001	14.45	0.014	58.21
2005	15,496.19	4.00	61,984.75	61.98	0.001	15.50	0.015	62.42
2006	16,541.16	4.00	66,164.65	66.16	0.001	16.54	0.017	66.63
2007	16,014.75	4.00	64,058.98	64.06	0.001	16.01	0.016	64.51
2008	18,197.79	4.00	72,791.14	72.79	0.001	18.20	0.018	73.30
2009	17,309.58	4.00	69,238.33	69.24	0.001	17.31	0.017	69.72
2010	27,613.68	4.00	110,454.72	110.45	0.001	27.61	0.028	111.23
2011	32,892.08	4.00	131,568.33	131.57	0.001	32.89	0.033	132.49
2012	35,375.59	4.00	141,502.38	141.50	0.001	35.38	0.035	142.49
2013	34,330.43	4.00	137,321.72	137.32	0.001	34.33	0.034	138.28
2014	35,141.26	4.00	140,565.04	140.57	0.001	35.14	0.035	141.55
2015	31,303.90	4.00	125,215.60	125.22	0.001	31.30	0.031	126.09
2016	2,445.92	4.00	9,783.70	9.78	0.001	2.45	0.002	9.85
2017	2,950.43	4.00	11,801.72	11.80	0.001	2.95	0.003	11.88
2018	2,644.24	4.00	10,576.94	10.58	0.001	2.64	0.003	10.65
2019	2,831.56	4.00	11,326.24	11.33	0.001	2.83	0.003	11.41
2020	3,010.21	4.00	12,040.85	12.04	0.001	3.01	0.003	12.13
2021	3,172.20	4.00	12,688.80	12.69	0.001	3.17	0.003	12.78
2022	3,337.23	4.00	13,348.93	13.35	0.001	3.34	0.003	13.44

According to paragraph 50 of the Nationally Determined Contribution of Georgia, information on the emission of atmospheric pollutants is presented in the form of a table in accordance with the Georgian Air Pollutant Emissions Inventory (https://www.ceip.at/status-of-reporting-and-review-results/2024-submission).

Table 4-36. Emissions of NOx, CO, NMVOC, and SOx from ferroalloys production (Gg) in 1990 - 2022

Year	NO_x Spraying (GG)	CO emission (GG)	NMVOC emissions (GG)	SO_x Spray (GG)	Year	NO_x Spraying (GG)	CO emission (GG)	NMVOC emissions (GG)	SO_x Spray (GG)
1990	NE	NE	NE	NE	2007	NE	NE	NE	NE
1991	NE	NE	NE	NE	2008	NE	NE	NE	NE
1992	NE	NE	NE	NE	2009	NE	NE	NE	NE
1993	NE	NE	NE	NE	2010	NE	NE	NE	NE
1994	NE	NE	NE	NE	2011	NE	NE	NE	NE
1995	NE	NE	NE	NE	2012	NE	NE	NE	NE
1996	NE	NE	NE	NE	2013	NE	NE	NE	NE
1997	NE	NE	NE	NE	2014	NE	NE	NE	NE
1998	NE	NE	NE	NE	2015	NE	NE	NE	NE
1999	NE	NE	NE	NE	2016	NE	NE	NE	NE
2000	NE	NE	NE	NE	2017	NE	NE	NE	NE
2001	NE	NE	NE	NE	2018	NE	NE	NE	NE
2002	NE	NE	NE	NE	2019	NE	NE	NE	NE
2003	NE	NE	NE	NE	2020	NE	NE	NE	NE
2004	NE	NE	NE	NE	2021	NE	NE	NE	NE
2005	NE	NE	NE	NE	2022	NE	NE	NE	NE
2006	NE	NE	NE	NE					

4.4.2.2. *Methodological issues*

Evaluation method

CO2 emissions from ferroalloy production are estimated using the IPCC 2006 Tier 1 approach. According to the Tier 1 method, CO2 emissions from ferroalloy production are calculated as follows:

$$CO_{2Emissions} = \sum_i (MP_i \times EF_i)$$

Where:

$CO_{2Emissions}$ – carbon dioxide emissions from the production of ferroalloys, t;

MP_i – quantity of ferroalloys produced by type i, t;

EF_i – general emission factor for ferroalloy type i, t CO_2/t specific ferroalloy produced.

Emission factor

The emission factors for estimating CO2 emissions from ferroalloy production using the IPCC 2006 Tier 1 approach are taken from Table 4.5 of Chapter 2, Volume 4 of the IPCC 2006 Guidelines and are 1.4 for ferrosilicon manganese, 4.0 for ferrosilicon (75% Si) and 1.3 for ferromanganese (7% C) (uncertainty ±25%).

Initial data

Several factories and workshops produce ferroalloys in Georgia, including Georgian Manganese LLC, Chiaturmanganum Georgia LLC, Geo Enterprise LLC, Georgian Alloys Group LLC, Russelloys LLC, GTM Group LLC, etc. Greenhouse gas emissions from 1990 to 2022 are estimated based on data provided by the National Statistics Service of Georgia. The uncertainty of the initial data is ±5%.

Below is the total amount of ferroalloys produced in Georgia by year.

Table 4-37. Amount of ferroalloys produced (t) in 1990 - 2022

Year	Quantity of ferroalloys produced (tons)	Year	Quantity of ferroalloys produced (tons)	Year	Quantity of ferroalloys produced (tons)	Year	Quantity of ferroalloys produced (tons)
1990	81,583.00	1999	32,690.00	2007	118,190.00	2015	231,025.10
1991	55,220.00	2000	26,545.99	2008	134,301.01	2016	244,592.39
1992	24,863.00	2001	40,598.99	2009	127,745.99	2017	295,042.90
1993	27,153.00	2002	34,643.01	2010	203,791.00	2018	264,423.62
1994	16,754.99	2003	63,356.99	2011	242,745.99	2019	283,156.06
1995	20,152.01	2004	106,651.00	2012	261,074.49	2020	301,021.16
1996	14,607.00	2005	114,363.00	2013	253,361.10	2021	317,220.11
1997	20,607.00	2006	122,075.00	2014	259,345.09	2022	333,723.21
1998	42,087.01						

As a result of the analysis of several years of data on ferroalloys produced by factories operating in Georgia, the percentage share of ferrosilicon manganese, ferrosilicon (75% Si), and ferromanganese (7% C) in the total amount of ferroalloys produced in Georgia was determined. According to the averaged data, 8 2.57 % of the total amount of ferroalloys produced in Georgia is ferrosilicon manganese, 13.55 % is ferrosilicon (75% Si) and 3.88 % is ferromanganese (7% C) (uncertainty ± 20%).

4.4.2.3. *Description of the flexibility used*

No flexibility was used.

4.4.2.4. *Uncertainty assessment and times series consistency*

Uncertainty assessment

See information in Annex II.

Times series consistency

For the entire reporting period, greenhouse gas emissions from the source category are estimated using the same method, and the initial data are obtained from a single source.

4.4.2.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.4.2.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

During the current inventory period, greenhouse gas emissions from the source category were not recalculated.

4.4.2.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission assessment within the category is linked to the establishment of a common national transparency system.

4.4.3. *Aluminum production (CRT 2C3)*

This source category does not occur in Georgia.

4.4.4. *Magnesium production (CRT 2C4)*

This source category does not occur in Georgia.

4.4.5. *Lead production (CRT 2C5)*

This source category does not occur in Georgia.

4.4.6. *Zinc production (CRT 2C6)*

This source category does not occur in Georgia.

4.4.7. *Other (CRT 2C7)*

This source category does not occur in Georgia.

4.5. Non-energy products of fuel and solvent consumption (CRT 2D)

In Georgia, the category of non-energy products for fuel and solvent consumption includes emissions only from the use of lubricants (2D1). Accordingly, the carbon dioxide emissions from this category are estimated for the lubricants subsection.

4.5.1. *Lubricant consumption (CRT 2D1)*

4.5.1.1. *Category description*

Data on lubricant use in Georgia have been available since 1990. In 1990, CO2 emissions from the lubricant consumption source category were at a high level. From 1991 to 1995, CO2 emissions decreased sharply (by 94%), which is associated with the difficult economic transformation of the country since the restoration of Georgia's independence. In 1995-2011, its amount was significantly reduced, and in 2009 it was not recorded at all. Also, low CO2 emissions were recorded in 2002. Since 2010, CO2 emissions have been characterized by a low growth rate, with an average annual increase of 6%. During this period, the peak of CO2 emissions was observed in 2022, and during the entire reporting period, the highest CO2 emissions from the lubricant use source category were in 1991.

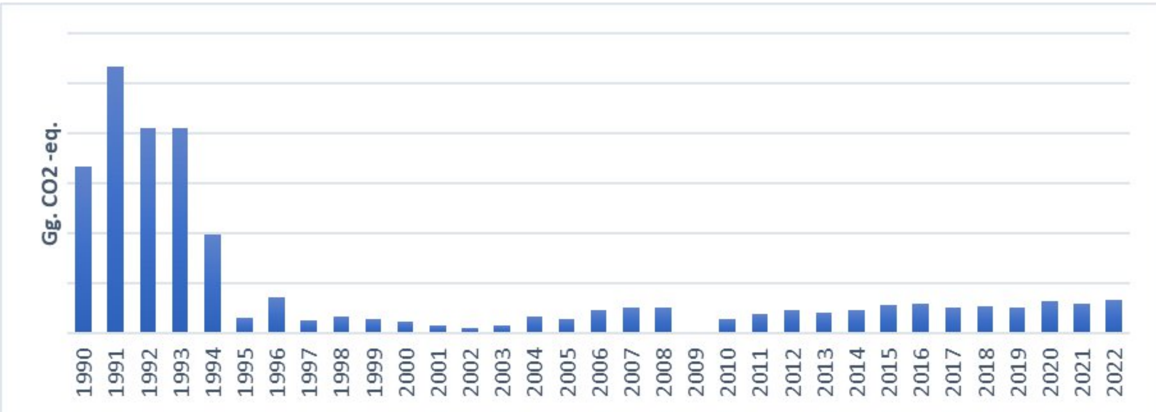
Since 1990 Lubricant consumption (2D1) has not been a key source category.

Table 4-38. CO2 emissions from lubricants (Gg) in 1990 - 2022

Year	Amount of lubricants consumed (TJ)	Carbon content in the lubricant (t C /tJ)	ODU factor	Molecular weight ratio (CO2/C) (44/12)	CO_2 - equivalent emission (T)	CO_2 - equivalent emission (GG)
1990	C	20	0.20	3.67	C	C
1991	C	20	0.20	3.67	C	C
1992	C	20	0.20	3.67	C	C
1993	C	20	0.20	3.67	C	C
1994	C	20	0.20	3.67	C	C
1995	C	20	0.20	3.67	C	C
1996	C	20	0.20	3.67	C	C
1997	C	20	0.20	3.67	C	C
1998	C	20	0.20	3.67	C	C
1999	C	20	0.20	3.67	C	C
2000	C	20	0.20	3.67	C	C
2001	C	20	0.20	3.67	C	C
2002	C	20	0.20	3.67	C	C
2003	C	20	0.20	3.67	C	C

Year	Amount of lubricants consumed (TJ)	Carbon content in the lubricant (t C /tJ)	ODU factor	Molecular weight ratio (CO2/C) (44/12)	CO $_2$ - equivalent emission (T)	CO $_2$ - equivalent emission (GG)
2004	C	20	0.20	3.67	C	C
2005	C	20	0.20	3.67	C	C
2006	C	20	0.20	3.67	C	C
2007	C	20	0.20	3.67	C	C
2008	C	20	0.20	3.67	C	C
2009	C	20	0.20	3.67	C	C
2010	C	20	0.20	3.67	C	C
2011	C	20	0.20	3.67	C	C
2012	C	20	0.20	3.67	C	C
2013	C	20	0.20	3.67	C	C
2014	C	20	0.20	3.67	C	C
2015	C	20	0.20	3.67	C	C
2016	C	20	0.20	3.67	C	C
2017	C	20	0.20	3.67	C	C
2018	C	20	0.20	3.67	C	C
2019	C	20	0.20	3.67	C	C
2020	C	20	0.20	3.67	C	C
2021	C	20	0.20	3.67	C	C
2022	C	20	0.20	3.67	C	C

Figure 4-11. CO2 emissions from lubricants (Gg) 1990-2022



4.5.1.2. *Methodological issues*

Evaluation method

CO2 emissions from lubricant use are estimated using the IPCC 2006 Tier 1 approach. According to the Tier 1 approach, N2O emissions from nitric acid production are calculated as follows:

$$CO_2Emissions = LC \times CC_{Lubricant} \times ODU_{Lubricant} \times \frac{44}{12}$$

Where:

CO $_{2Emissions}$ – carbon dioxide emissions from lubricant consumption, t;
LC – amount of lubricants consumed, TJ ;
CC $_{Lubricant}$ – standard carbon content in lubricants;
ODU $_{Lubricant}$ – ODU factor according to the standard composition of the lubricant;
The ratio of the molecular (atomic) masses of CO2 and C.

Emission factor

CO2 emissions from lubricant use according to the IPCC 2006 Tier 1 approach, the reference carbon content of lubricants (CC Lubricant) is taken from the data in Volume 2, Chapter 1, Table 1.3 of the IPCC 2006 Guidelines and is 20 (uncertainty ± 3%). The numerical value of the ODU factor according to the reference lubricant composition is selected from the data in Volume 3, Chapter 5, Table 5.2 of the same Guidelines and is 0.2 (uncertainty ± 50%).

Initial data

In Georgia, the National Statistics Service of Georgia has been recording lubricant consumption since 2011. The amount of lubricants consumed from 1990 to 2010 has been reconstructed based on data published by the International Energy Agency (IEA). Given this, the uncertainty of the initial data is ± 10%.

Below is the total amount of lubricants consumed by year.

Table 4-39. Amount of lubricants consumed (TJ) in 1990 - 2022

Year	Amount of lubricants consumed (TJ)	Year	Amount of lubricants consumed (TJ)	Year	Amount of lubricants consumed (TJ)	Year	Amount of lubricants consumed (TJ)
1990	C	1999	C	2007	C	2015	C
1991	C	2000	C	2008	C	2016	C
1992	C	2001	C	2009	C	2017	C
1993	C	2002	C	2010	C	2018	C
1994	C	2003	C	2011	C	2019	C
1995	C	2004	C	2012	C	2020	C
1996	C	2005	C	2013	C	2021	C
1997	C	2006	C	2014	C	2022	C
1998	C						

4.5.1.3. *Description of the flexibility used*

No flexibility was used.

4.5.1.4. *Uncertainty assessment and times series consistency*

Uncertainty assessment

See information in Annex II.

Times series consistency

For the entire reporting period, greenhouse gas emissions from the source category are estimated using the same method, and the initial data are obtained from a single source.

4.5.1.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.5.1.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

During the current inventory period, greenhouse gas emissions from the source category were not recalculated.

4.5.1.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission assessment within the category is linked to the establishment of a common national transparency system.

4.5.2. *Paraffin consumption (CRT 2D2)*

This source category does not occur in Georgia.

4.5.3. *Solvent consumption (CRT 2D3)*

This source category does not occur in Georgia.

4.5.4. *Other (CRT 2D4)*

This source category does not occur in Georgia.

4.6. Electrical equipment manufacturing (CRT 2E)

4.6.1. *Integrated circuits and/or semiconductors (CRT 2E1)*

This source category does not occur in Georgia.

4.6.2. *Liquid crystal flat panel display (CRT 2E2)*

This source category does not occur in Georgia.

4.6.3. *Solar panels (CRT 2E)*

This source category does not occur in Georgia.

4.6.4. *Heat transfer fluids (CRT 2E4)*

This source category does not occur in Georgia.

4.6.5. *Other (CRT 2E5)*

This source category does not occur in Georgia.

4.7. Use of substitute products for ozone-depleting substances (CRT 2F)

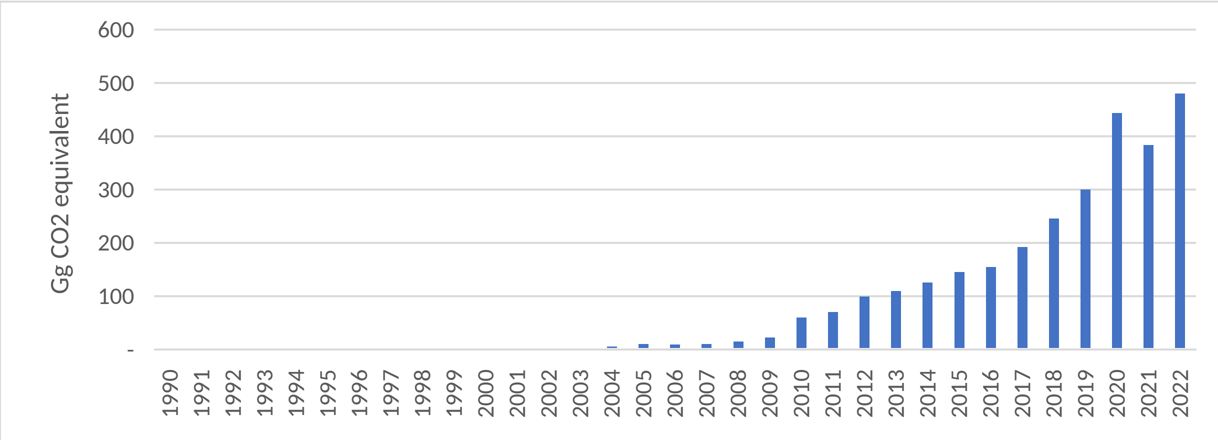
In Georgia, the category of ozone-depleting substances (ODS) substitute products include refrigerants and coolers (2F1) and aerosols (2F4). In 2001, greenhouse gas emissions from this category were first recorded (»0.24 Gg CO2 eq.). In the early 2000s, its amount increased slightly and by 2010 reached 59 Gg CO2 eq. In the following decade, greenhouse gas emissions increased even more and by 2020 amounted to 443 Gg CO2 eq. In 2021, emissions decreased by 14%, which is associated with a decrease in demand for air conditioners during the pandemic. At the end of the reporting period, greenhouse gas emissions from the category of ozone-depleting substances (ODS) substitute products amounted to 480 Gg CO2 eq.

Table 4-40. GHG emissions from the use of ozone-depleting substances (Gg) in 1990 - 2022

Year	Greenhouse gases (HFC) Emissions (Gg CO2 eq.)	Year	Greenhouse gases (HFC) Emissions (Gg CO2 eq.)	Year	Greenhouse gases (HFC) Emissions (Gg CO2 eq.)	Year	Greenhouse gases (HFC) Emissions (Gg CO2 eq.)
1990	NO	1998	NO	2006	9.21	2014	125.35
1991	NO	1999	NO	2007	9.66	2015	144.82
1992	NO	2000	NO	2008	14.90	2016	154.16
1993	NO	2001	0.24	2009	22.29	2017	192.21

Year	Greenhouse gases (HFC) Emissions (Gg CO2 eq.)	Year	Greenhouse gases (HFC) Emissions (Gg CO2 eq.)	Year	Greenhouse gases (HFC) Emissions (Gg CO2 eq.)	Year	Greenhouse gases (HFC) Emissions (Gg CO2 eq.)
1994	NO	2002	0.94	2010	59.36	2018	244.92
1995	NO	2003	2.85	2011	70.06	2019	299.47
1996	NO	2004	5.18	2012	98.79	2020	443.62
1997	NO	2005	9.44	2013	109.13	2021	383.55
						2022	479.59

figure 4-12. GHG emissions from the use of ozone-depleting substances (Gg) substitutes, 1990-2022



4.7.1. *Refrigerants and air conditioners (CRT 2F1)*

4.7.1.1. *Refrigerants and stationary coolers (CRT 2F1a)*

4.7.1.1.1. *Category description*

Greenhouse gas emissions from the use of refrigerants and air conditioners are calculated based on HFCs imported into Georgia. These compounds and mixtures are: HFC-134a, R-404A, R-407C, R-507A, and R-410A. Analysis of the content of these mixtures revealed four different hydrofluorocarbon compounds, which were the main sources of emissions in the period 2001-2022. Emissions from the use of hydrofluorocarbons have been calculated since 2001, after their determination in imported goods.

In general, greenhouse gas emissions from the use of hydrofluorocarbons in Georgia are characterized by an increasing trend. In 2001-2007, emissions of fluorinated gases were very small to almost negligible (within 0.2-9.7 Gg CO2 eq.). Since 2007, their amount has increased sharply and »reached a peak in 2020 (443 Gg CO2 eq.). In 2021, greenhouse gas emissions decreased by 14%, which is largely due to the import of the same amount of these substances over the previous 5 years. In 2022, greenhouse gas emissions increased by 20% and reached the highest level during the entire reporting period (»479 Gg CO2 eq.).

The use of refrigerants and air conditioners (2F1) is the key source category for HFC emissions in 2001-2022, according to the level and trend assessment.

Table 4-41. HFCs from the use of refrigerants and air conditioners (t of CO2 eq.) in 2001 - 2022

Year	HFC-32 t CO2 eq. Emission	HFC-32 t CO2 eq. Stock	HFC-125 t CO2 eq. Emission	HFC-125 t CO2 eq. Stock	HFC-134a t CO2 eq. Emission	HFC-134a t CO2 eq. Stock	HFC-143a t CO2 eq. Emission	HFC-143a t CO2 eq. Stock
2001	2.34	15.57	53.73	358.21	109.20	728.00	74.88	499.20
2002	14.36	95.76	213.29	1,421.90	462.46	3,083.08	250.85	1,672.32
2003	77.61	517.39	723.36	4,822.42	1,464.81	9,765.42	587.62	3,917.47
2004	178.08	1,187.19	1,603.90	10,692.66	2,145.99	14,306.61	1,248.28	8,321.85
2005	277.49	1,849.94	2,632.90	17,552.66	4,345.05	28,967.01	2,184.24	14,561.57
2006	282.58	1,883.87	2,517.56	16,783.72	4,482.65	29,884.36	1,931.48	12,876.54
2007	275.23	1,834.85	2,422.85	16,152.31	5,136.26	34,241.71	1,828.96	12,193.06
2008	311.02	2,073.47	3,497.81	23,318.71	7,664.44	51,096.25	3,426.61	22,844.10
2009	404.51	2,696.71	4,606.95	30,713.03	12,714.99	84,766.61	4,559.98	30,399.88
2010	927.74	6,184.95	14,562.36	97,082.37	26,298.54	175,323.62	17,570.39	117,135.90
2011	1,889.20	12,528.49	19,541.98	128,757.48	30,340.18	199,173.88	18,289.74	119,810.00
2012	2,274.77	14,814.39	21,413.37	138,006.75	56,328.11	365,047.56	18,777.85	119,881.70
2013	2,709.83	16,212.55	23,606.66	142,019.05	63,938.81	395,893.35	18,876.28	115,233.84
2014	4,640.22	27,783.83	33,807.84	197,950.28	66,223.29	417,157.02	20,675.19	117,437.30
2015	6,125.48	37,408.25	41,388.02	242,009.45	75,632.53	437,295.12	21,669.15	115,001.89
2016	7,336.89	48,366.59	44,664.09	296,706.00	73,343.46	480,343.55	28,817.72	192,118.16
2017	8,891.68	59,277.86	53,613.83	357,425.51	82,600.58	529,079.40	47,028.56	313,523.75
2018	10,396.32	69,260.98	66,435.52	422,594.22	95,397.55	578,585.82	72,384.36	446,654.56
2019	11,962.75	77,319.13	79,432.48	496,111.72	115,421.88	617,407.71	92,556.94	580,554.56
2020	14,452.88	81,217.57	122,914.26	530,383.74	153,599.79	614,993.94	152,040.18	635,776.72
2021	16,586.48	81,035.12	117,488.43	605,666.02	126,939.84	676,996.12	122,142.25	750,160.44
2022	14,816.95	83,072.18	121,064.79	709,282.83	207,037.92	629,477.79	136,202.24	855,360.04

Figure 4-13. HFCs from the use of refrigerants and cooling agents (Gg CO2 eq.) 1990-2022

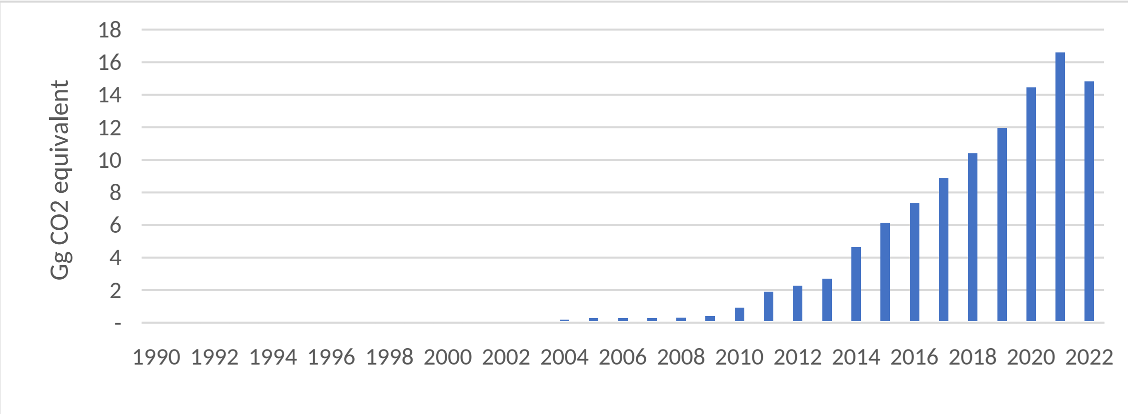


Table 4. 37. Fluorinated gas emissions from the use of refrigerants and air conditioners (vol.) 2001-2022

Year	HFC-32 T Emission	HFC-32 T Stock	HFC-125 T Emission	HFC-125 T Stock	HFC-134a T Emission	HFC-134a T Stock	HFC-143a T Emission	HFC-143a T Stock
2001	0.00	0.02	0.02	0.11	0.08	0.56	0.02	0.10
2002	0.02	0.14	0.07	0.45	0.36	2.37	0.05	0.35
2003	0.11	0.76	0.23	1.52	1.13	7.51	0.12	0.82
2004	0.26	1.75	0.51	3.37	1.65	11.01	0.26	1.73
2005	0.41	2.73	0.83	5.54	3.34	22.28	0.46	3.03
2006	0.42	2.78	0.79	5.29	3.45	22.99	0.40	2.68
2007	0.41	2.71	0.76	5.10	3.95	26.34	0.38	2.54
2008	0.46	3.06	1.10	7.36	5.90	39.30	0.71	4.76
2009	0.60	3.98	1.45	9.69	9.78	65.21	0.95	6.33
2010	1.37	9.14	4.59	30.63	20.23	134.86	3.66	24.40

Year	HFC-32 T Emission	HFC-32 T Stock	HFC-125 T Emission	HFC-125 T Stock	HFC-134a T Emission	HFC-134a T Stock	HFC-143a T Emission	HFC-143a T Stock
2011	2.79	18.51	6.16	40.62	23.34	153.21	3.81	24.96
2012	3.36	21.88	6.76	43.54	43.33	280.81	3.91	24.98
2013	4.00	23.95	7.45	44.80	49.18	304.53	3.93	24.01
2014	6.85	41.04	10.66	62.44	50.94	320.89	4.31	24.47
2015	9.05	55.26	13.06	76.34	58.18	336.38	4.51	23.96
2016	10.84	71.44	14.09	93.60	56.42	369.50	6.00	40.02
2017	13.13	87.56	16.91	112.75	63.54	406.98	9.80	65.32
2018	15.36	102.31	20.96	133.31	73.38	445.07	15.08	93.05
2019	17.67	114.21	25.06	156.50	88.79	474.93	19.28	120.95
2020	21.35	119.97	38.77	167.31	118.15	473.07	31.68	132.45
2021	24.50	119.70	37.06	191.06	97.65	520.77	25.45	156.28
2022	21.89	122.71	38.19	223.75	159.26	484.21	28.38	178.20

4.7.1.1.2. *Methodological issues*

Evaluation method

Emissions of fluorinated gases from the use of refrigerants and air conditioners have been estimated using the IPCC 2006 Tier 1 approach. In accordance with the Tier 1 approach, the calculation of HFC emissions from the use of refrigerants and air conditioners was performed using the Excel appendix to the same IPCC manual (Appendix V).

In Georgia, hydrofluorocarbons are not yet produced in the country. Accordingly, the production rate is zero. The same situation is in terms of exports. Therefore, emissions from the consumption of refrigerants and air conditioners correspond to imported hydrofluorocarbons and equipment, mainly for air conditioning and cooling.

Emission factor and other assumptions

In addition, the following assumptions are taken into account when estimating emissions of fluorinated gases recorded in Georgia (uncertainty ± 25%):

Table 4. 38. Assumptions specified in the assessment of fluorinated hydrocarbon emissions for 2001-2022.

Admission name	HFC-32	HFC-125	HFC-134a	HFC-143a
New device sales growth rate (%)	25	10	2.5	10
Operating period (years)	10	10	10	10
Emission factor (%)	15	15	15	15
Share of destroyed quantity (%)	25	25	25	25

Initial data

The initial data for the full reporting period are provided by the Georgian Refrigeration Association. Imports of HFC-134a, HFC-125, HFC-143a, and HFC-32 are recorded annually in Georgia. The uncertainty of the initial data is ±5%.

Table 4. 39. Quantity of imported hydrofluorocarbons (tons) 2001-2022.

Year	Imported HFC-32 R-Ba (tons)	Imported HFC-125 R-Ba (t)	Imported HFC-134a R-Ba (t)	Imported HFC-143a R-Ba (t)	Year	Imported HFC-32 R-Ba (tons)	Imported HFC-125 R-Ba (t)	Imported HFC-134a R-Ba (t)	Imported HFC-143a R-Ba (t)
2001	0.02	0.11	0.56	0.10	2012	6.26	9.31	152.19	3.98
2002	0.12	0.35	1.90	0.26	2013	5.90	8.77	70.52	3.22

Year	Imported HFC-32 R-Ba (tons)	Imported HFC-125 R-Ba (t)	Imported HFC-134a R-Ba (t)	Imported HFC-143a R-Ba (t)	Year	Imported HFC-32 R-Ba (tons)	Imported HFC-125 R-Ba (t)	Imported HFC-134a R-Ba (t)	Imported HFC-143a R-Ba (t)
2003	0.64	1.14	5.50	0.52	2014	21.62	26.10	65.78	4.91
2004	1.10	2.08	4.62	1.04	2015	21.39	25.41	73.92	4.39
2005	1.24	2.67	12.93	1.56	2016	29.73	35.22	89.55	5.99
2006	0.46	0.59	4.05	0.10	2017	29.74	35.37	92.25	6.14
2007	0.35	0.60	6.80	0.26	2018	16.47	39.00	76.92	26.63
2008	0.76	3.03	16.92	2.60	2019	18.93	43.09	112.68	28.70
2009	1.38	3.44	31.80	2.29	2020	11.83	36.18	114.61	29.22
2010	5.75	22.39	79.44	19.02	2021	19.69	43.90	120.85	29.75
2011	10.76	14.68	39.05	4.31	2022	26.03	67.09	156.92	49.02

4.7.1.1.3. *Description of the flexibility used*

No flexibility was used.

4.7.1.1.4. *Uncertainty assessment and times series consistency*

Uncertainty assessment

See information in Annex II.

Times series consistency

For the entire reporting period, greenhouse gas emissions from the source category are estimated using the same method, and the initial data are obtained from a single source.

4.7.1.1.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.7.1.1.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

During the current inventory period, greenhouse gas emissions from the source category were not recalculated.

4.7.1.1.7. *Planned improvements related to the category, including improvements identified during the inspection*

4.7.1.2. *Mobile coolers (CRT 2F1b)*

This source category is assessed together with 2F1a because when recording the consumption of imported HFCs, information is presented only by gases.

4.7.2. *Foaming agents (CRT 2F2)*

4.7.2.1. *Category description*

This source category has not been assessed, as foaming agents are not registered in Georgia.

4.7.3. *Fire extinguishers (CRT 2F3)*

4.7.3.1. *Category description*

This source category has not been assessed, as there is no accounting of substances used in fire extinguishers in Georgia.

4.7.4. *Aerosols (CRT 2F4)*

4.7.4.1. *Category description*

In Georgia, metered dose inhalers are used for medical purposes, mainly for the management of asthma and chronic obstructive pulmonary disease (COPD), when respiratory function is limited. Mometasone, budesonide, and Accelovert, which contain the fluorocarbon 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea), are actively used in Georgia.

HFC-227ea emissions were lowest in 2017 at 0.07 Gg CO2 eq. In subsequent years, emissions increased with the increase in imports of metered dose inhalers. In 2022, HFC-227ea emissions reached 0.47 Gg CO2 eq. During the reporting period, emissions were highest in 2020 at 0.61 Gg CO2 eq.

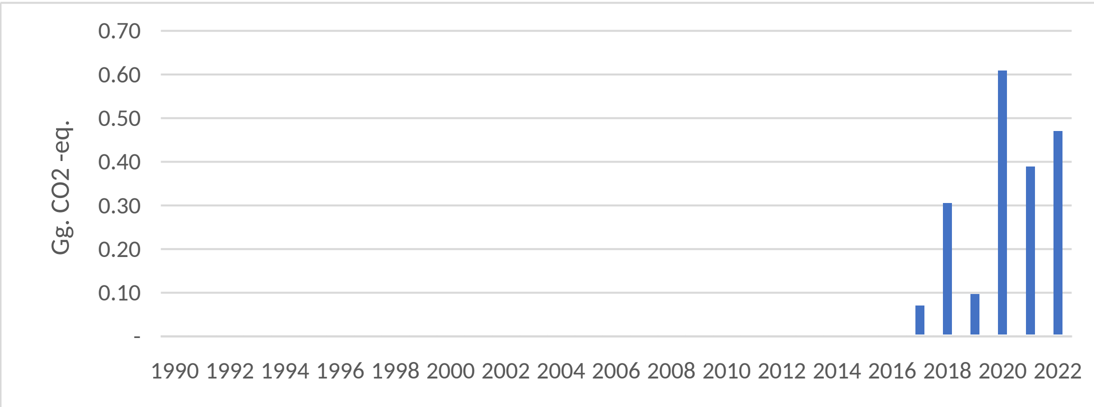
Aerosols (2F4) have not been a major source category of HFC emissions since their appearance without any interruption.

Table 4-42. HFC-227ea emissions from aerosol consumption (Gg) 1990 - 2022

Year	Number of metered dose inhalers	The coefficient determining the amount of HFC contained in the aerosol sold	HFC-227ea spraying (g)	HFC-227ea spraying (Gg)	CO_2 - eq. emission (Gg)
1990	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO
2001	NO	NO	NO	NO	NO
2002	NO	NO	NO	NO	NO
2003	NO	NO	NO	NO	NO
2004	NO	NO	NO	NO	NO
2005	NO	NO	NO	NO	NO
2006	NO	NO	NO	NO	NO
2007	NO	NO	NO	NO	NO
2008	NO	NO	NO	NO	NO
2009	NO	NO	NO	NO	NO
2010	NO	NO	NO	NO	NO
2011	NO	NO	NO	NO	NO
2012	NO	NO	NO	NO	NO
2013	NO	NO	NO	NO	NO
2014	NO	NO	NO	NO	NO
2015	NO	NO	NO	NO	NO
2016	NO	NO	NO	NO	NO
2017	22,000.00	0.96	21,120.00	0.00002	0.07

Year	Number of metered dose inhalers	The coefficient determining the amount of HFC contained in the aerosol sold	HFC-227ea spraying (g)	HFC-227ea spraying (Gg)	CO_2 - eq. emission (Gg)
201 8	95,000.00	0.96	91,200.00	0.00009	0.31
201 9	30,000.00	0.96	28,800.00	0.00003	0.10
2020	189,450.00	0.96	181,872.00	0.00018	0.61
2021	120,900.00	0.96	116,064.00	0.00012	0.39
2022	146,290.00	0.96	140,438.40	0.00014	0.47

Figure 4-14. HFC - 227ea Emissions From aerosol consumption (Gg) 1990-2022



4.7.4.2. Methodological issues

Evaluation method

HFC-227ea emissions from aerosol use are estimated using the IPCC 2006 Tier 1 approach. According to the Tier 1 method, HFC-227ea emissions from aerosol use are calculated as follows:

$$Emission_t = S_t \times EF + S_{t-1} \times (1 - EF)$$

Where,

S t – the amount of HFC contained in aerosol sold in year t;

S t-1 – the amount of HFC contained in aerosol sold in year t-1;

EF – emission factor (share of HFC emitted in year t)

Emission factor

To estimate HFC-227ea emissions from aerosol use using the IPCC 2006 Tier 1 approach, the emission factor (EF) for HFC-227ea is taken from the CBIT1 project research results and is 1.00 (uncertainty ± 20%).

Initial data

There is an official database in Georgia where it is possible to check the annual import of medicines (www.Pharmacy.moh.gov.ge). However, identifying the amount of propellants HFC-134a and HFC-227ea used is associated with expert assessment, due to the following difficulties:

Information about the presence of propellants is not indicated on medication labels.

It is possible to collect information on annual imports and to assume the composition from various international studies. Imports and actual consumption may not coincide. In addition, information on the quantity of medicines sold may be collected, but there is no data on whether the purchased MDIs are fully or correctly used. Therefore, for this assessment, it is assumed that all imported MDIs were fully used in the same year.

A coefficient of 0.96 was chosen to determine the amount of HFC contained in aerosols sold in Georgia, according to the CBIT project research (uncertainty ± 20%).

Below is the total number of metered dose inhalers imported into Georgia by year.

Table 4-43. Number of imported metered dose inhalers (t) in 1990 - 2002

Year	Number of metered dose inhalers (g)	Year	Number of metered dose inhalers (g)	Year	Number of metered dose inhalers (g)	Year	Number of metered dose inhalers (g)
1990	NO	1999	NO	2007	NO	2015	NO
1991	NO	2000	NO	2008	NO	2016	NO
1992	NO	2001	NO	2009	NO	2017	22,000.00
1993	NO	2002	NO	2010	NO	2018	95,000.00
1994	NO	2003	NO	2011	NO	2019	30,000.00
1995	NO	2004	NO	2012	NO	2020	189,450.00
1996	NO	2005	NO	2013	NO	2021	120,900.00
1997	NO	2006	NO	2014	NO	2022	146,290.00
1998	NO						

4.7.4.3. *Description of the flexibility used*

No flexibility was used.

4.7.4.4. *Uncertainty assessment and times series consistency*

Uncertainty assessment

See information in Annex II.

Times series consistency

For the entire reporting period, greenhouse gas emissions from the source category are estimated using the same method, and the initial data are obtained from a single source.

4.7.4.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.7.4.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

During the current inventory period, greenhouse gas emissions from the source category were not recalculated.

4.7.4.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission assessment within the category is linked to the establishment of a common national transparency system.

4.7.5. *Solvents (CRT 2F5)*

4.7.5.1. *Category description*

This source category has not been assessed because Georgia does not record substances used in solvents.

4.7.6. *Other (CRT 2F6)*

This source category does not occur in Georgia.

4.8. Other Product Manufacture and Use (CRT 2G)

4.8.1. *Electrical equipment (CRT 2G1)*

4.8.1.1. *Electrical equipment manufacturing (CRT 2G1a)*

This source category does not occur in Georgia.

4.8.1.2. *Consumption of electrical appliances (CRT 2G1b)*

4.8.1.2.1. *Category description*

Sulfur hexafluoride SF6 emissions in the Georgian electricity transmission system are associated with the use of MV and HV electrical equipment (35 kV and higher voltage) that contain SF6 as an insulating material. The transmission system operator (TSO) in Georgia is JSC Georgian State Electrosystem (GSE), while the distribution system operator (DSO) in Georgia is JSC ENERGO-PRO Georgia and JSC Telasi, which own the above-mentioned equipment.

In Georgia, medium and high-voltage circuit breakers and power transformers with gas insulation, which contain SF6 as an insulating substance, have been used since 2010. Accordingly, the accounting of SF6 emissions from the use of these devices began in 2010. Greenhouse gas emissions from the use of SF6 are characterized by an increasing trend. During the reporting period, SF6 emissions are very small, almost negligible, and increase from 0.55 to 1.14 Gg CO2 eq. In 2022, SF6 emissions reached the highest level during the entire reporting period (»1.14 Gg CO2 eq.).

The source category for the use of electrical appliances (2G1b) is not a key source category for the assessment of greenhouse gas emissions.

Table 4-44. SF6 emissions from electrical equipment use (tons of CO2 equivalent) 2001-2022

Year	Total amount of SF6 in the installed equipment (TNC) (T)	SF6 emission factor	SF6 spraying (T)	SF6 spraying (GG)	CO_2 - equivalent emission (GG)
1990	NA	NA	NA	NA	NA
1991	NA	NA	NA	NA	NA
1992	NA	NA	NA	NA	NA
1993	NA	NA	NA	NA	NA
1994	NA	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA
1996	NA	NA	NA	NA	NA
1997	NA	NA	NA	NA	NA
1998	NA	NA	NA	NA	NA

Year	Total amount of SF6 in the installed equipment (TNC) (T)	SF6 emission factor	SF6 spraying (T)	SF6 spraying (GG)	CO_2 - equivalent emission (GG)
1999	NA	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA
2001	NA	NA	NA	NA	NA
2002	NA	NA	NA	NA	NA
2003	NA	NA	NA	NA	NA
2004	NA	NA	NA	NA	NA
2005	NA	NA	NA	NA	NA
2006	NA	NA	NA	NA	NA
2007	NA	NA	NA	NA	NA
2008	NA	NA	NA	NA	NA
2009	NA	NA	NA	NA	NA
2010	4.67	0.005	0.02	0.00	0.55
2011	5.27	0.005	0.03	0.00	0.62
2012	5.75	0.005	0.03	0.00	0.68
2013	5.77	0.005	0.03	0.00	0.68
2014	6.31	0.005	0.03	0.00	0.74
2015	6.69	0.005	0.03	0.00	0.79
2016	7.07	0.005	0.04	0.00	0.83
2017	7.44	0.005	0.04	0.00	0.87
2018	7.96	0.005	0.04	0.00	0.93
2019	8.47	0.005	0.04	0.00	1.00
2020	8.99	0.005	0.04	0.00	1.06
2021	9.50	0.005	0.05	0.00	1.12
2022	9.72	0.005	0.05	0.00	1.14

Figure 4-15. SF6 emissions from electrical equipment use (tons of CO2 eq.) 2001-2022

4.8.1.2.2. *Methodological issues*

Evaluation method

SF6 from the use of electrical equipment Emissions are estimated using the IPCC 2006 Tier 1 approach. According to the Tier 1 method, the calculation of SF6 emissions from the use of electrical equipment includes manufacturing emissions (ME), equipment installation emissions (IE), equipment use emissions (UE), and equipment disposal emissions (DE) and is as follows:

$$TE_{SF6} = ME + IE + UE + DE$$

Where,

TE_{SF6} – SF6 emissions from the use of electrical equipment, t,

ME – emissions from equipment production, t;

IE – emissions from the installation of the device, t;
UE – equipment usage emissions, t;
DE – Equipment Destruction Emissions, Vol.

ME is not assessed in Georgia because circuit breakers are not manufactured in the country and all equipment is imported. Installation emissions are ignored because SF6 emissions were not present for most of the equipment during installation. In addition, the decommissioning of SF6-containing circuit breakers in Georgia has not yet been recorded because the service life of the equipment exceeds the period since installation.

Currently, SF6 emissions from electrical equipment are generated during the use of electrical equipment during leakage, maintenance, storage, and malfunctions of circuit breakers. In most cases, SF6 filling of circuit breakers and power transformers is carried out through easily accessible connectors. In accordance with the 2006 IPCC guidelines, SF6 emissions from equipment use (UE) are estimated as the Equipment Emission Factor (IEF) multiplied by the Total Quantity of SF6 in the installed equipment (TNC).

$$UE = IEF \times TNC$$

Where,
UE – SF6 emissions from equipment use, t;
IEF – device emission factor;
TNC – Total amount of SF6 in the installed equipment.

Emission factor

SF6 emissions from the source category of electrical equipment use according to the IPCC 2006 Tier 1 approach, the equipment SF6 emission factor (IEF) is taken from the research data conducted within the framework of the CBIT project and is 0.005 (uncertainty ± 3%).

Initial data

In Georgia, JSC Georgian State Electrosystem (GSE), JSC ENERGO-PRO Georgia, and JSC Telasi own SF6 -containing circuit breakers and gas-insulated power transformers. SF6 emissions from the use of electrical equipment in 2010-2022 are estimated based on data received from JSC Georgian State Electrosystem (GSE), JSC ENERGO-PRO Georgia, and JSC Telasi. The uncertainty of the initial data is ± 2%.

Below is the total amount of SF6 in electrical equipment installed in Georgia by year.

Table 4. 43. Total amount of SF6 in installed equipment (tons) 2010-2022.

Year	The total amount of SF6 in the installed equipment (TNC). (t)	Year	The total amount of SF6 in the installed equipment (TNC). (t)	Year	The total amount of SF6 in the installed equipment (TNC). (t)	Year	The total amount of SF6 in the installed equipment (TNC). (t)
2010	4.67	2013	5.77	2016	7.07	2019	8.47
2011	5.27	2014	6.31	2017	7.44	2020	8.99
2012	5.75	2015	6.69	2018	7.96	2021	9.50
						2022	9.72

4.8.1.2.3. *Description of the flexibility used*

No flexibility was used.

4.8.1.2.4. *Uncertainty assessment and times series consistency*

Uncertainty assessment

See information in Annex II.

Times series consistency

For the entire reporting period, greenhouse gas emissions from the source category are estimated using the same method, and the initial data are obtained from a single source.

4.8.1.2.5. *Category-appropriate quality control and assurance and verification*

The general inventory QC procedures were conducted in accordance with the IPCC 2006 Guidelines. The general inventory QC focused on checking activity data and emission factor parameters and archiving reference materials. The QA/QC procedures are summarized in Chapter 1.

4.8.1.2.6. *Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.*

For the full reporting period (1990-2022), SF6 emissions from the source category of electrical equipment use are estimated using the IPCC 2006 Tier 1 approach, with a country-specific SF6 emission factor (IEF). The previous inventory report covered the reporting period (1990-2017), and greenhouse gas emissions were estimated using the IPCC 2006 Tier 1 approach, with a reference SF6 emission factor (IEF). Following the principle of time consistency, as the assessment approach improves, greenhouse gas emissions have been recalculated for the overall reporting period (1990-2017). The differences in SF6 emissions between the approaches are given in the table.

Table 4-45. Differences between SF6 emissions

Year	IPCC 2006 “Level 1 ” CSEF SF6 spraying (GG)	IPCC 2006 “Level 1 ” DEF SF6 spraying (GG)	Difference SF6 spraying (GG)	Year	IPCC 2006 “Level 1 ” CSEF SF6 spraying (GG)	IPCC 2006 “Level 1 ” DEF SF6 spraying (GG)	Difference SF6 spraying (GG)
1990	NA	NA	NA	2004	NA	NA	NA
1991	NA	NA	NA	2005	NA	NA	NA
1992	NA	NA	NA	2006	NA	NA	NA
1993	NA	NA	NA	2007	NA	NA	NA
1994	NA	NA	NA	2008	NA	NA	NA
1995	NA	NA	NA	2009	NA	NA	NA
1996	NA	NA	NA	2010	0.000023	0.000009	0.000014
1997	NA	NA	NA	2011	0.000026	0.00001 1	0.000016
1998	NA	NA	NA	2012	0.000029	0.00001 2	0.000017
1999	NA	NA	NA	2013	0.000029	0.00001 2	0.000017
2000	NA	NA	NA	2014	0.000032	0.00001 3	0.000019
2001	NA	NA	NA	2015	0.000033	0.000013	0.000020
2002	NA	NA	NA	2016	0.000035	0.000014	0.000021
2003	NA	NA	NA	2017	0.000037	0.00001 5	0.000022

4.8.1.2.7. *Planned improvements related to the category, including improvements identified during the inspection*

Further improvement of greenhouse gas emission assessment within the category is linked to the establishment of a common national transparency system.

4.8.1.3. *Disposal of electrical appliances (CRT 2G1c)*

This source category does not occur in Georgia.

4.8.2. *SF_6 and PFCs during the use of other products (CRT 2G2)*

This source category does not occur in Georgia.

4.8.2.1. *Military equipment (CRT 2G2a)*

This source category does not occur in Georgia.

4.8.2.2. *Accelerators (CRT 2G2b)*

This source category does not occur in Georgia.

4.8.2.3. *Other (CRT 2G2c)*

This source category does not occur in Georgia.

4.8.3. *N2O emissions during product consumption (CRT 2G3)*

4.8.3.1. *Medical/technical devices (CRT 2G3a)*

This source category does not occur in Georgia.

4.8.3.2. *Propellants in pressurized and aerosol products (CRT 2G3b)*

This source category does not occur in Georgia.

4.8.3.3. *Other (CRT 2G3c)*

This source category does not occur in Georgia.

4.8.4. *Other (CRT 2G4)*

This source category does not occur in Georgia.

4.9. Other (CRT 2H)

There are no GHG emission estimation methods described in the 2006 IPCC guidelines for this category.

4.9.1. *Paper production (CRT 2H1)*

There are no GHG emission estimation methods described in the 2006 IPCC guidelines for this category.

4.9.2. *Food and beverage manufacturing (CRT 2H2)*

There are no GHG emission estimation methods described in the 2006 IPCC guidelines for this category.

4.9.3. *Other (CRT 2H3)*

There are no GHG emission estimation methods described in the 2006 IPCC guidelines for this category.

Chapter 5. Agriculture (CRT sector 3)

5.1. Sector Overview and General Information

Agriculture has historically been one of the main sectors of the Georgian economy. At present, 40% of the population lives in rural areas and is involved in agricultural activities. The agricultural sector remains vital to Georgia's economy, which is reflected in its priority status in the country's strategic documents. Georgian farmers are essential in meeting the fundamental societal need for safe and affordable food.

Georgia's relatively small area encompasses nearly every type of climate on Earth (except for equatorial and tropical climates). It ranges from the humid subtropics along the Black Sea coast in Western Georgia to the dry subtropics in Eastern Georgia and extends to the eternal snow and glacier zone in the Caucasus.

According to the "2014 Agricultural Census", 73.1% of farms in Georgia cultivated up to one hectare of land, 25% - from one to 5 hectares, and only 1.5% of farms - more than 5 hectares of land. Agricultural land in Georgia covers 2.55 million hectares, which represents approximately 37% of the total area (forests, approximately 41%, and other areas, approximately 23%). The shares of agricultural activity are as follows: annual crops occupy 220,300 ha, perennial crops - 226,100 ha, and pastures and hay meadows - 1,776,000 ha. Between 2005 and 2010, the amount of agricultural sown land has fallen sharply (by about twice). In 2022, the sown area was only 31% of the 1990 level. In 2022, the area under crops amounted to only 31% of the 1990 level. Georgia's agricultural lands are significantly degraded, resulting in low yields. Synthetic N fertilizers and organic N fertilizers are used to improve soil fertility. Since 1990, the livestock population has been significantly decreased in Georgia. Compared to 1990, in 2022, the cattle number decreased by 34%, the sheep number by 44%, and the swine number by 83%.

The Georgian agricultural sector, as a source of greenhouse gas emissions, includes the following categories: enteric fermentation, manure management, direct and indirect N2O emissions from managed soils, biomass burning in cropland, and urea application. Since rice is not cultivated in Georgia, the IPCC category for greenhouse gas emissions from rice cultivation has not been evaluated. Additionally, there are no savannahs in Georgia, so the IPCC category for established savanna burning is not applicable.

5.1.1. *Greenhouse gas emissions trend*

Greenhouse gas emissions from the agricultural sector were calculated for the years 2018-2022 and, to ensure time series consistency, were recalculated for the previous, 1990-2017 years. The results are presented in Tables 5-1, 5-2, and 5-3.

Table 5-1. Greenhouse gas emissions from the agriculture sector (Gg) in 1990-2022 years

Year	3.A.1 Enteric fermentation	3.A.2 Manure management	3.C.1.b Biomass burning in cropland	**Total Gg CH_4**	3.A.2 Direct N_2O emissions from manure management	3.C.6 Indirect N_2O emissions from manure management	3.C.4 Direct emissions from managed soils	3.C.5 Indirect emissions from managed soils	3.C.1.b Biomass burning in cropland	**Total Gg N_2O**	3.C.3 Urea application	**Total Gg CO_2**
1990	106.44	12.27	0.08	**118.79**	0.42	0.26	2.28	0.65	0.002	**3.62**	0.0	**0.0**
1991	96.63	10.87	0.07	**107.57**	0.37	0.24	2.00	0.57	0.002	**3.17**	0.0	**0.0**
1992	77.36	7.94	0.06	**85.36**	0.28	0.18	1.56	0.44	0.001	**2.46**	0.0	**0.0**
1993	68.44	6.59	0.05	**75.08**	0.24	0.17	1.36	0.38	0.001	**2.16**	0.0	**0.0**
1994	66.11	6.11	0.04	**72.26**	0.24	0.17	1.27	0.35	0.001	**2.02**	0.0	**0.0**
1995	64.99	5.66	0.03	**70.68**	0.23	0.17	1.33	0.36	0.001	**2.10**	0.0	**0.0**
1996	63.93	5.16	0.04	**69.12**	0.23	0.18	1.65	0.45	0.001	**2.50**	0.0	**0.0**
1997	63.84	5.10	0.05	**68.99**	0.23	0.18	1.78	0.47	0.001	**2.66**	0.0	**0.0**
1998	64.38	5.01	0.03	**69.42**	0.23	0.17	1.56	0.41	0.001	**2.37**	0.0	**0.0**
1999	67.80	5.26	0.06	**73.12**	0.25	0.18	1.81	0.48	0.001	**2.72**	0.0	**0.0**
2000	69.86	5.37	0.02	**75.26**	0.26	0.18	1.68	0.45	0.001	**2.56**	0.0	**0.0**
2001	69.53	5.35	0.08	**74.96**	0.26	0.18	1.80	0.47	0.002	**2.71**	0.0	**0.0**
2002	71.12	5.43	0.05	**76.60**	0.26	0.19	1.93	0.51	0.001	**2.89**	0.0	**0.0**
2003	72.22	5.59	0.05	**77.86**	0.27	0.19	2.01	0.53	0.001	**3.00**	0.0	**0.0**
2004	68.64	5.42	0.05	**74.11**	0.26	0.18	1.73	0.46	0.001	**2.63**	0.0	**0.0**
2005	68.85	5.31	0.06	**74.22**	0.26	0.18	1.75	0.46	0.002	**2.64**	0.1	**0.1**
2006	62.18	4.57	0.03	**66.78**	0.22	0.15	1.55	0.43	0.001	**2.36**	0.1	**0.1**
2007	59.95	3.79	0.05	**63.79**	0.19	0.14	1.36	0.37	0.001	**2.06**	0.1	**0.1**
2008	59.08	3.68	0.05	**62.80**	0.18	0.14	1.38	0.37	0.001	**2.07**	0.1	**0.1**
2009	56.81	3.75	0.08	**60.59**	0.18	0.14	1.33	0.37	0.001	**2.01**	0.3	**0.3**
2010	57.88	3.71	0.03	**61.63**	0.18	0.14	1.29	0.36	0.001	**1.96**	0.8	**0.8**
2011	59.22	3.78	0.06	**63.07**	0.18	0.14	1.32	0.35	0.002	**2.00**	0.2	**0.2**
2012	61.53	4.21	0.05	**65.78**	0.20	0.15	1.45	0.40	0.001	**2.19**	0.4	**0.4**
2013	66.55	4.45	0.05	**71.05**	0.21	0.16	1.73	0.47	0.001	**2.57**	0.5	**0.5**
2014	68.76	4.52	0.04	**73.32**	0.21	0.16	1.71	0.47	0.001	**2.55**	1.7	**1.7**
2015	70.76	4.71	0.07	**75.54**	0.22	0.17	1.79	0.48	0.002	**2.66**	2.7	**2.7**
2016	68.06	4.61	0.07	**72.74**	0.21	0.16	1.70	0.46	0.002	**2.53**	1.7	**1.7**
2017	63.97	4.35	0.06	**68.39**	0.20	0.15	1.48	0.41	0.002	**2.24**	1.9	**1.9**
2018	61.26	4.18	0.07	**65.51**	0.19	0.15	1.43	0.39	0.002	**2.16**	2.5	**2.5**
2019	61.04	4.32	0.07	**65.43**	0.19	0.15	1.34	0.37	0.002	**2.05**	2.7	**2.7**
2020	64.41	4.58	0.06	**69.05**	0.20	0.16	1.51	0.41	0.002	**2.28**	4.8	**4.8**
2021	64.17	4.53	0.08	**68.78**	0.20	0.15	1.51	0.41	0.002	**2.27**	3.1	**3.1**
2022	58.90	4.22	0.08	**63.20**	0.18	0.14	1.34	0.36	0.002	**2.02**	3.9	**3.9**

Table 5-2. Greenhouse gas emissions from the agriculture sector (Gg CO2-eq) in 1990-2022 years

Year	3.A.1 Enteric fermentation	3.A.2Manure management	3.C.1.b Biomass burning in cropland	**Total Gg CH_4**	3.A.2 Direct N_2O emissions from manure management	3.C.6 Indirect N_2O Emissions from manure management	3.C.4Direct emissions from managed soils	3.C.5 Indirect emissions from managed soils	3.C.1.b Biomass burning in cropland	**Total N_2O**	3.C.3 Urea application	Total CO_2	**Total Gg CO_2-eq**
1990	2,980.4	343.5	2.2	**3,326.1**	110.7	70.1	605.5	171.1	0.5	**958.0**	0.0	**0.0**	**4,284.2**
1991	2,705.6	304.4	1.9	**3,011.9**	97.8	63.4	529.6	150.0	0.5	**841.3**	0.0	**0.0**	**3,853.2**
1992	2,166.2	222.3	1.6	**2,390.1**	73.9	48.2	412.5	115.9	0.4	**650.9**	0.0	**0.0**	**3,041.0**
1993	1,916.2	184.6	1.3	**2,102.2**	64.1	44.3	360.9	101.7	0.3	**571.3**	0.0	**0.0**	**2,673.5**
1994	1,851.0	171.2	1.1	**2,023.2**	62.7	44.6	335.4	91.7	0.3	**534.7**	0.0	**0.0**	**2,557.9**
1995	1,819.7	158.5	0.9	**1,979.2**	61.9	45.9	352.3	96.0	0.2	**556.3**	0.0	**0.0**	**2,535.5**
1996	1,790.0	144.4	1.0	**1,935.4**	60.8	46.8	436.4	119.2	0.3	**663.5**	0.0	**0.0**	**2,598.9**
1997	1,787.5	142.8	1.3	**1,931.6**	60.8	47.5	471.1	125.5	0.3	**705.2**	0.0	**0.0**	**2,636.8**
1998	1,802.6	140.3	0.8	**1,943.8**	61.5	44.3	412.4	109.7	0.2	**628.1**	0.0	**0.0**	**2,571.9**
1999	1,898.5	147.4	1.6	**2,047.4**	65.7	47.0	480.8	127.4	0.4	**721.2**	0.0	**0.0**	**2,768.6**
2000	1,956.2	150.5	0.6	**2,107.3**	68.1	48.3	444.0	118.7	0.2	**679.3**	0.0	**0.0**	**2,786.6**
2001	1,947.0	149.7	2.2	**2,098.9**	68.0	48.4	476.8	124.2	0.5	**718.1**	0.0	**0.0**	**2,817.0**
2002	1,991.3	152.2	1.4	**2,144.8**	69.2	49.5	511.2	136.2	0.3	**766.4**	0.0	**0.0**	**2,911.2**
2003	2,022.2	156.5	1.5	**2,180.2**	71.0	50.4	532.2	141.4	0.4	**795.4**	0.0	**0.0**	**2,975.6**
2004	1,921.9	151.8	1.4	**2,075.1**	68.9	48.5	458.1	121.8	0.3	**697.6**	0.0	**0.0**	**2,772.8**
2005	1,927.8	148.6	1.6	**2,078.1**	67.6	47.0	462.7	121.0	0.4	**698.7**	0.1	**0.1**	**2,776.8**
2006	1,741.0	127.8	1.0	**1,869.8**	58.5	41.0	410.0	114.8	0.2	**624.5**	0.1	**0.1**	**2,494.4**
2007	1,678.7	106.1	1.4	**1,786.1**	49.1	38.0	359.7	97.6	0.3	**544.8**	0.1	**0.1**	**2,331.0**
2008	1,654.2	102.9	1.4	**1,758.5**	47.5	37.6	365.0	98.8	0.3	**549.3**	0.1	**0.1**	**2,307.9**
2009	1,590.8	104.9	2.2	**1,697.8**	47.3	36.7	352.2	97.0	0.2	**533.4**	0.3	**0.3**	**2,231.4**
2010	1,620.7	104.0	0.8	**1,725.5**	47.1	37.0	340.9	94.6	0.2	**519.8**	0.8	**0.8**	**2,246.1**
2011	1,658.3	105.9	1.7	**1,765.9**	47.6	37.6	350.5	93.8	0.4	**530.0**	0.2	**0.2**	**2,296.0**
2012	1,722.8	117.7	1.4	**1,842.0**	52.3	39.3	384.3	105.0	0.3	**581.2**	0.4	**0.4**	**2,423.5**
2013	1,863.3	124.5	1.4	**1,989.3**	55.4	42.2	458.0	124.6	0.4	**680.5**	0.5	**0.5**	**2,670.2**
2014	1,925.3	126.5	1.1	**2,052.9**	56.1	43.0	454.0	123.4	0.3	**676.7**	1.7	**1.7**	**2,731.3**
2015	1,981.2	131.9	2.1	**2,115.2**	57.3	44.8	473.3	127.8	0.5	**703.7**	2.7	**2.7**	**2,821.5**
2016	1,905.7	129.1	2.1	**2,036.8**	54.6	42.8	450.2	122.6	0.5	**670.7**	1.7	**1.7**	**2,709.2**
2017	1,791.2	121.9	1.8	**1,914.9**	52.2	40.6	393.1	108.4	0.4	**594.7**	1.9	**1.9**	**2,511.5**
2018	1,715.3	117.1	2.0	**1,834.4**	50.7	39.0	379.3	104.2	0.5	**573.7**	2.5	**2.5**	**2,410.6**
2019	1,709.2	121.1	1.9	**1,832.1**	50.4	39.1	355.5	96.7	0.5	**542.2**	2.7	2.7	**2,377.1**
2020	1,803.4	128.3	1.8	**1,933.5**	52.9	41.2	399.6	108.8	0.4	**603.0**	4.8	4.8	**2,541.3**
2021	1,796.9	126.7	2.2	**1,925.8**	52.1	40.4	399.3	108.6	0.5	**600.9**	3.1	3.1	**2,529.8**
2022	1,649.3	118.0	2.3	**1,769.7**	48.4	37.2	353.9	96.4	0.6	**536.5**	3.9	3.9	**2,310.1**

The share of emissions from the agricultural sector and the categories of this sector in the country's national GHG emissions are given in Table 5-3. This table clearly shows that the largest source of methane in this sector is "methane emissions from enteric fermentation", while the largest source of nitrous oxide is "direct N_2O emissions from managed soils".

According to this table, the share of methane in 1990-2022 varies between 73.3-79.1 percent, and the share of nitrous oxide varies between 20.9-26.7 percent. In the previous GHG inventory (within the framework of Georgia's Fourth National Communication to the UNFCCC), the share of methane was within 43-54 percent, and the share of nitrous oxide was within 46-57 percent. Such a large difference is mainly due to the use of different values of global warming potential (GWP).

Table 5-3. Share of greenhouse gases and categories in agriculture sector emissions, %

Year	3.A.1 Enteric fermentation	3.A.2 Manure management	3.C.1.b Biomass burning in cropland	**Total CH_4**	3.A.2 N_2O direct emissions from manure management	3.C.6 Indirect N_2O emissions from manure management	3.C.4 Direct emissions from managed soils	3.C.5 Indirect emissions from managed soils	3.C.1.b Biomass burning in cropland	**Total N_2O**	3.C.3 Urea application	**Total CO_2**	**Total GHG**
1990	69.6	8.0	0.1	77.6	2.6	1.6	14.1	4.0	0.013	22.4	0.000	0.000	100
1991	70.2	7.9	0.0	78.2	2.5	1.6	13.7	3.9	0.012	21.8	0.000	0.000	100
1992	71.2	7.3	0.1	78.6	2.4	1.6	13.6	3.8	0.013	21.4	0.000	0.000	100
1993	71.7	6.9	0.0	78.6	2.4	1.7	13.5	3.8	0.012	21.4	0.000	0.000	100
1994	72.4	6.7	0.0	79.1	2.5	1.7	13.1	3.6	0.010	20.9	0.000	0.000	100
1995	71.8	6.3	0.0	78.1	2.4	1.8	13.9	3.8	0.009	21.9	0.000	0.000	100
1996	68.9	5.6	0.0	74.5	2.3	1.8	16.8	4.6	0.010	25.5	0.000	0.000	100
1997	67.8	5.4	0.1	73.3	2.3	1.8	17.9	4.8	0.012	26.7	0.000	0.000	100
1998	70.1	5.5	0.0	75.6	2.4	1.7	16.0	4.3	0.008	24.4	0.000	0.000	100
1999	68.6	5.3	0.1	74.0	2.4	1.7	17.4	4.6	0.014	26.0	0.000	0.000	100
2000	70.2	5.4	0.0	75.6	2.4	1.7	15.9	4.3	0.006	24.4	0.000	0.000	100
2001	69.1	5.3	0.1	74.5	2.4	1.7	16.9	4.4	0.019	25.5	0.000	0.000	100
2002	68.4	5.2	0.0	73.7	2.4	1.7	17.6	4.7	0.012	26.3	0.000	0.000	100
2003	68.0	5.3	0.1	73.3	2.4	1.7	17.9	4.8	0.012	26.7	0.000	0.000	100
2004	69.3	5.5	0.1	74.8	2.5	1.7	16.5	4.4	0.013	25.2	0.000	0.000	100
2005	69.4	5.4	0.1	74.8	2.4	1.7	16.7	4.4	0.014	25.2	0.003	0.003	100
2006	69.8	5.1	0.0	75.0	2.3	1.6	16.4	4.6	0.010	25.0	0.006	0.006	100
2007	72.0	4.6	0.1	76.6	2.1	1.6	15.4	4.2	0.014	23.4	0.004	0.004	100
2008	71.7	4.5	0.1	76.2	2.1	1.6	15.8	4.3	0.015	23.8	0.004	0.004	100
2009	71.3	4.7	0.1	76.1	2.1	1.6	15.8	4.3	0.010	23.9	0.012	0.012	100
2010	72.2	4.6	0.0	76.8	2.1	1.6	15.2	4.2	0.009	23.1	0.036	0.036	100
2011	72.2	4.6	0.1	76.9	2.1	1.6	15.3	4.1	0.018	23.1	0.007	0.007	100
2012	71.1	4.9	0.1	76.0	2.2	1.6	15.9	4.3	0.014	24.0	0.015	0.015	100
2013	69.8	4.7	0.1	74.5	2.1	1.6	17.2	4.7	0.013	25.5	0.018	0.018	100
2014	70.5	4.6	0.0	75.2	2.1	1.6	16.6	4.5	0.010	24.8	0.062	0.062	100
2015	70.2	4.7	0.1	75.0	2.0	1.6	16.8	4.5	0.018	24.9	0.095	0.095	100
2016	70.3	4.8	0.1	75.2	2.0	1.6	16.6	4.5	0.019	24.8	0.061	0.061	100
2017	71.3	4.9	0.1	76.2	2.1	1.6	15.7	4.3	0.017	23.7	0.076	0.076	100
2018	71.2	4.9	0.1	76.1	2.1	1.6	15.7	4.3	0.021	23.8	0.103	0.103	100
2019	73.5	4.9	0.1	78.4	2.1	1.7	13.9	3.7	0.017	21.4	0.101	0.101	100
2020	71.7	4.9	0.1	76.6	2.1	1.7	15.3	4.1	0.016	23.2	0.182	0.182	100
2021	71.3	4.9	0.1	76.3	2.1	1.6	15.6	4.3	0.021	23.6	0.123	0.123	100
2022	72.1	4.9	0.1	77.1	2.1	1.6	14.9	4.1	0.024	22.8	0.165	0.165	100

5.1.2. *Methodological Issues*

Emissions from categories 3.A.1 Enteric fermentation, 3.A.2 Manure management, 3.C.1.b Biomass burning in croplands, 3.C.3 Urea application, 3.C.4 Direct N_2O emissions from managed soils, 3.C.5 Indirect N_2O emissions from managed soils and 3.C.6 Indirect N_2O emissions from manure management were estimated using the Tier 1 methodological approach and default values of emission factors, and for key categories using the Tier 2 methodological approach and country-specific (national) emission factors. A brief description of the methods used to estimate emissions by category is provided in Table 5-4. A more detailed description is available in Sections 5.2-5.8.

Table 5-4. Methods and emission factors used for assessing GHG emissions from the agriculture sector

Category code and name	CO_2		CH_4		N_2O	
	Method	EF	Method	EF	Method	EF
3.A.1 Enteric fermentation			T1, T2	CS, D		
3.A.2 Manure management			T2	CS		
3.C.1.b Biomass burning in croplands			T1	D	T1	D
3.A.2 Direct N_2O emissions from manure management					T2	CS
3.C.6 Indirect N_2O emissions from manure management					T1, T2	D, CS
3.C.4 Direct N_2O emissions from managed soils					T1	D
Synthetic N fertilizers					*T1*	*D*
Organic N fertilizer is applied to the soil.					*T1*	*D*
Emissions from animal manure on pastures					*T1*	*D*
Decomposition of crop residues					*T1*	*D*
3.C.5 Indirect N_2O emissions from managed soils					T1	D
N_2O from atmospheric deposition of N volatilized from managed soils					*T1*	*D*
N_2O emissions from nitrogen leaching and runoff					*T1*	*D*
3.C.3 Urea application	T1	D				

EF – emission factor T1 – Tier 1; T2 – Tier 2; CS – Country specific; D – Default

5.1.3. *Uncertainty assessment and time series consistency*

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

5.1.4. *Category-appropriate quality control and assurance and verification*

Standard quality control and quality assurance procedures were carried out for all categories, and forms and checklists were filled in. Activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. To correct errors identified during quality control, changes were made in summary tables 5-1 and 5-2, as well as table 5-5. In addition, the category codes were brought into line with the 2006 Reporting Guidance.

5.1.5. *Category-specific recalculation, including explanatory information and justification for recalculations, changes made in response to the verification/review process, and impacts.*

GHG emissions from the agriculture sector were recalculated using updated activity data for 1990-2017 years (statistical publications of the National Statistics Office of Georgia and other relevant publications in this field, as well as expert assessments) and updated national emission factors, also using different values of global warming potential. Compared to the previous inventory cycle (in the frames of Georgia's Fourth National Communication (FNC) to the UNFCCC), the recalculation for 1990-2017 revealed a decreasing trend in greenhouse gas emissions (Table 5-5). The recalculated values for specific categories are provided in the relevant subchapters.

Table 5-5. Comparison of recalculated emissions with the corresponding values in the Fourth National Communication

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC4, Gg CO_2-eq	4,102	3,713	3,079	2,831	2,683	2,805	3,344	3,526	3,184	3,560	3,317	3,474	3,719	3,833
NC5, Gg CO_2-eq	4,284	3,853	3,041	2,673	2,558	2,535	2,599	2,637	2,572	2,769	2,787	2,817	2,911	2,976
Difference, %	4.4	3.8	-1.2	-5.6	-4.7	-9.6	-22.3	-25.2	-19.2	-22.2	-16.0	-18.9	-21.7	-22.4
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NC4, Gg CO_2-eq	3,436	3,461	3,329	3,022	3,132	3,061	3,055	2,981	3,223	3,582	3,633	3,745	3,798	3,488
NC5, Gg CO_2-eq	2,773	2,777	2,494	2,331	2,308	2,230	2,246	2,296	2,424	2,670	2,731	2,822	2,709	2,511
Difference, %	-19.3	-19.8	-25.1	-22.9	-26.3	-27.1	-26.5	-23.0	-24.8	-25.5	-24.8	-24.7	-28.7	-28.0

5.1.6. *Planned improvements related to the category, including improvements identified during the inspection*

Planned improvements for categories are described in the relevant sections.

5.1.7. *Completeness assessment*

The current inventory of greenhouse gas emissions includes emissions from 7 source categories: 3.A.1 Enteric fermentation, 3.A.2 Manure management, 3.C.4 Direct N_2O emissions from managed soils, 3.C.5 Indirect N_2O emissions from managed soils, 3.C.6 Indirect N_2O emissions from manure management, 3.C.1.b Biomass burning in croplands, and 3.C.3 Urea application.

Table 5-6. Assessment of the completeness of greenhouse gas emissions from the agriculture sector

№	IPCC category code	Category	CO_2	CH_4	N_2O
1	3.A.1	Enteric fermentation		X	
2	3.A.2	Manure management		X	X
3	3.C.7	Rice cultivation	It doesn't happen- NO		
4	3.C.4	Direct N_2O emissions from managed soils			X
5	3.C.5	Indirect N_2O emissions from managed soils			X
6	3.C.6	Indirect N_2O emissions from manure management			X
7	3.C.1.b	Biomass burning in croplands		X	X
8	3.C.2	Liming	Not estimated - NE		
9	3.C.3	Urea application	X		

5.2. Livestock (3.A)

Livestock farming is one of the oldest and traditional sectors, which has played and still plays an important role in the country's economy. This opinion is confirmed by the fact that there is not a single livestock species in Georgia that is not represented by local, including endemic, breeds. This category includes methane emissions from enteric fermentation and methane and nitrous oxide emissions from manure management.

5.2.1. *Enteric fermentation (3.A.1)*

Enteric fermentation includes the following sources in the national GHG inventory: dairy cattle, other cattle, buffalo, sheep, goats, horses, asses and swine. “Enteric fermentation” emissions between 1990 and 2022 varied mainly according to livestock population. Methane emissions from enteric fermentation in Gg are presented in Table 5–7.

Table 5-7. Methane emissions (in Gg) from enteric fermentation in livestock

Year	**3.A.1.a.i Dairy cattle**	*Brown Caucasian*	*Georgian Mountain*	*Mingrelian Red*	**3.A.1.a.ii Other cattle**	3.A.1.b Buffaloes	3.A.1.c Sheep	3.A.1.d Goats	3.A.2.f Horses	3.A.1.g Asses	3.A.1.h Swine	Total Gg CH_4	Total Gg CO_2-eq
1990	**47.68**	39.62	4.98	2.62	**47.22**	2.18	7.75	0.34	0.35	0.03	0.88	**106.44**	**2,980**
1991	**42.01**	35.24	5.72	3.41	**44.37**	1.81	7.06	0.29	0.33	0.03	0.73	**96.63**	**2,706**
1992	**29.11**	31.43	5.46	3.25	**40.14**	1.35	5.73	0.23	0.30	0.03	0.48	**77.36**	**2,166**
1993	**21.54**	30.96	5.75	3.41	**40.12**	1.22	4.60	0.19	0.35	0.05	0.37	**68.44**	**1,916**
1994	**16.37**	33.24	6.59	3.91	**43.74**	1.22	3.77	0.20	0.39	0.06	0.37	**66.11**	**1,851**
1995	**11.19**	35.99	7.61	4.50	**48.10**	1.23	3.37	0.25	0.43	0.06	0.35	**64.99**	**1,820**
1996	**5.68**	38.91	8.76	5.17	**52.84**	1.25	3.00	0.26	0.47	0.08	0.33	**63.93**	**1,790**
1997	**4.59**	39.23	9.39	5.54	**54.16**	1.25	2.62	0.30	0.50	0.09	0.33	**63.84**	**1,787**
1998	**3.47**	39.66	10.10	5.95	**55.70**	1.25	2.61	0.33	0.55	0.10	0.37	**64.38**	**1,803**
1999	**2.40**	41.83	11.31	6.65	**59.79**	1.31	2.77	0.40	0.61	0.11	0.41	**67.80**	**1,898**
2000	**1.14**	43.31	12.43	7.31	**63.05**	1.34	2.73	0.40	0.63	0.11	0.44	**69.86**	**1,956**
2001	**0.69**	42.46	12.94	7.59	**62.99**	1.31	2.84	0.46	0.69	0.10	0.45	**69.53**	**1,947**
2002	**0.50**	42.66	13.79	8.09	**64.54**	1.33	3.06	0.44	0.69	0.11	0.45	**71.12**	**1,991**
2003	**0.43**	42.42	14.55	8.52	**65.50**	1.33	3.14	0.47	0.77	0.12	0.47	**72.22**	**2,022**
2004	**0.32**	39.11	14.23	8.33	**61.67**	1.23	3.45	0.58	0.78	0.13	0.48	**68.64**	**1,922**
2005	**0.31**	38.39	14.82	8.66	**61.88**	1.21	3.60	0.48	0.80	0.13	0.46	**68.85**	**1,928**
2006	**0.22**	33.81	13.84	8.09	**55.75**	1.07	3.48	0.46	0.77	0.08	0.34	**62.18**	**1,741**
2007	**0.41**	31.75	13.79	8.05	**53.59**	1.01	3.56	0.43	0.76	0.09	0.11	**59.95**	**1,679**
2008	**0.20**	30.71	14.16	8.26	**53.12**	0.98	3.45	0.40	0.76	0.08	0.09	**59.08**	**1,654**
2009	**0.69**	28.68	14.04	8.18	**50.90**	0.93	3.01	0.36	0.72	0.07	0.14	**56.81**	**1,591**
2010	**0.31**	28.76	14.96	8.71	**52.43**	0.94	2.98	0.29	0.72	0.11	0.11	**57.88**	**1,621**
2011	**0.32**	28.75	15.90	9.26	**53.91**	0.94	2.88	0.27	0.72	0.08	0.11	**59.22**	**1,658**
2012	**0.44**	28.72	16.90	9.83	**55.45**	0.95	3.44	0.27	0.72	0.06	0.20	**61.53**	**1,723**
2013	**0.24**	30.16	18.89	10.98	**60.03**	1.00	3.98	0.30	0.72	0.08	0.19	**66.55**	**1,863**
2014	**0.37**	30.04	20.06	11.66	**61.77**	1.06	4.33	0.27	0.72	0.07	0.17	**68.76**	**1,925**
2015	**1.03**	29.73	21.19	12.31	**63.22**	1.06	4.21	0.25	0.72	0.10	0.16	**70.76**	**1,981**
2016	**1.00**	27.39	20.87	12.12	**60.37**	1.04	4.38	0.30	0.73	0.10	0.14	**68.06**	**1,906**
2017	**0.94**	24.69	20.14	11.69	**56.51**	1.01	4.28	0.26	0.72	0.10	0.15	**63.97**	**1,791**
2018	**0.80**	22.72	19.88	11.53	**54.13**	1.02	4.10	0.25	0.71	0.10	0.16	**61.26**	**1,715**
2019	**2.25**	21.07	19.81	11.49	**52.37**	1.01	4.21	0.25	0.70	0.10	0.16	**61.04**	**1,709**
2020	**2.40**	21.27	21.55	12.49	**55.31**	1.01	4.48	0.25	0.70	0.10	0.17	**64.41**	**1,803**
2021	**2.52**	20.13	22.02	12.76	**54.91**	1.01	4.52	0.26	0.70	0.10	0.15	**64.17**	**1,797**
2022	**2.54**	17.36	20.58	11.92	**49.85**	1.00	4.32	0.25	0.70	0.10	0.15	**58.90**	**1,649**

5.2.1.1. *Cattle (3.A.1.a)*

Livestock farming is of particular importance in Georgia, as it is the main source of livelihood for the rural population. Despite the rather low productivity of cattle common in Georgia, the rural population has at least one cow. The average annual cow milk yield in Georgia is 1,000 kg, while in developed countries (Israel, USA, Netherlands, etc.) the milk yield is 9,000-11,000 kg. Two sources are considered within this subcategory: dairy cattle and "other cattle". Dairy cows are bred to produce large amounts of milk, from which dairy products are made. According to the Intergovernmental Panel on Climate Change (IPCC) *Reporting Guidelines and Tables* (2006 IPCC, Chapter 8), dairy cattle include cattle the milk of which is produced for commercial purposes, and calves and heifers that are intended for dairy purposes. "Other cattle" refers to all non-dairy cattle, including cattle raised for meat production (beef cattle), breeding animals, as well as multipurpose cattle and bulls. Multipurpose breeds are used for both milk and meat production.

Table 5-8 shows cattle population and distribution by breeds in 1990-2022 years.

Table 5-8. Cattle population (in thousand heads) and distribution by breeds in 1990-2022 years

Year	Cattle breed					Total
	Dairy cattle	Georgian Mountain	Mingrelian Red	Brown Caucasian	**„Other cattle“**	
1990	**481.6**	*138.3*	*57.8*	*580.8*	**776.9**	**1,258.6**
1991	**424.4**	*158.7*	*75.4*	*516.6*	**750.6**	**1,175.0**
1992	**294.0**	*151.6*	*71.8*	*460.7*	**684.1**	**978.1**
1993	**217.5**	*159.6*	*75.5*	*453.8*	**688.9**	**906.4**
1994	**165.4**	*182.9*	*86.3*	*487.3*	**756.5**	**921.9**
1995	**113.0**	*211.1*	*99.5*	*527.6*	**838.2**	**951.2**
1996	**57.4**	*243.0*	*114.3*	*570.5*	**927.8**	**985.2**
1997	**46.4**	*260.6*	*122.4*	*575.0*	**958.1**	**1,004.5**
1998	**35.1**	*280.2*	*131.4*	*581.4*	**993.0**	**1,028.1**
1999	**24.2**	*313.9*	*147.0*	*613.2*	**1,074.1**	**1,098.3**
2000	**11.5**	*345.1*	*161.5*	*634.9*	**1,141.5**	**1,153.0**
2001	**6.9**	*359.1*	*167.8*	*622.4*	**1,149.4**	**1,156.3**
2002	**5.1**	*382.8*	*178.7*	*625.3*	**1,186.8**	**1,191.9**
2003	**4.3**	*403.8*	*188.4*	*621.9*	**1,214.1**	**1,218.4**
2004	**3.3**	*394.9*	*184.0*	*573.4*	**1,152.3**	**1,155.6**
2005	**3.1**	*411.2*	*191.5*	*562.8*	**1,165.5**	**1,168.6**
2006	**2.3**	*384.2*	*178.7*	*495.7*	**1,058.6**	**1,060.9**
2007	**4.1**	*382.7*	*177.9*	*465.4*	**1,026.0**	**1,030.1**
2008	**2.1**	*392.9*	*182.5*	*450.1*	**1,025.5**	**1,027.6**
2009	**7.0**	*389.6*	*180.8*	*420.4*	**990.8**	**997.8**
2010	**3.1**	*415.1*	*192.6*	*421.6*	**1,029.3**	**1,032.4**
2011	**3.2**	*441.2*	*204.5*	*421.5*	**1,067.3**	**1,070.5**
2012	**4.4**	*468.9*	*217.2*	*421.0*	**1,107.2**	**1,111.6**
2013	**2.4**	*524.3*	*242.7*	*442.1*	**1,209.1**	**1,211.5**
2014	**3.8**	*556.8*	*257.7*	*440.4*	**1,254.9**	**1,258.7**
2015	**10.4**	*588.0*	*272.0*	*435.8*	**1,295.8**	**1,306.2**
2016	**10.1**	*579.1*	*267.7*	*401.5*	**1,248.4**	**1,258.5**
2017	**9.5**	*558.9*	*258.2*	*361.9*	**1,179.0**	**1,188.5**
2018	**8.0**	*551.7*	*254.8*	*333.1*	**1,139.6**	**1,147.6**
2019	**22.7**	*549.8*	*253.8*	*308.9*	**1,112.5**	**1,135.2**
2020	**24.2**	*598.0*	*275.9*	*311.9*	**1,185.8**	**1,210.0**
2021	**25.5**	*611.2*	*281.9*	*295.1*	**1,188.3**	**1,213.8**
2022	**25.6**	*571.1*	*263.3*	*254.4*	**1,088.8**	**1,114.5**

Methane emissions from enteric fermentation in cattle are presented in Table 5-9. Emissions vary significantly from year to year due to changes in livestock population and distribution by breed.

Table 5-9. Methane emission from enteric fermentation in cattle

year	**3.A.1.a.i Dairy Cattle**	*Brown Caucasian*	*Georgian Mountain*	*Mingrelian Red*	**3.A.1.a.ii Other Cattle**	**Total Cattle**	
	Gg CH_4						Gg CO_2-eq
1990	**47.68**	39.62	4.98	2.62	**47.22**	**94.90**	**2,657**
1991	**42.01**	35.24	5.72	3.41	**44.37**	**86.38**	**2,419**
1992	**29.11**	31.43	5.46	3.25	**40.14**	**69.25**	**1,939**
1993	**21.54**	30.96	5.75	3.41	**40.12**	**61.66**	**1,726**

year	3.A.1.a.i Dairy Cattle	*Brown Caucasian*	*Georgian Mountain*	*Mingrelian Red*	3.A.1.a.ii Other Cattle	Total Cattle	
	Gg CH_4						Gg CO_2-eq
1994	**16.37**	33.24	6.59	3.91	**43.74**	**60.11**	**1,683**
1995	**11.19**	35.99	7.61	4.50	**48.10**	**59.29**	**1,660**
1996	**5.68**	38.91	8.76	5.17	**52.84**	**58.53**	**1,639**
1997	**4.59**	39.23	9.39	5.54	**54.16**	**58.75**	**1,645**
1998	**3.47**	39.66	10.10	5.95	**55.70**	**59.18**	**1,657**
1999	**2.40**	41.83	11.31	6.65	**59.79**	**62.19**	**1,741**
2000	**1.14**	43.31	12.43	7.31	**63.05**	**64.19**	**1,797**
2001	**0.69**	42.46	12.94	7.59	**62.99**	**63.68**	**1,783**
2002	**0.50**	42.66	13.79	8.09	**64.54**	**65.04**	**1,821**
2003	**0.43**	42.42	14.55	8.52	**65.50**	**65.92**	**1,846**
2004	**0.32**	39.11	14.23	8.33	**61.67**	**61.99**	**1,736**
2005	**0.31**	38.39	14.82	8.66	**61.88**	**62.18**	**1,741**
2006	**0.22**	33.81	13.84	8.09	**55.75**	**55.97**	**1,567**
2007	**0.41**	31.75	13.79	8.05	**53.59**	**53.99**	**1,512**
2008	**0.20**	30.71	14.16	8.26	**53.12**	**53.33**	**1,493**
2009	**0.69**	28.68	14.04	8.18	**50.90**	**51.59**	**1,444**
2010	**0.31**	28.76	14.96	8.71	**52.43**	**52.74**	**1,477**
2011	**0.32**	28.75	15.90	9.26	**53.91**	**54.23**	**1,518**
2012	**0.44**	28.72	16.90	9.83	**55.45**	**55.89**	**1,565**
2013	**0.24**	30.16	18.89	10.98	**60.03**	**60.27**	**1,688**
2014	**0.37**	30.04	20.06	11.66	**61.77**	**62.14**	**1,740**
2015	**1.03**	29.73	21.19	12.31	**63.22**	**64.26**	**1,799**
2016	**1.00**	27.39	20.87	12.12	**60.37**	**61.37**	**1,718**
2017	**0.94**	24.69	20.14	11.69	**56.51**	**57.45**	**1,609**
2018	**0.80**	22.72	19.88	11.53	**54.13**	**54.93**	**1,538**
2019	**2.25**	21.07	19.81	11.49	**52.37**	**54.62**	**1,529**
2020	**2.40**	21.27	21.55	12.49	**55.31**	**57.70**	**1,616**
2021	**2.52**	20.13	22.02	12.76	**54.91**	**57.44**	**1,608**
2022	**2.54**	17.36	20.58	11.92	**49.85**	**52.39**	**1,467**

5.2.1.1.1. *Dairy cattle (3.A.1.a.i)*

Source Category Description

Dairy cattle in Georgia are mainly raised in agricultural enterprises. In 1990, the dairy cattle population in these enterprises amounted to 33.7% of the total cattle population in the country. Since 1990, after the collapse of the USSR, the share of dairy cattle has rapidly decreased and amounted to only 5.1% in 1996. In the last 2019-2022 years, their share fluctuated within 2%.

Methane emissions from dairy cattle are presented in Table 5-10.

Table 5-10. Methane emissions (Gg) from enteric fermentation in dairy cattle in 1990-2022 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
CH_4 Emissions	47.68	42.01	29.11	21.54	16.37	11.19	5.68	4.59	3.47	2.40	1.14	0.69	0.50	0.43	0.32	0.31	0.22
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
CH_4 Emissions	0.41	0.20	0.69	0.31	0.32	0.44	0.24	0.37	1.03	1.00	0.94	0.80	2.25	2.40	2.52	2.54	

Methodological Issues

Given that the breeds of dairy cattle existing in Georgia are unknown and, in addition, this subcategory has accounted for a small share of the livestock population in recent years, a Tier 1 approach was used. The amount of methane emitted is calculated by multiplying per head emission rate by the dairy cattle population.

$$EM = EF \cdot Pop$$

Where:

EM Methane emissions from dairy cattle

EF Methane emission factor for dairy cattle, kg CH4/head/year

Pop Dairy Cattle Population

Activity data: Data on the dairy cattle population are taken from the statistical publications of the National Statistics Office of Georgia.[39] Compared to 2018, in 2019-2022, the share of cattle farmed in agricultural enterprises significantly increased from 0.7 percent to 2.0-2.3 percent (statistical publications of the National Statistics Office of Georgia for 2021 and 2022).

Table 5-11. Dairy cattle population (in thousand heads) in 1990-2022 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Population	481.6	424.4	294.0	217.5	165.4	113.0	57.4	46.4	35.1	24.2	11.5	6.9	5.1	4.3	3.3	3.1	2.3
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Population	4.1	2.1	7.0	3.1	3.2	4.4	2.4	3.8	10.4	10.1	9.5	8.0	22.7	24.2	25.5	25.6	

Emission factor: For dairy cattle, the default emission factor for the Eastern European region was used, EF= 99 kg CH_4/head/year.

Description of any flexibility used

Flexibility is not used

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations included in the 2006 IPCC Guidelines.

Category-specific quality control and quality assurance and validation

For the sub-category "Enteric Fermentation from Dairy Cattle", standard quality control and quality assurance procedures were carried out, and forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both printed and electronic form. During quality control, errors were identified in Tables 5-10 and 5-11. As a result, data on the number of dairy cattle and methane emissions from dairy cattle of this breed in 2019-2022 were corrected.

Category-specific recalculation, *including explanatory information and justification for recalculations, changes made in response to the verification/review process, and impacts*

Not carried out.

[39] ttps://www.geostat.ge/en/single-categories/102/agriculture-of-georgia

Planned improvements related to the category, *including improvements specified during an inspection*

The national methane emission factor for enteric fermentation in dairy cattle will be determined.

5.2.1.1.2. *Other Cattle (3.A.1.a.ii)*

Source Category Description

Other cattle include beef and multipurpose cattle, bulls, and offspring**.** Cattle are a critically important source of livelihood for the majority of rural households, providing multiple benefits (income, source of food (meat, milk), manure for fertilizer, working power, and means of transportation).

Among "other cattle" local breeds: Georgian Mountain and Red Megrelian predominate. Georgian Mountain and Red Megrelian are late-maturing breeds and are characterized by low weight, low milk yield of cows, and high milk fat content. The breed "Brown Caucasian" has been widespread in the country from the 1930s to the 20th century. The Brown Caucasian was produced by mating the Swiss chestnut with local breeds of cattle of the Kostroma breed.

Methane emissions from enteric fermentation in "Other cattle" are presented in Table 5-12.

Table 5-12. Methane emissions from enteric fermentation in "Other cattle"

Year	*Brown Caucasian*	*Georgian Mountain*	*Mingrelian Red*	**3.A.1.a.ii Total**	
				Gg CH_4	**Gg CO_2-eq**
1990	39.62	4.98	2.62	**47.22**	**1,322.2**
1991	35.24	5.72	3.41	**44.37**	**1,242.3**
1992	31.43	5.46	3.25	**40.14**	**1,123.9**
1993	30.96	5.75	3.41	**40.12**	**1,123.4**
1994	33.24	6.59	3.91	**43.74**	**1,224.6**
1995	35.99	7.61	4.50	**48.10**	**1,346.8**
1996	38.91	8.76	5.17	**52.84**	**1,479.7**
1997	39.23	9.39	5.54	**54.16**	**1,516.4**
1998	39.66	10.10	5.95	**55.70**	**1,559.7**
1999	41.83	11.31	6.65	**59.79**	**1,674.1**
2000	43.31	12.43	7.31	**63.05**	**1,765.4**
2001	42.46	12.94	7.59	**62.99**	**1,763.8**
2002	42.66	13.79	8.09	**64.54**	**1,807.0**
2003	42.42	14.55	8.52	**65.50**	**1,833.9**
2004	39.11	14.23	8.33	**61.67**	**1,726.8**
2005	38.39	14.82	8.66	**61.88**	**1,732.5**
2006	33.81	13.84	8.09	**55.75**	**1,560.9**
2007	31.75	13.79	8.05	**53.59**	**1,500.4**
2008	30.71	14.16	8.26	**53.12**	**1,487.4**
2009	28.68	14.04	8.18	**50.90**	**1,425.1**
2010	28.76	14.96	8.71	**52.43**	**1,468.1**
2011	28.75	15.90	9.26	**53.91**	**1,509.4**
2012	28.72	16.90	9.83	**55.45**	**1,552.5**
2013	30.16	18.89	10.98	**60.03**	**1,680.9**
2014	30.04	20.06	11.66	**61.77**	**1,729.5**
2015	29.73	21.19	12.31	**63.22**	**1,770.2**
2016	27.39	20.87	12.12	**60.37**	**1,690.5**
2017	24.69	20.14	11.69	**56.51**	**1,582.3**
2018	22.72	19.88	11.53	**54.13**	**1,515.7**
2019	21.07	19.81	11.49	**52.37**	**1,466.3**
2020	21.27	21.55	12.49	**55.31**	**1,548.6**
2021	20.13	22.02	12.76	**54.91**	**1,537.6**
2022	17.36	20.58	11.92	**49.85**	**1,395.8**

Methodological Issues

"Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories", developed by the Intergovernmental Panel on Climate Change, recommends that if enteric fermentation is a key source, then the Tier 2 approach should be used for animal categories significantly contributing to the country's total emissions.

Methane emissions from "other cattle" contribute about 90% of emissions from enteric fermentation as a whole. Accordingly, a Tier 2 methodological approach was used for this category.

Tier 2 represents a more complicated approach, which requires detailed characteristics of cattle (breed, age, weight, milk production, birth, etc.). The emission factor for each selected animal category (type) was assessed based on these data. Afterward, emissions are calculated for each group of cattle by multiplying a population of cattle (grouping is made according to breed and age) with the corresponding emission factor and summing up calculated emissions.

Activity data: Tables 5-13, 5-14, and 5-15 present the cattle population (in thousand heads) by breed and by age.

Table 5-13. Distribution of Georgian Mountain cattle by age in 1990-2022 years

Category	year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Calf (female)	0-1	15	18	17	18	20	24	27	29	31	35	38	40	43	45	44	46	43
Heifer	1-2	12	14	13	14	16	18	21	23	24	27	30	31	33	35	34	36	33
Heifer	2-3	11	12	12	12	14	16	19	20	22	24	27	28	30	31	30	32	30
Heifer	3-4	10	12	11	12	14	16	18	20	21	24	26	27	29	30	30	31	29
Cow	4-5	4	4	4	4	5	6	6	7	7	8	9	9	10	11	10	11	10
Lactating cow	4-5	14	17	16	17	19	22	25	27	29	33	36	37	40	42	41	43	40
Cow	5-6	4	4	4	4	5	6	6	7	7	8	9	9	10	11	10	11	10
Lactating cow	5-6	14	17	16	17	19	22	25	27	29	33	36	37	40	42	41	43	40
Cow	>6	7	8	8	8	10	11	13	14	15	16	18	19	20	21	21	21	20
Lactating cow	>6	29	33	32	33	38	44	51	54	58	65	72	75	80	84	82	86	80
Calf (male)	0-1	5	5	5	5	6	7	8	9	10	11	12	12	13	14	14	14	13
Bullock	1-2	4	5	5	5	6	6	7	8	8	9	10	11	12	12	12	12	12
Bullock	2-3	3	4	4	4	4	5	6	6	7	8	8	9	9	10	10	10	9
Bullock	3-4	3	3	3	3	4	4	5	5	6	6	7	7	8	8	8	8	8
Bull (Castrate)	4-5	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3	3
Bull (Castrate)	5-6	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3
Bull (Castrate)	>6	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
Total		**138**	**159**	**152**	**160**	**183**	**211**	**243**	**261**	**280**	**314**	**345**	**359**	**383**	**404**	**395**	**411**	**384**
Category	Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Calf (female)	0-1	43	44	43	46	49	52	58	62	66	65	62	62	61	67	68	64	
Heifer	1-2	33	34	34	36	38	41	45	48	51	50	48	48	48	52	53	49	
Heifer	2-3	30	30	30	32	34	36	40	43	45	45	43	43	42	46	47	44	
Heifer	3-4	29	30	29	31	33	35	40	42	44	44	42	42	41	45	46	43	
Cow	4-5	10	10	10	11	12	12	14	15	15	15	15	14	14	16	16	15	
Lactating cow	4-5	40	41	41	43	46	49	55	58	61	60	58	58	57	62	64	60	
Cow	5-6	10	10	10	11	12	12	14	15	15	15	15	14	14	16	16	15	
Lactating cow	5-6	40	41	41	43	46	49	55	58	61	60	58	58	57	62	64	60	
Cow	>6	20	20	20	22	23	24	27	29	31	30	29	29	29	31	32	30	
Lactating cow	>6	80	82	81	87	92	98	109	116	123	121	117	115	115	125	127	119	
Calf (male)	0-1	13	14	13	14	15	16	18	19	20	20	19	19	19	21	21	20	
Bullock	1-2	12	12	12	13	13	14	16	17	18	18	17	17	17	18	18	17	
Bullock	2-3	9	10	9	10	11	11	13	14	14	14	14	13	13	15	15	14	
Bullock	3-4	8	8	8	8	9	9	11	11	12	12	11	11	11	12	12	11	
Bull (Castrate)	4-5	3	3	3	3	4	4	4	5	5	5	5	5	5	5	5	5	
Bull (Castrate)	5-6	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	
Bull (Castrate)	>6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	
Total		**383**	**393**	**390**	**415**	**441**	**469**	**524**	**557**	**588**	**579**	**559**	**552**	**550**	**598**	**611**	**571**	

Table 5-14. Distribution of Mingrelian Red cattle by age in 1990-2022 years

Category	Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Calf (Heifer)	0-1	6	8	8	8	10	11	13	14	15	16	18	19	20	21	21	21	20
Heifer	1-2	5	7	6	7	7	9	10	11	11	13	14	15	15	16	16	17	15
Heifer	2-3	4	6	6	6	7	8	9	9	10	11	12	13	14	15	14	15	14
Heifer	3-4	4	6	5	6	7	8	9	9	10	11	12	13	13	14	14	14	13
Cow	4-5	2	2	2	2	2	3	3	3	3	4	4	4	5	5	5	5	5
Lactating cow	4-5	6	8	7	8	9	10	12	13	14	15	17	18	19	20	19	20	19
Cow	5-6	2	2	2	2	2	3	3	3	3	4	4	4	5	5	5	5	5
Lactating cow	5-6	6	8	7	8	9	10	12	13	14	15	17	18	19	20	19	20	19
Cow	>6	3	4	4	4	5	5	6	6	7	8	8	9	9	10	10	10	9
Lactating cow	>6	12	16	15	16	18	21	24	26	27	31	34	35	37	39	38	40	37
Calf (male)	0-1	2	3	2	3	3	3	4	4	5	5	6	6	6	6	6	7	6
Bullock	1-2	2	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	5
Bullock	2-3	1	2	2	2	2	2	3	3	3	4	4	4	4	5	4	5	4
Bullock	3-4	1	2	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4
Bull (Castrate)	4-5	0.5	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	1
Bull (Castrate)	5-6	0.4	0.5	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bull (Castrate)	>6	0.2	0.3	0.3	0.3	0.4	0.4	0.5	1	1	1	1	1	1	1	1	1	1
Total		**58**	**75**	**72**	**75**	**86**	**99**	**114**	**122**	**131**	**147**	**161**	**168**	**179**	**188**	**184**	**191**	**179**
Category	Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Calf (female)	0-1	20	20	20	21	23	24	27	29	30	30	29	28	28	31	31	29	
Heifer	1-2	15	16	16	17	18	19	21	22	24	23	22	22	22	24	24	23	
Heifer	2-3	14	14	14	15	16	17	19	20	21	21	20	20	20	21	22	20	
Heifer	3-4	13	14	14	15	15	16	18	19	21	20	19	19	19	21	21	20	
Cow	4-5	5	5	5	5	5	6	6	7	7	7	7	7	7	7	7	7	
Lactating cow	4-5	19	19	19	20	21	23	25	27	28	28	27	27	26	29	29	27	
Cow	5-6	5	5	5	5	5	6	6	7	7	7	7	7	7	7	7	7	
Lactating cow	5-6	19	19	19	20	21	23	25	27	28	28	27	27	26	29	29	27	
Cow	>6	9	10	9	10	11	11	13	13	14	14	13	13	13	14	15	14	
Lactating cow	>6	37	38	38	40	43	45	51	54	57	56	54	53	53	58	59	55	
Calf (male)	0-1	6	6	6	7	7	7	8	9	9	9	9	9	9	9	10	9	
Bullock	1-2	5	6	5	6	6	7	7	8	8	8	8	8	8	8	9	8	
Bullock	2-3	4	4	4	5	5	5	6	6	7	6	6	6	6	7	7	6	
Bullock	3-4	4	4	4	4	4	4	5	5	5	5	5	5	5	6	6	5	
Bull (Castrate)	4-5	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	
Bull (Castrate)	5-6	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	
Bull (Castrate)	>6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Total		**178**	**183**	**181**	**193**	**205**	**217**	**243**	**258**	**272**	**268**	**258**	**255**	**254**	**276**	**282**	**263**	

Table 5-15. Distribution of Brown Caucasian cattle by age in 1990-2022 years

Category	Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Calf (Heifer)	0-1	78	70	62	61	66	71	77	78	79	83	86	84	84	84	77	76	67
Heifer	1-2	69	61	54	54	58	62	67	68	69	72	75	74	74	73	68	66	59
Heifer	2-3	62	55	49	49	52	57	61	62	62	66	68	67	67	67	62	60	53
Cow	3-4	15	13	12	12	13	14	15	15	15	16	17	16	16	16	15	15	13
Lactating cow	3-4	61	54	48	47	51	55	59	60	61	64	66	65	65	65	60	59	52
Cow	4-5	15	13	12	12	13	14	15	15	15	16	17	16	16	16	15	15	13
Lactating cow	4-5	61	54	48	47	51	55	59	60	61	64	66	65	65	65	60	59	52
Cow	>5	30	27	24	24	25	28	30	30	30	32	33	32	33	32	30	29	26

Lactating cow	>5	121	108	96	95	102	110	119	120	121	128	132	130	130	130	120	117	103
Calf (male)	0-1	25	22	20	20	21	23	25	25	25	27	28	27	27	27	25	24	22
Bullock	1-2	18	16	14	14	15	16	17	17	18	19	19	19	19	19	17	17	15
Bullock	2-3	13	12	11	10	11	12	13	13	13	14	14	14	14	14	13	13	11
Bull (Castrate)	3-4	6	6	5	5	5	6	6	6	6	7	7	7	7	7	6	6	5
Bull (Castrate)	4-5	3	3	3	3	3	3	3	3	3	4	4	4	4	4	3	3	3
Bull (Castrate)	>5	3	3	2	2	2	3	3	3	3	3	3	3	3	3	3	3	2
Total		**581**	**517**	**461**	**454**	**487**	**528**	**570**	**575**	**581**	**613**	**635**	**622**	**625**	**622**	**573**	**563**	**496**
Category	year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Calf (Heifer)	0-1	63	61	57	57	57	57	60	60	59	54	49	45	42	42	40	34	
Heifer	1-2	55	53	50	50	50	50	52	52	51	47	43	39	36	37	35	30	
Heifer	2-3	50	48	45	45	45	45	47	47	47	43	39	36	33	33	32	27	
Cow	3-4	12	12	11	11	11	11	12	11	11	10	9	9	8	8	8	7	
Lactating cow	3-4	49	47	44	44	44	44	46	46	45	42	38	35	32	33	31	27	
Cow	4-5	12	12	11	11	11	11	12	11	11	10	9	9	8	8	8	7	
Lactating cow	4-5	49	47	44	44	44	44	46	46	45	42	38	35	32	33	31	27	
Cow	>5	24	23	22	22	22	22	23	23	23	21	19	17	16	16	15	13	
Lactating cow	>5	97	94	88	88	88	88	92	92	91	84	75	69	64	65	62	53	
Calf (male)	0-1	20	20	18	18	18	18	19	19	19	17	16	14	13	14	13	11	
Bullock	1-2	14	14	13	13	13	13	13	13	13	12	11	10	9	9	9	8	
Bullock	2-3	11	10	10	10	10	10	10	10	10	9	8	8	7	7	7	6	
Bull (Castrate)	3-4	5	5	5	5	5	5	5	5	5	4	4	4	3	3	3	3	
Bull (Castrate)	4-5	3	3	2	2	2	2	3	3	3	2	2	2	2	2	2	1	
Bull (Castrate)	>5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	
Total		**465**	**450**	**420**	**422**	**422**	**421**	**442**	**440**	**436**	**402**	**362**	**333**	**309**	**312**	**295**	**254**	

Emission factors: Emission factors were calculated using the Tier 2 approach as described in the 2006 IPCC. The following equation was used to estimate the CH_4 emission factor for enteric fermentation from livestock:[40]

$$EF = \left[\frac{GE \bullet \left(\frac{Y_m}{100} \right) \bullet 365}{55.65} \right]$$

Where:

EF Emission factor, kg CH_4/year

GE Total energy consumption, MJ/head/day

Y_m methane conversion factor, per cent of gross energy in feed converted to methane.

55.65 Energy content of methane, (MJ/kg CH_4)

The following equation is used to calculate GE:[41]

$$GE = \frac{\left(\frac{NE_m + NE_a + NE_l + NE_{work} + NE_p}{REM} \right) + \left(\frac{NE_g}{REG} \right)}{\frac{DE\%}{100}}$$

Where:

NE_m net energy required by the animal for maintenance, (MGJ/day)[42].

$$NE_m = Cf_i \bullet (Weight)^{0.75}$$

[40] *2006 IPCC, Chapter 10, p. 10.31, equation 10.21*

[41] *2006 2006 IPCC, Chapter 10, p. 10.21, Equation 10.16*

[42] 2006 IPCC, Chapter 10, p. 10.15, Equation 10.3

Cfi=0.322 for non-lactating vows, Cf=0.386 for lactating cows, and Cfi=0.370 for bulls (IPCC 2006, Chapter 10, p.10.16, Table 10.4)

NE_a net energy for animal activity, MJ/day[43].

$$NE_a = C_a \ NE_m$$

C_a coefficient corresponding to animal's feeding situation, (MGJ/day/kg).

NE_l net energy for lactation, MGJ/day[44].

$$NE_l = Milk \ (1.47 + 0.40 \ Fat)$$

Where:

Milk amount of milk produced, kg milk/day

The fat content of milk, % of weight.

NE_{work} net energy for work, MJ/day.

$$NE_{work} = 0.10 \ NE_m \ Hours$$

NE_p net energy required for pregnancy, MJ/day[45].

$$NE_P = C_{pregnancy} \ NE_m$$

Where:

$C_{pregnancy}$ pregnancy coefficient.

For cattle $C_{pregnancy}$ =0.1 (2006 IPCC, chapter 10, p.10.20, table 10.7).

REM ratio of net energy available in the diet for maintenance to digestible energy[46].

$$REM = \left[1.123 - \left(4.092 \ 10^{-3} \ DE\%\right) + \left[1.126 \ 10^{-5} \ (DE\%)^2\right] - \left(\frac{25.4}{DE\%}\right)\right]$$

Where:

DE% digestibility of feed expressed as a fraction of gross energy (digestible energy/gross energy).

NE_g net energy needed for growth[47], MJ/Day

$$NE_g = 22.02 \ \left[\left(\frac{BW_o}{C \ BW_{365}}\right)\right]^{0.75} \ WG^{1.097}$$

Where:

BW Average live body weight of animals in the population, kg

MW the mature body weight of mature females in moderate body condition4, kg

BW_o Live body weight of the animal at the beginning of the inventory year, kg

C The coefficient is equal to 0.8 for females and C=1.2 for bulls. (IPCC 2006, Chapter 10, p.10.17).

BW365 Live body weight of the animal at the end of the year, kg

WG Average daily weight gain of animals in the population, kg/day

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[43] *2006 IPCC, Chapter 10, p. 10.16, Equation 10.5*

[44] *2006 IPCC, Chapter 10, p.10.18, Equation 10.8*

[45] *2006 IPCC, chapter 10, p. 10.20, equation 10.13*

[46] 2006 IPCC, chapter 10, p.10.20, equation 10.14

[47] 2006 IPCC, chapter 10, p.10.17, equation 10.6

REG ratio of net energy available for growth in a diet to digestible energy consumed.[48]

$$REG = \left[1.164 - \left(5.160 \ 10^{-3} \ DE\%\right) + \left[1.308 \ 10^{-5} \ (DE\%)^2 - \left(\frac{37.4}{DE\%}\right)\right]\right]$$

Used parameters

Y_m - Methane conversion factor

Within the framework of the GEF-funded project "Integrated Transparency Framework for the Implementation of the Paris Agreement in Georgia", a group of experts from the National Statistics Office of Georgia (hereinafter referred to as the "Consultant"), based on a survey of farmers, estimated the supposed distribution of livestock by breed, maximum daily milk yield of cows, types of feed used and specific feeding conditions for cattle. To estimate the value of Ym, the share of different types of food for livestock feeding was used.

Table 5-16. Proportion of different types of feed used to feed livestock

Grass	Hay, straw	Bran, compound feed
7.0 %	63.0 %	29.9%

Ym was calculated based on Tables 5-16 and 5-17.

Table 5-17. Ym values for housed and grazing cattle by diet[49]

	diet	Ym, %
Housed cattle	Forage-based	7.4
	High forage mix	6.7
	Low forage mix	5.6
	Concentrate based	3.8
Pasture	Grass only	7.1

Ym = **6.83%** (7% x 7.1 + 63 % x 7.4 + 29.9 % x 5.6)

C_a - Activity coefficient

The consultant assessed the specific conditions for livestock feeding (table 5-19). Ca is determined based on Table 5-18 (2006 IPCC, Chapter 10, Table 10.5) and Table 5-19. Ca = 0.085. Details are given below.

Table 5-18. C_a - activity coefficients corresponding to the animal's feeding situation

Situation	Definition	Ca
Stall	Animals are confined to a small area (i.e., tethered, pen, barn) with the result that they expend very little or no energy to acquire feed	0

[48] 2006 IPCC, chapter 10, p. 10.21,equation 10.15

[49] Liu, Y. Liu, X. Shi, J. Wang, J. P. Murphy, R. Maghirang. *Enteric Methane Conversion Factor for Dairy and Beef Cattle: Effects of Feed Digestibility and Intake Level*. Published 2017, Biology, Transactions of the ASABE https://bae.k-state.edu//~zifeiliu/files/fac_zifeiliu/Zifeiliu/24%20Liu2017_Enteric%20methane%20conversion%20factor%20for%20dairy%20and%20beef%20cattle.pdf

Pasture	Animals are confined in areas with sufficient forage requiring modest energy expenses to acquire feed. .	0.17
Grazing over large areas	Animals graze in open-range land or hilly terrain and expend significant energy to acquire feed.	0.36

Table 5-19. Distribution of livestock according to specific feeding conditions

	Feed Stalls	Mixed, part of the time (night) in the stall, part of the pasture close to the farm	Grazing on large areas, if grazing for more than 2 months per year
Cattle number, thousand heads	3.1	386.0	49.9
Corresponding Ca	0	0.085 [= (0.17 + 0) / 2]	0.09=(0.36 x 3/12)

For the herd (averaged) **Ca = 0.085** (0 x 3.1 + 0.085 x 386 + 0.09 x 49.9) / (3.1 + 386 + 49.9)

DE – digestible energy. The dependence of DE on food/diet type was assessed using Table 5-20. (2006 IPCC, Chapter 10, Table 10.8). The results are given in Table 5-21.

Table 5-20. NE_{ma} dependence on diet type

Diet type	NE_{ma} (MJ / kg dry mass)
High grain diet > 90%	7.5 - 8.5
High-quality forage (e.g., vegetative legumes & grasses)	6.5 - 7.5
Moderate quality forage (e.g., midseason legumes & grasses)	5.5 - 6.5
Low-quality forage (e.g., straws, mature grasses)	3.5 - 5.5
Source: Estimates obtained from predictive models in NRC (1996), NEma can also be estimated using the equation: NE_{ma} = REM x 18.45 x DE% / 100.	

Using the equation from this table, the dependence of DE on diet type was estimated. The results are given in Table 5-21.

$$NE_{ma} = REM \times 18.45 \times DE\% / 100.$$

Table 5-21. Dependence of DE on diet type

Diet type	Scope		Average	
	NE_{ma}	DE	NE_{ma}	DE
High grain diet > 90%	7.5-8.5	75-83	8	79
High-quality forage (e.g., vegetative legumes & grasses)	6.5-7.5	67-75	7	71
Moderate quality forage (e.g., midseason legumes & grasses)	5.5-6.5	60-67	6	64
Low-quality forage (e.g., straws, mature grasses)	3.5-5.5	46-60	4.5	53

Consultant estimated share of different types of cattle feeds, used in farms.

Table 5-22. Estimated share of different types of cattle feeds, used in farms

Grass	Hay, straw	Bran, combined food
7.0 %	63.0 %	29.9%
67.5 =(64+71)/2	53	79

Estimated average per herd **DE = 62%** (= 7% x 67.5 + 63 % x 53 + 29.9 % x 79) / (3.1 + 386 + 49.9)

Characteristics of cattle are given in Tables 5-23, 5-24, and 5-25.

Table 5-23. Cattle females live-weight standards

Breed	Live weight by month, kg														
	Newborn	6	7	8	9	10	12	15	18	24	30	36	48	60	72
Georgian mountains	13	55	60	70	80	85	100	115	130	135	157	169	180[1)]	200[2)]	210[3)]
Mingrelian Red	15	75	85	95	105	115	130	160	190	200	217	234	250[1)]	280[2)]	300[3)]
Brown Caucasian	32	152	168	187	203	220	250	297	345	397	420	443[1)]	487[2)]	520[3)]	520

[1)] first birth; [2)] second birth; [3)] adult.

Table 5-24. Cattle males' live-weight standards

Breed	Live weight by month, kg														
	Newborn	6	7	8	9	10	12	15	18	24	30	36	48	60	72
Georgian mountains	13	60	65	75	85	95	110	140	160	190	220	255	290	320	320
Mingrelian Red	15	80	90	100	110	125	160	200	210	310	350	390	460	480	480
Brown Caucasian	32	170	195	225	240	263	310	385	458	543	613	693	773	820	820

Table 5-25. Average milk yield and milk fat content

Breed	Fat, %	Milked, kg							
		Average in the herd		First lactation		Second lactation		Third and following lactation	
		Annual	Daily	Annual	Daily	Annual	Daily	Annual	Daily
Georgian mountains	4.3	1,358	3.7	1,228	3.4	1,302	3.6	1,376	3.8
Mingrelian Red	4.3	1,460	4.0	1,047	2.9	1,269	3.5	1,491	4.1
Brown Caucasian	3.7	2,610	7.1	2,349	6.4	2,597	7.1	2,845	7.8

Estimated methane emission factors for cattle are presented in Table 5-26.

Table 5-26. Estimated/Calculated methane emission factors

Category	Age, Year	EF, kg CH_4/Head	
		Georgian Mountain	Mingrelian Red
Calf (female)	0-1	13	16
Heifer	1-2	22	31
Heifer	2-3	26	32
Heifer	3-4	25	33
Heifer	4-5	28	37
Lactating cow	4-5	51	62
Cow	5-6	28	38
Lactating cow	5-6	53	65
Cow	>6	28	36
Lactating cow	>6	53	65
Calf (male)	0-1	14	18
Bullock	1-2	28	42
Bullock	2-3	35	49
Bullock	3-4	37	55
Bull (Castrate)	4-5	49	49
Bull (Castrate)	5-6	47	70
Bull (Castrate)	>6	47	64

Category	Age, year	EF, kg CH_4/Head
		Brown Caucasian
Calf (female)	0-1	27
Heifer	1-2	50
Heifer	2-3	48
Cow	3-4	53
Lactating cow	3-4	95
Cow	4-5	56
Lactating cow	4-5	101
Cow	>5	52
Lactating cow	>5	101
Calf (male)	0-1	30
Bullock	1-2	67
Bullock	2-3	78
Bull (Castrate)	3-4	74
Bull (Castrate)	4-5	78
Bull (Castrate)	>5	93

Emissions: Methane emissions from cattle are presented in Tables 5-27, 5-28, and 5-29.

Table 5-27. Methane emissions from Georgian mountain cattle in 1990-2022 years

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Calf (female)	0.20	0.23	0.22	0.23	0.27	0.31	0.36	0.38	0.41	0.46	0.51	0.53	0.56	0.59	0.58	0.60	0.56
Heifer	0.26	0.30	0.29	0.30	0.34	0.40	0.46	0.49	0.53	0.59	0.65	0.68	0.72	0.76	0.74	0.77	0.72
Heifer	0.27	0.31	0.30	0.32	0.36	0.42	0.48	0.52	0.55	0.62	0.68	0.71	0.76	0.80	0.78	0.81	0.76
Heifer	0.26	0.30	0.29	0.30	0.35	0.40	0.46	0.50	0.53	0.60	0.66	0.69	0.73	0.77	0.75	0.79	0.73
Cow	0.10	0.12	0.11	0.12	0.13	0.15	0.18	0.19	0.20	0.23	0.25	0.26	0.28	0.30	0.29	0.30	0.28
Lactating cow	0.74	0.85	0.81	0.86	0.98	1.13	1.30	1.40	1.50	1.68	1.85	1.93	2.05	2.17	2.12	2.21	2.06
Cow	0.10	0.12	0.11	0.12	0.13	0.16	0.18	0.19	0.21	0.23	0.25	0.26	0.28	0.30	0.29	0.30	0.28
Lactating cow	0.77	0.88	0.84	0.88	1.01	1.17	1.35	1.44	1.55	1.74	1.91	1.99	2.12	2.24	2.19	2.28	2.13
Cow	0.20	0.23	0.22	0.23	0.26	0.30	0.35	0.37	0.40	0.45	0.50	0.52	0.55	0.58	0.57	0.59	0.55
Lactating cow	1.54	1.77	1.69	1.78	2.04	2.35	2.71	2.90	3.12	3.50	3.85	4.00	4.27	4.50	4.40	4.58	4.28
Calf (Male)	0.06	0.07	0.07	0.07	0.09	0.10	0.11	0.12	0.13	0.15	0.16	0.17	0.18	0.19	0.18	0.19	0.18
Bullock	0.12	0.14	0.13	0.14	0.16	0.18	0.21	0.22	0.24	0.27	0.30	0.31	0.33	0.35	0.34	0.35	0.33
Bullock	0.12	0.14	0.13	0.14	0.16	0.18	0.21	0.22	0.24	0.27	0.30	0.31	0.33	0.35	0.34	0.35	0.33
Bullock	0.10	0.12	0.11	0.12	0.14	0.16	0.18	0.20	0.21	0.24	0.26	0.27	0.29	0.30	0.30	0.31	0.29
Bull (Castrate)	0.06	0.06	0.06	0.06	0.07	0.09	0.10	0.11	0.11	0.13	0.14	0.14	0.15	0.16	0.16	0.17	0.15
Bull (Castrate)	0.04	0.05	0.05	0.05	0.06	0.07	0.08	0.08	0.09	0.10	0.11	0.11	0.12	0.13	0.12	0.13	0.12
Bull (Castrate)	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.08	0.08	0.08
Total	**5.0**	**5.7**	**5.5**	**5.7**	**6.6**	**7.6**	**8.8**	**9.4**	**10.1**	**11.3**	**12.4**	**12.9**	**13.8**	**14.6**	**14.2**	**14.8**	**13.8**
Category	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Calf (female)	0.56	0.58	0.57	0.61	0.65	0.69	0.77	0.82	0.86	0.85	0.82	0.81	0.81	0.88	0.90	0.84	
Heifer	0.72	0.74	0.73	0.78	0.83	0.88	0.99	1.05	1.11	1.09	1.05	1.04	1.03	1.12	1.15	1.07	
Heifer	0.76	0.78	0.77	0.82	0.87	0.93	1.04	1.10	1.16	1.15	1.11	1.09	1.09	1.18	1.21	1.13	
Heifer	0.73	0.75	0.74	0.79	0.84	0.90	1.00	1.06	1.12	1.11	1.07	1.05	1.05	1.14	1.17	1.09	
Cow	0.28	0.29	0.28	0.30	0.32	0.34	0.38	0.41	0.43	0.42	0.41	0.40	0.40	0.44	0.45	0.42	
Lactating cow	2.05	2.11	2.09	2.23	2.37	2.52	2.81	2.99	3.16	3.11	3.00	2.96	2.95	3.21	3.28	3.06	
Cow	0.28	0.29	0.29	0.31	0.33	0.35	0.39	0.41	0.43	0.43	0.41	0.41	0.41	0.44	0.45	0.42	
Lactating cow	2.12	2.17	2.16	2.30	2.44	2.60	2.90	3.08	3.25	3.21	3.09	3.05	3.04	3.31	3.38	3.16	
Cow	0.55	0.56	0.56	0.60	0.63	0.67	0.75	0.80	0.85	0.83	0.80	0.79	0.79	0.86	0.88	0.82	
Lactating cow	4.27	4.38	4.34	4.63	4.92	5.23	5.84	6.21	6.55	6.45	6.23	6.15	6.13	6.66	6.81	6.36	
Calf (Male)	0.18	0.18	0.18	0.19	0.21	0.22	0.24	0.26	0.27	0.27	0.26	0.26	0.26	0.28	0.28	0.27	
Bullock	0.33	0.34	0.33	0.35	0.38	0.40	0.45	0.48	0.50	0.50	0.48	0.47	0.47	0.51	0.52	0.49	
Bullock	0.33	0.34	0.33	0.36	0.38	0.40	0.45	0.48	0.50	0.50	0.48	0.47	0.47	0.51	0.52	0.49	
Bullock	0.29	0.29	0.29	0.31	0.33	0.35	0.39	0.42	0.44	0.43	0.42	0.41	0.41	0.45	0.46	0.43	
Bull (Castrate)	0.15	0.16	0.16	0.17	0.18	0.19	0.21	0.22	0.24	0.23	0.23	0.22	0.22	0.24	0.25	0.23	
Bull (Castrate)	0.12	0.12	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.18	0.18	0.17	0.17	0.19	0.19	0.18	
Bull (Castrate)	0.08	0.08	0.08	0.08	0.09	0.09	0.10	0.11	0.12	0.11	0.11	0.11	0.11	0.12	0.12	0.11	
Total	**13.8**	**14.2**	**14.0**	**15.0**	**15.9**	**16.9**	**18.9**	**20.1**	**21.2**	**20.9**	**20.1**	**19.9**	**19.8**	**21.5**	**22.0**	**20.6**	

Table 5-28. Methane emissions from Megrelian Red cattle in 1990-2022 years

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Calf (female)	0.10	0.13	0.13	0.13	0.15	0.18	0.20	0.22	0.23	0.26	0.29	0.30	0.32	0.34	0.33	0.34	0.32
Heifer	0.15	0.20	0.19	0.20	0.23	0.26	0.30	0.32	0.35	0.39	0.43	0.44	0.47	0.50	0.49	0.51	0.47
Heifer	0.14	0.19	0.18	0.19	0.22	0.25	0.29	0.31	0.33	0.37	0.40	0.42	0.45	0.47	0.46	0.48	0.45
Heifer	0.14	0.19	0.18	0.19	0.21	0.24	0.28	0.30	0.32	0.36	0.40	0.41	0.44	0.46	0.45	0.47	0.44
Cow	0.06	0.07	0.07	0.07	0.08	0.09	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.18	0.18	0.17
Lactating cow	0.38	0.49	0.47	0.49	0.56	0.65	0.74	0.80	0.85	0.96	1.05	1.09	1.16	1.22	1.20	1.24	1.16
Cow	0.06	0.07	0.07	0.07	0.08	0.10	0.11	0.12	0.13	0.14	0.16	0.16	0.18	0.18	0.18	0.19	0.18
Lactating cow	0.39	0.51	0.49	0.51	0.58	0.67	0.77	0.83	0.89	1.00	1.09	1.14	1.21	1.28	1.25	1.30	1.21
Cow	0.11	0.14	0.13	0.14	0.16	0.19	0.21	0.23	0.25	0.28	0.30	0.32	0.34	0.35	0.35	0.36	0.34
Lactating cow	0.78	1.01	0.97	1.02	1.16	1.34	1.54	1.65	1.77	1.98	2.17	2.26	2.40	2.53	2.48	2.58	2.40
Calf (Male)	0.04	0.05	0.04	0.05	0.05	0.06	0.07	0.07	0.08	0.09	0.10	0.10	0.11	0.11	0.11	0.12	0.11

Bullock	0.07	0.10	0.09	0.10	0.11	0.13	0.15	0.16	0.17	0.19	0.21	0.22	0.23	0.24	0.24	0.25	0.23
Bullock	0.07	0.09	0.09	0.09	0.10	0.12	0.14	0.15	0.16	0.18	0.19	0.20	0.21	0.22	0.22	0.23	0.21
Bullock	0.06	0.08	0.08	0.08	0.09	0.11	0.13	0.13	0.14	0.16	0.18	0.18	0.20	0.21	0.20	0.21	0.20
Bull (Castrate)	0.02	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.05	0.06	0.07	0.07	0.07	0.08	0.07	0.08	0.07
Bull (Castrate)	0.03	0.04	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.08
Bull (Castrate)	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05
Total	**2.6**	**3.4**	**3.2**	**3.4**	**3.9**	**4.5**	**5.2**	**5.5**	**5.9**	**6.7**	**7.3**	**7.6**	**8.1**	**8.5**	**8.3**	**8.7**	**8.1**
Category	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Calf (Heifer)	0.32	0.33	0.32	0.34	0.36	0.39	0.43	0.46	0.49	0.48	0.46	0.45	0.45	0.49	0.50	0.47	
Heifer	0.47	0.48	0.48	0.51	0.54	0.57	0.64	0.68	0.72	0.71	0.68	0.67	0.67	0.73	0.75	0.70	
Heifer	0.45	0.46	0.45	0.48	0.51	0.54	0.61	0.65	0.68	0.67	0.65	0.64	0.64	0.69	0.71	0.66	
Heifer	0.44	0.45	0.45	0.47	0.50	0.53	0.60	0.63	0.67	0.66	0.64	0.63	0.63	0.68	0.69	0.65	
Cow	0.17	0.17	0.17	0.18	0.20	0.21	0.23	0.25	0.26	0.26	0.25	0.24	0.24	0.26	0.27	0.25	
Lactating cow	1.16	1.19	1.17	1.25	1.33	1.41	1.58	1.67	1.77	1.74	1.68	1.66	1.65	1.79	1.83	1.71	
Cow	0.17	0.18	0.18	0.19	0.20	0.21	0.24	0.25	0.27	0.26	0.25	0.25	0.25	0.27	0.28	0.26	
Lactating cow	1.20	1.24	1.22	1.30	1.39	1.47	1.64	1.74	1.84	1.81	1.75	1.73	1.72	1.87	1.91	1.78	
Cow	0.33	0.34	0.34	0.36	0.38	0.41	0.46	0.48	0.51	0.50	0.49	0.48	0.48	0.52	0.53	0.49	
Lactating cow	2.39	2.46	2.43	2.59	2.75	2.92	3.27	3.47	3.66	3.60	3.47	3.43	3.41	3.71	3.79	3.54	
Calf (male)	0.11	0.11	0.11	0.12	0.12	0.13	0.15	0.16	0.17	0.16	0.16	0.15	0.15	0.17	0.17	0.16	
Bullock	0.23	0.23	0.23	0.25	0.26	0.28	0.31	0.33	0.35	0.34	0.33	0.33	0.33	0.35	0.36	0.34	
Bullock	0.21	0.22	0.22	0.23	0.24	0.26	0.29	0.31	0.32	0.32	0.31	0.30	0.30	0.33	0.34	0.31	
Bullock	0.20	0.20	0.20	0.21	0.22	0.24	0.27	0.28	0.30	0.29	0.28	0.28	0.28	0.30	0.31	0.29	
Bull (Castrate)	0.07	0.07	0.07	0.08	0.08	0.09	0.10	0.10	0.11	0.11	0.10	0.10	0.10	0.11	0.11	0.11	
Bull (Castrate)	0.08	0.09	0.08	0.09	0.10	0.10	0.11	0.12	0.13	0.12	0.12	0.12	0.12	0.13	0.13	0.12	
Bull (Castrate)	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.07	
Total	**8.1**	**8.3**	**8.2**	**8.7**	**9.3**	**9.8**	**11.0**	**11.7**	**12.3**	**12.1**	**11.7**	**11.5**	**11.5**	**12.5**	**12.8**	**11.9**	

Table 5-29. Methane emissions from Brown Caucasian cattle in 1990-2022 years

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Calf (female)	2.09	1.86	1.66	1.63	1.75	1.90	2.05	2.07	2.09	2.21	2.29	2.24	2.25	2.24	2.06	2.03	1.78
Heifer	3.46	3.07	2.74	2.70	2.90	3.14	3.39	3.42	3.46	3.65	3.78	3.70	3.72	3.70	3.41	3.35	2.95
Heifer	3.01	2.68	2.39	2.35	2.52	2.73	2.96	2.98	3.01	3.18	3.29	3.22	3.24	3.22	2.97	2.92	2.57
Cow	0.81	0.72	0.64	0.63	0.68	0.74	0.79	0.80	0.81	0.85	0.88	0.87	0.87	0.87	0.80	0.78	0.69
Lactating cow	5.75	5.11	4.56	4.49	4.82	5.22	5.65	5.69	5.75	6.07	6.28	6.16	6.19	6.15	5.67	5.57	4.91
Cow	0.84	0.75	0.67	0.66	0.71	0.77	0.83	0.84	0.85	0.89	0.92	0.91	0.91	0.90	0.83	0.82	0.72
Lactating cow	6.14	5.46	4.87	4.80	5.15	5.58	6.03	6.08	6.15	6.48	6.71	6.58	6.61	6.57	6.06	5.95	5.24
Cow	1.58	1.40	1.25	1.23	1.32	1.43	1.55	1.56	1.58	1.66	1.72	1.69	1.70	1.69	1.56	1.53	1.35
Lactating cow	12.24	10.89	9.71	9.57	10.27	11.12	12.02	12.12	12.26	12.92	13.38	13.12	13.18	13.11	12.09	11.86	10.45
Calf (Male)	0.76	0.68	0.60	0.60	0.64	0.69	0.75	0.75	0.76	0.80	0.83	0.82	0.82	0.82	0.75	0.74	0.65
Bullock	1.18	1.05	0.94	0.92	0.99	1.07	1.16	1.17	1.18	1.25	1.29	1.27	1.27	1.27	1.17	1.15	1.01
Bullock	1.03	0.92	0.82	0.81	0.87	0.94	1.01	1.02	1.03	1.09	1.13	1.11	1.11	1.11	1.02	1.00	0.88
Bull (Castrate)	0.46	0.41	0.37	0.36	0.39	0.42	0.45	0.46	0.46	0.49	0.50	0.49	0.50	0.49	0.46	0.45	0.39
Bull (Castrate)	0.26	0.24	0.21	0.21	0.22	0.24	0.26	0.26	0.26	0.28	0.29	0.28	0.28	0.28	0.26	0.26	0.23
Bull (Castrate)	0.27	0.24	0.21	0.21	0.22	0.24	0.26	0.26	0.27	0.28	0.29	0.29	0.29	0.29	0.26	0.26	0.23
Total	**39.6**	**35.2**	**31.4**	**31.0**	**33.2**	**36.0**	**38.9**	**39.2**	**39.7**	**41.8**	**43.3**	**42.5**	**42.7**	**42.4**	**39.1**	**38.4**	**33.8**
Category	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Calf (female)	1.68	1.62	1.51	1.52	1.52	1.52	1.59	1.59	1.57	1.45	1.30	1.20	1.11	1.12	1.06	0.92	
Heifer	2.77	2.68	2.50	2.51	2.51	2.51	2.63	2.62	2.59	2.39	2.15	1.98	1.84	1.86	1.76	1.51	
Heifer	2.41	2.33	2.18	2.18	2.18	2.18	2.29	2.28	2.26	2.08	1.88	1.73	1.60	1.62	1.53	1.32	
Cow	0.65	0.63	0.59	0.59	0.59	0.59	0.62	0.61	0.61	0.56	0.50	0.46	0.43	0.43	0.41	0.35	
Lactating cow	4.61	4.46	4.16	4.17	4.17	4.17	4.38	4.36	4.31	3.97	3.58	3.30	3.06	3.09	2.92	2.52	
Cow	0.68	0.65	0.61	0.61	0.61	0.61	0.64	0.64	0.63	0.58	0.53	0.48	0.45	0.45	0.43	0.37	
Lactating cow	4.92	4.76	4.44	4.46	4.46	4.45	4.67	4.65	4.61	4.24	3.83	3.52	3.26	3.30	3.12	2.69	
Cow	1.26	1.22	1.14	1.14	1.14	1.14	1.20	1.20	1.18	1.09	0.98	0.90	0.84	0.85	0.80	0.69	
Lactating cow	9.81	9.49	8.86	8.89	8.88	8.87	9.32	9.28	9.19	8.46	7.63	7.02	6.51	6.57	6.22	5.36	

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Calf (Male)	0.61	0.59	0.55	0.55	0.55	0.55	0.58	0.58	0.57	0.53	0.47	0.44	0.41	0.41	0.39	0.33	
Bullock	0.95	0.92	0.86	0.86	0.86	0.86	0.90	0.90	0.89	0.82	0.74	0.68	0.63	0.64	0.60	0.52	
Bullock	0.83	0.80	0.75	0.75	0.75	0.75	0.79	0.78	0.77	0.71	0.64	0.59	0.55	0.55	0.52	0.45	
Bull (Castrate)	0.37	0.36	0.33	0.34	0.34	0.33	0.35	0.35	0.35	0.32	0.29	0.26	0.25	0.25	0.23	0.20	
Bull (Castrate)	0.21	0.20	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.18	0.16	0.15	0.14	0.14	0.13	0.12	
Bull (Castrate)	0.21	0.21	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.18	0.17	0.15	0.14	0.14	0.14	0.12	
Total	**31.7**	**30.7**	**28.7**	**28.8**	**28.8**	**28.7**	**30.2**	**30.0**	**29.7**	**27.4**	**24.7**	**22.7**	**21.1**	**21.3**	**20.1**	**17.4**	

Description of any flexibility used

Flexibility is not used

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Consistency of time series

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-specific quality control and quality assurance and validation

For the category "Enteric Fermentation from Other Cattle", standard quality control and quality assurance procedures were carried out, and forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both printed and electronic form. During quality assurance, a difference in the cattle number was identified between the data included in the inventory and the data published by Geostat. This was explained by the fact that, based on the 2014 Agricultural Census, the National Statistics Office of Georgia updated the sector survey sampling frame in 2016. Since 2014, the data has decreased significantly compared to previous years. Taking this into account, the data for 2014-2022 have been corrected.

Category-specific recalculation, *including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts.*

CH_4 emissions from source category 3.A.1 "Enteric fermentation from cattle" were recalculated as a result of updating the activity data used on the number and distribution of cattle by breed. Compared to the results recorded in the 4NC of Georgia, changes made in the current inventory cycle resulted in an increasing trend in CH4 emissions in 1990-1994 and a decreasing trend in CH4 emissions in 1996-2017 (Table 5-30).

Table 5-30. Methane emissions from enteric fermentation in cattle, recalculated for 1990-2017 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5NC	94.9	86.4	69.2	61.7	60.1	59.3	58.5	58.8	59.2	62.2	64.2	63.7	65.0	65.9
4NC	78.3	73.1	60.6	56.4	57.6	59.5	61.8	63.0	64.6	69.2	72.7	73.0	75.4	77.2
Difference, %	21	18	14	9	4	0	-5	-7	-8	-10	-12	-13	-14	-15
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5NC	62.0	62.2	56.0	54.0	53.3	51.6	52.7	54.2	55.9	60.3	62.1	64.3	61.4	57.5
4NC	73.2	74.2	67.3	65.6	67.6	64.4	67.3	66.8	70.8	75.4	81.7	85.0	86.3	81.2
Difference, %	-15	-16	-17	-18	-21	-20	-22	-19	-21	-20	-24	-24	-29	-29

Planned improvements related to the category, including improvements identified during the inspection

The planned improvement concerns the updating of activity data and productivity indices used to estimate greenhouse gas emissions from this source category.

5.2.1.1.3. *Methane emissions from enteric fermentation in livestock: 3.A.1.c sheep, 3.A.1.h swine, 3.A.1.b buffalo, 3.A.1.d goats, 3.A.1.f horses, 3.A.1.g asses and mules*

Source Category Description

Methane emissions from enteric fermentation in livestock (excluding cattle) ranged from 5.00 to 11.54 Gg CH_4 between 1990 and 2022. CH_4 emissions amounted to 11.54 Gg in 1990 and decreased by 42% to 6.67 Gg in 2022.

Table 5-31. Methane emissions (in Gg) from enteric fermentation in livestock (excluding cattle)

									Share of livestock species in total methane emissions from enteric fermentation, %					
Year	3.A.1.b Buffalo	3.A.1.C Sheep	3.A.1.d Goats	3.A.1.f Horses	3.A.1.g Asse	3.A.1.h Swine	Gg CH_4	Gg CO_2-eq	3.A.1.b Buffalo	3.A.1.C Sheep	3.A.1.d Goats	3.A.1.f Horses	3.A.1.g Asses	3.A.1.h Swine
1990	2.18	7.75	0.34	0.35	0.03	0.88	11.54	323.2	2.1	7.3	0.3	0.3	0.03	0.8
1991	1.81	7.06	0.29	0.33	0.03	0.73	10.25	287.0	1.9	7.3	0.3	0.3	0.04	0.8
1992	1.35	5.73	0.23	0.30	0.03	0.48	8.12	227.3	1.7	7.4	0.3	0.4	0.04	0.6
1993	1.22	4.60	0.19	0.35	0.05	0.37	6.78	189.8	1.8	6.7	0.3	0.5	0.1	0.5
1994	1.22	3.77	0.20	0.39	0.06	0.37	5.99	167.8	1.8	5.7	0.3	0.6	0.1	0.6
1995	1.23	3.37	0.25	0.43	0.06	0.35	5.70	159.6	1.9	5.2	0.4	0.7	0.1	0.5
1996	1.25	3.00	0.26	0.47	0.08	0.33	5.40	151.3	2.0	4.7	0.4	0.7	0.1	0.5
1997	1.25	2.62	0.30	0.50	0.09	0.33	5.09	142.5	2.0	4.1	0.5	0.8	0.1	0.5
1998	1.25	2.61	0.33	0.55	0.10	0.37	5.20	145.7	1.9	4.1	0.5	0.8	0.2	0.6
1999	1.31	2.77	0.40	0.61	0.11	0.41	5.61	157.2	1.9	4.1	0.6	0.9	0.2	0.6
2000	1.34	2.73	0.40	0.63	0.11	0.44	5.67	158.8	1.9	3.9	0.6	0.9	0.2	0.6
2001	1.31	2.84	0.46	0.69	0.10	0.45	5.85	163.9	1.9	4.1	0.7	1.0	0.2	0.6
2002	1.33	3.06	0.44	0.69	0.11	0.45	6.08	170.2	1.9	4.3	0.6	1.0	0.2	0.6
2003	1.33	3.14	0.47	0.77	0.12	0.47	6.30	176.4	1.8	4.4	0.6	1.1	0.2	0.7
2004	1.23	3.45	0.58	0.78	0.13	0.48	6.65	186.1	1.8	5.0	0.8	1.1	0.2	0.7
2005	1.21	3.60	0.48	0.80	0.13	0.46	6.67	186.8	1.8	5.2	0.7	1.2	0.2	0.7
2006	1.07	3.48	0.46	0.77	0.08	0.34	6.21	173.8	1.7	5.6	0.7	1.2	0.1	0.6
2007	1.01	3.56	0.43	0.76	0.09	0.11	5.96	166.8	1.7	5.9	0.7	1.3	0.2	0.2
2008	0.98	3.45	0.40	0.76	0.08	0.09	5.75	161.1	1.7	5.8	0.7	1.3	0.1	0.1
2009	0.93	3.01	0.36	0.72	0.07	0.14	5.22	146.3	1.6	5.3	0.6	1.3	0.1	0.2
2010	0.94	2.98	0.29	0.72	0.11	0.11	5.14	144.0	1.6	5.2	0.5	1.2	0.2	0.2
2011	0.94	2.88	0.27	0.72	0.08	0.11	5.00	139.9	1.6	4.9	0.5	1.2	0.1	0.2
2012	0.95	3.44	0.27	0.72	0.06	0.20	5.64	158.0	1.5	5.6	0.4	1.2	0.1	0.3
2013	1.00	3.98	0.30	0.72	0.08	0.19	6.28	175.7	1.5	6.0	0.5	1.1	0.1	0.3
2014	1.06	4.33	0.27	0.72	0.07	0.17	6.62	185.3	1.5	6.3	0.4	1.0	0.1	0.2
2015	1.06	4.21	0.25	0.72	0.10	0.16	6.50	182.1	1.5	5.9	0.4	1.0	0.1	0.2
2016	1.04	4.38	0.30	0.73	0.10	0.14	6.69	187.3	1.5	6.4	0.4	1.1	0.1	0.2
2017	1.01	4.28	0.26	0.72	0.10	0.15	6.52	182.5	1.6	6.7	0.4	1.1	0.2	0.2
2018	1.02	4.10	0.25	0.71	0.10	0.16	6.33	177.3	1.7	6.7	0.4	1.2	0.2	0.3
2019	1.01	4.21	0.25	0.70	0.10	0.16	6.43	180.0	1.7	6.9	0.4	1.2	0.2	0.3
2020	1.01	4.48	0.25	0.70	0.10	0.17	6.70	187.7	1.6	7.0	0.4	1.1	0.2	0.3

									Share of livestock species in total methane emissions from enteric fermentation, %					
Year	3.A.1.b Buffalo	3.A.1.C Sheep	3.A.1.d Goats	3.A.1.f Horses	3.A.1.g Asse	3.A.1.h Swine	Gg CH_4	Gg CO_2-eq	3.A.1.b Buffalo	3.A.1.C Sheep	3.A.1.d Goats	3.A.1.f Horses	3.A.1.g Asses	3.A.1.h Swine
2021	1.01	4.52	0.26	0.70	0.10	0.15	6.74	188.7	1.6	7.0	0.4	1.1	0.2	0.2
2022	1.00	4.32	0.25	0.70	0.10	0.15	6.52	182.5	1.7	7.3	0.4	1.2	0.2	0.3

Methodological issues

The 2006 IPCC Tier 1 approach was used to estimate methane emissions from enteric fermentation in buffalo, sheep, goats, horses, asses, and swine. The amount of methane emitted by livestock is calculated by multiplying the emission rate per animal by the number of animals:

$$EM_i = EF_i \ \ Pop_i$$

Where:

EM_i Methane emission from animal type i, kg CH_4

i The index indicates the type of animal

EF_i Methane emission factor for animal type i, kg CH_4/head/year

Pop_i Number of Animal type i

Activity data: Livestock population in 1990-2022 years is given in Table 5-32. The data sources are the statistical publications of the National Statistics Office of Georgia and FAOSTAT.

https://www.fao.org/faostat/en/#data/EMN, https://www.fao.org/statistics/en

Table 5-32. Livestock population (in thousand heads) in 1990-2022 years

Year	3.A.1.b Buffalo	3.A.1.c Sheep	3.A.1.d Goats	3.A.1.f Horses	3.A.1.g Asses	3.A.1.h Swine
1990	39.7	1,549.8	68.3	19.6	3.4	880.2
1991	32.9	1,411.0	58.6	18.2	3.4	732.5
1992	24.5	1,146.4	45.2	16.8	3.4	476.2
1993	22.2	920.3	37.8	19.5	5.0	365.1
1994	22.2	753.9	39.4	21.4	5.5	366.9
1995	22.4	673.9	50.9	23.8	6.3	352.6
1996	22.8	599.6	52.4	26.3	8.3	332.5
1997	22.7	524.5	59.0	27.8	9.1	330.3
1998	22.8	521.7	65.0	+30.3	10.3	365.9
1999	23.8	553.2	80.2	34.1	11.4	411.1
2000	24.4	546.9	80.7	35.2	11.4	443.4
2001	23.9	567.5	91.7	38.6	10.4	445.4
2002	24.1	611.2	88.3	38.6	11.4	446.1
2003	24.1	628.8	93.4	42.5	12.4	473.8
2004	22.3	689.2	115.7	43.4	13.0	483.9
2005	22.0	719.8	95.5	44.4	13.0	455.3
2006	19.4	696.8	92.4	42.8	8.0	343.5
2007	18.4	711.0	86.1	42.3	9.0	109.9
2008	17.9	690.0	79.4	42.0	8.0	86.4
2009	16.9	602.3	71.5	40.0	7.0	135.2
2010	17.0	596.8	57.1	40.0	11.0	110.1
2011	17.1	576.8	53.6	40.0	8.0	105.1
2012	17.2	688.2	54.4	40.0	6.0	204.3
2013	18.2	796.0	60.8	40.0	8.0	191.2
2014	19.3	865.9	53.7	40.0	7.0	169.7

Year	3.A.1.b Buffalo	3.A.1.c Sheep	3.A.1.d Goats	3.A.1.f Horses	3.A.1.g Asses	3.A.1.h Swine
2015	19.3	841.6	49.8	40.1	10.0	161.5
2016	18.8	875.9	60.6	40.8	10.0	136.2
2017	18.4	855.9	51.1	40.0	9.8	150.7
2018	18.5	819.1	50.3	39.3	9.7	163.2
2019	18.4	841.9	49.7	39.0	9.7	155.5
2020	18.4	896.2	50.3	38.8	9.7	165.7
2021	18.3	904.3	52.5	38.7	9.6	152.9
2022	18.2	863.8	50.2	38.8	9.7	150.2

Emission factors: Emission factors are taken according to default values for developing countries (2006 IPCC, Chapter 10, p. 10.28, Table 10.10).

Table 5-33. Emission factors for methane emissions from enteric fermentation in buffalo, sheep, goats, horses, asses, and swine

	3.A.1.b Buffalo	3.A.1.c Sheep	3.A.1.d Goats	3.A.1.f Horses	3.A.1.g Asses	3.A.1.h Swine
EF, kg CH_4/head/year	55	5	5	18	10	1

Description of any flexibility used

Flexibility is not used.

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series Consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-appropriate quality control and quality assurance and validation

For the category "Methane emissions from enteric fermentation in livestock", standard quality control and quality assurance procedures were carried out, and forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

Category-specific recalculation, including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts

CH_4 emissions from enteric fermentation in buffalo, sheep, goats, horses, asses, and swine were recalculated by adjusting activity data (animal population). Compared to the results recorded in the Georgian 4NC, changes made in the current inventory cycle resulted in an increasing trend in CH_4 emissions (except for a few years) (Table 5-34).

Table 5-34. CH4 emissions from enteric fermentation in buffalo, sheep, goats, horses, asses, and swine (recalculated for 1990-2017 years)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5NC	11.5	10.3	8.12	6.78	5.99	5.70	5.40	5.09	5.20	5.61	5.67	5.85	6.08	6.30
4NC	11.4	10.2	8.39	6.85	5.94	5.63	5.30	5.09	5.20	5.56	5.52	5.89	6.03	6.19
Difference, %	1.7	0.3	-3.2	-1.1	0.9	1.3	1.9	0.0	-0.1	0.9	2.8	-0.6	0.9	1.7
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5NC	6.65	6.67	6.21	5.96	5.75	5.22	5.14	5.00	5.64	6.28	6.62	6.50	6.69	6.52

4NC	6.76	6.66	6.05	5.66	5.53	5.07	4.97	4.80	5.47	6.11	6.00	6.12	6.19	5.91
Difference, %	-1.7	0.2	2.6	5.3	4.1	3.0	3.5	4.2	3.1	2.7	10.4	6.2	8.0	10.3

Planned improvements related to the category, including improvements identified during the inspection

No improvements are planned.

5.2.2. *Manure management (3.A.2)*

Both CH_4 and N_2O are emitted during the processing or storage of livestock manure. The intensity of emissions depends on the amount of manure processed, the properties of the manure, and the type of manure management system. Typically, poorly aerated/ventilated manure management systems produce large amounts of CH_4 but smaller amounts of N_2O, while well-aerated systems produce less CH_4 but more N_2O.

5.2.2.1. *Methane emissions from the management of livestock manure (3.A.2.a.i Dairy cattle, 3.A.2.a.ii Other cattle, 3.A.2.c Sheep, 3.A.2.h Swine, 3.A.2.b Buffaloes, 3.A.2.d Goats, 3.A.2.f Horses, 3.A.2.g Asses, 3.A.2.i Poultry)*

Source category description

Shortly after manure is excreted, it begins to decompose. If little oxygen is present, the decomposition will be mainly anaerobic and thus produces CH_4. The quantity of CH_4 produced depends on the type of waste management system, in particular, the amount of aeration, and the quantity of manure.

To estimate methane emissions from manure management, the total livestock population was divided into subgroups to better reflect the average amount of manure produced by an animal or poultry per year, as well as the manure management practices. Table 5-35 presents the calculated methane emissions from manure management.

Table 5-35. Methane emissions from manure management

Year	3.A.2.a.i Dairy Cattle	3.A.2.a.ii Other Cattle	3.A.2.b Buffalo	3.A.2.C Sheep	3.A.2.d Goats	3.A.2.f Horses	3.A.2.g Asses	3.A.2.h Swine	3.A.2.i Poultry	**Total Gg CH_4**	**Total Gg CO_2-eq**
1990	6.26	2.57	0.08	0.23	0.01	0.03	0.003	2.64	0.44	**12.27**	**343.5**
1991	5.52	2.43	0.07	0.21	0.01	0.03	0.003	2.20	0.40	**10.87**	**304.4**
1992	3.82	2.20	0.05	0.17	0.01	0.03	0.003	1.43	0.22	**7.94**	**222.3**
1993	2.83	2.21	0.04	0.14	0.01	0.03	0.005	1.10	0.24	**6.59**	**184.6**
1994	2.15	2.41	0.04	0.11	0.01	0.04	0.005	1.10	0.25	**6.11**	**171.2**
1995	1.47	2.66	0.04	0.10	0.01	0.04	0.006	1.06	0.28	**5.66**	**158.5**
1996	0.75	2.93	0.05	0.09	0.01	0.04	0.007	1.00	0.29	**5.16**	**144.4**
1997	0.60	3.01	0.05	0.08	0.01	0.05	0.008	0.99	0.31	**5.10**	**142.8**
1998	0.46	3.10	0.05	0.08	0.01	0.05	0.009	1.10	0.16	**5.01**	**140.3**
1999	0.31	3.33	0.05	0.08	0.01	0.06	0.010	1.23	0.17	**5.26**	**147.4**
2000	0.15	3.52	0.05	0.08	0.01	0.06	0.010	1.33	0.16	**5.37**	**150.5**
2001	0.09	3.53	0.05	0.09	0.02	0.06	0.009	1.34	0.17	**5.35**	**149.7**
2002	0.07	3.62	0.05	0.09	0.02	0.06	0.010	1.34	0.18	**5.43**	**152.2**
2003	0.06	3.69	0.05	0.09	0.02	0.07	0.011	1.42	0.18	**5.59**	**156.5**
2004	0.04	3.48	0.04	0.10	0.02	0.07	0.012	1.45	0.20	**5.42**	**151.8**

Year	3.A.2.a.i Dairy Cattle	3.A.2.a.ii Other Cattle	3.A.2.b Buffalo	3.A.2.C Sheep	3.A.2.d Goats	3.A.2.f Horses	3.A.2.g Asses	3.A.2.h Swine	3.A.2.i Poultry	**Total Gg CH_4**	**Total Gg CO_2-eq**
2005	0.04	3.50	0.04	0.11	0.02	0.07	0.012	1.37	0.15	**5.31**	**148.6**
2006	0.03	3.16	0.04	0.10	0.02	0.07	0.007	1.03	0.11	**4.57**	**127.8**
2007	0.05	3.05	0.04	0.11	0.01	0.07	0.008	0.33	0.12	**3.79**	**106.1**
2008	0.03	3.03	0.04	0.10	0.01	0.07	0.007	0.26	0.13	**3.68**	**102.9**
2009	0.09	2.91	0.03	0.09	0.01	0.07	0.006	0.41	0.13	**3.75**	**104.9**
2010	0.04	3.00	0.03	0.09	0.01	0.07	0.010	0.33	0.13	**3.71**	**104.0**
2011	0.04	3.10	0.03	0.09	0.01	0.07	0.007	0.32	0.13	**3.78**	**105.9**
2012	0.06	3.19	0.03	0.10	0.01	0.07	0.005	0.61	0.12	**4.21**	**117.7**
2013	0.03	3.47	0.04	0.12	0.01	0.07	0.007	0.57	0.14	**4.45**	**124.5**
2014	0.05	3.58	0.04	0.13	0.01	0.07	0.006	0.51	0.13	**4.52**	**126.5**
2015	0.14	3.67	0.04	0.13	0.01	0.07	0.009	0.47	0.19	**4.71**	**131.9**
2016	0.13	3.52	0.04	0.13	0.01	0.07	0.009	0.50	0.21	**4.61**	**129.1**
2017	0.12	3.30	0.04	0.14	0.01	0.07	0.009	0.46	0.21	**4.35**	**121.9**
2018	0.10	3.17	0.04	0.13	0.01	0.06	0.009	0.45	0.21	**4.18**	**117.1**
2019	0.30	3.08	0.04	0.13	0.01	0.06	0.01	0.47	0.24	**4.32**	**121.1**
2020	0.31	3.26	0.04	0.13	0.01	0.06	0.01	0.50	0.26	**4.58**	**128.3**
2021	0.33	3.25	0.04	0.14	0.01	0.06	0.01	0.46	0.24	**4.53**	**126.7**
2022	0.33	2.96	0.04	0.13	0.01	0.06	0.01	0.45	0.23	**4.22**	**118.0**

Methodological Issues

Total methane emissions from manure management amount to 70% for "Other cattle". Emissions were calculated using the IPCC Tier 2 approach[50].

$$CH_{4Manure} = \sum_{(T)} \frac{(EF_{(T)} \ \ N_{(T)})}{10^6}$$

$$EF_{(T)} = (VS_{(T)}\ 365) \left| B_{o(T)} \ \frac{0.67kg}{m^3} \ \Sigma_{S,K} \frac{MCF_{S,k}}{100} \ MS_{(T,S,k)} \right|^{51}$$

Where:

$CH_{4Manure}$ CH_4 emissions from manure management, Gg CH_4/year

$EF_{(T)}$ CH_4 emission factor for livestock category T, kgCH4/head/year

$N_{(T)}$ Number of livestock Category T

T Category of Livestock

$VS_{(T)}$ daily Volatile solid excreted for livestock category *T*, kg dry mass/head/day

365 basis for calculating annual VS production, days/year

$Bo_{(T)}$ maximum methane-producing capacity for manure produced by livestock category *T*, m^3 CH_4/kg VS emitted

0.67 Conversion factor of m^3 CH_4 to kg CH_4, kg CH_4/m^3 CH_4

$MCF_{S,k}$ Methane conversion factor for each manure management system S, %

$MS_{(T,S,k)}$ fraction of livestock category *T*'s manure handled using manure management system *S* (dimensionless)

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50 2006 IPCC, Chapter 10, p. 10.37, equation 10.22; 2006 IPCC, Chapter 10, p. 10.41, equation 10.23

51 2006 IPCC, Chapter 10, p. 10.41, Equation 10.23

$VS_{(T)}$) was estimated based on total energy and digestibility, variables that were also used to develop emission factors from enteric fermentation using the Tier 2 approach.[52]

$$VS_{(T)} = \left[GE_{(T)} \left(1 - \frac{DE\%}{100}\right) + (UE \ \ GE_{(T)})\right] \left[\left(\frac{1 - ASH}{18.45}\right)\right]$$

Ash - ash content of manure calculated as a fraction of the dry matter feed intake (ASH=0.08 for cattle (as there is no country-specific value). UE $GE_{(T)}$ = 0.04 $GE_{(T)}$ (2006 IPCC, chapter 10, P. 10.42).

18.45 = conversion factor for dietary GE per kg of dry matter (MJ/kg) (2006 IPCC, Chapter 10, p. 10.42).

Table 5-36. Calculated VS

Cattle breed	Georgian Mountain	Mingrelian Red	Brown Caucasian
VS, kg dry weight/animal/day	1.43	2.22	3.30

The proportion of manure from "other cattle" managed in different systems was estimated based on Table 5-19.

Activity data: The cattle population data are the same as those used to estimate methane emissions from enteric fermentation (Tables 5-12, 5-13, and 5-14).

Emission factors: Due to the lack of country-specific data about Bo, the default value for Eastern European countries from the 2006 IPCC has been used: Bo=0.17 m^3 CH_4 / (kg VS) (2006 IPCC, Chapter 10, pages 10.77-10.78), Tables 10A-4-10A-5). The MCFs for “other cattle” are taken from Tables 10A-4 and 10A-5 (temperate climate case with an annual mean temperature of 15°C).

Table 5-37. Share of manure from “other cattle” in management systems.

Manure Management System	Solid Storage	Pasture range and paddock
Fraction	45%	55%

Table 5-38. MCF for “other cattle”

Manure Management System	Pastures and paddock	Daily Spread	Solid Storage
MCF	1.5%	0.5%	4.0%

For other livestock, the IPCC Tier 1 approach, based on default emission factors, was used. Default values for the Asian region were used as emission factors for dairy cattle, buffalo, and swine [2006 IPCC, Chapter 10, pp. 10.38-10.39, Table 10.14]. For other livestock (goats, horses, asses, and poultry), typical emission factors for developing countries with temperatures between 15°C and 25°C (temperate climate) were used [2006 IPCC, Chapter 10, p. 10.40, Table 10.15].

Data on the number of other animals are the same as those used to estimate methane emissions from enteric fermentation (see Table 5-32). Data on the poultry population are given in Table 5.39. Statistical publications of the National Statistics Office of Georgia provide data by poultry type only from 2016.

Table 5-39. Number of poultry (thousand heads) in 1990-2022 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000

[52] 2006 IPCC, Chapter 10, p. 10.42, Equation 10.24

Poultry	21,760	20,167	11,210	11,857	12,290	13,847	14,645	15,542	8,240	8,473	7,826
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Poultry	8,495	8,899	9,201	9,836	7,482	5,401	6,150	6,682	6,675	6,522	6,360
Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Layer	-	-	-	-	4,023	4,110	3,971	4,649	4,990	4,546	4,406
Broiler	-	-	-	-	4,023	4,110	3,971	4,649	4,990	4,546	4,406
Turkey	-	-	-	-	80	74	66	74.1	78.5	79.1	67
Duck	-	-	-	-	90	84	96.5	84.4	77	74.2	74
Poultry	6,159	6,761	6,658	8,309	8,215	8,378	8,104	9,457	10,136	9,246	8,953

Table 5-40. Methane emission factors for livestock

Livestock	Dairy Cattle	Buffalo	Sheep	Goat	Horses	Asses Donkey	Swine	Layer	Broiler	Turkey	Duck
EF, $kgCH_4$/head/year	13	2	0.15	0.17	1.64	0.9	3	0.03	0.02	0.09	0.03

Description of any flexibility used

Flexibility is not used.

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Consistency of time series

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-specific quality control/quality assurance and validation

For the category "Methane emissions from manure management", standard quality control and quality assurance procedures were carried out, and forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

Category-specific recalculations, *explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts*

CH_4 emissions from the category "Methane emissions from manure management" were recalculated for the years 1990-2017 (Table 5-41). Significant differences are due to recalculated values of Volatile solid (Vs) for cattle and changes in Bo values for "other cattle".

Table 5-41. Recalculated "Methane emissions from manure management" (in Gg) for 1990-2017 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC5	12.27	10.87	7.94	6.59	6.11	5.66	5.16	5.10	5.01	5.26	5.37	5.35	5.43	5.59
NC4	5.80	5.05	3.55	3.00	3.01	3.01	2.98	3.01	3.04	3.33	3.50	3.55	3.60	3.76
Difference, %	111	115	124	120	103	88	73	69	65	58	53	51	51	49
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NC5	5.42	5.31	4.57	3.79	3.68	3.75	3.71	3.78	4.21	4.45	4.52	4.71	4.61	4.35
NC4	3.76	3.61	2.95	1.99	1.94	2.06	2.01	1.96	2.44	2.50	2.50	2.56	2.48	2.43
Difference, %	44	47	55	90	89	82	84	93	72	78	80	84	86	79

Planned improvements related to the category, *including improvements identified during the inspection*

A new study of livestock and manure management systems could be conducted for the next inventory. Methane emissions from swine manure management will be calculated using the IPCC Tier 2 approach.

5.2.2.2. *Nitrous oxide emissions from the livestock manure management (3.A.2.a.i Dairy cattle, 3.A.2.a.ii Other cattle, 3.A.2.c Sheep, 3.A.2.h Swine, 3.A.2.b Buffalo, 3.A.2.d Goats, 3.A.2.f Horses, 3.A.2.g Asses, 3.A.2.i Poultry)*

Direct N_2O emissions occur through nitrification and denitrification of nitrogen in manure. Indirect emissions are caused by losses of Volatile nitrogen, which are mainly formed as ammonia and NOx.

Source Category Description

During manure storage and processing, before application to the soil, direct N_2O emissions occur through combined nitrification and denitrification of nitrogen contained in the manure. Nitrification is the aerobic oxidation of ammonium (NH4+) to nitrate (NO3-), while denitrification is the reduction of (NO3-) to N2O or nitrogen (N2). In general, as the degree of aeration of the waste increases, the amount of N_2O produced also increases. The manure management system (MMS) is an important controlling factor for N_2O emissions. N_2O emissions from some types of systems ("anaerobic lagoon", "liquid systems", "solid storage" and "other systems") are considered in the manure management category. Manure applied to agricultural soils ("daily spread") is included in the methodology for calculating direct N_2O emissions from agricultural soils. Table 5-42 shows direct emissions of Nitrous oxide from manure management.

Table 5-42. Direct N2O emissions from manure management

Year	Livestock										
	3.A.2.a.i Dairy Cattle	3.A.2.a.ii Other cattle	3.A.2.b Buffalo	3.A.2.C Sheep	3.A.2.d Goats	3.A.2.f Horses	3.A.2.g Asses	3.A.2.h Swine	3.A.2.i Poultry	**Total Gg N_2O**	**Total Gg CO_2-eq**
1990	0.116	0.122	0.023	0.025	0.001	0.004	0.000	0.115	0.011	**0.418**	**110.7**
1991	0.102	0.114	0.019	0.023	0.001	0.004	0.000	0.095	0.010	**0.369**	**97.8**
1992	0.071	0.103	0.014	0.018	0.001	0.004	0.000	0.062	0.006	**0.279**	**73.9**
1993	0.052	0.103	0.013	0.015	0.001	0.004	0.001	0.047	0.006	**0.242**	**64.1**
1994	0.040	0.112	0.013	0.012	0.001	0.005	0.001	0.048	0.006	**0.237**	**62.7**
1995	0.027	0.123	0.013	0.011	0.001	0.005	0.001	0.046	0.007	**0.234**	**61.9**
1996	0.014	0.134	0.013	0.010	0.001	0.006	0.001	0.043	0.007	**0.230**	**60.8**
1997	0.011	0.137	0.013	0.008	0.001	0.006	0.001	0.043	0.008	**0.229**	**60.8**
1998	0.008	0.141	0.013	0.008	0.001	0.007	0.001	0.048	0.004	**0.232**	**61.5**
1999	0.006	0.151	0.014	0.009	0.002	0.007	0.002	0.053	0.004	**0.248**	**65.7**
2000	0.003	0.159	0.014	0.009	0.002	0.008	0.002	0.058	0.004	**0.257**	**68.1**
2001	0.002	0.158	0.014	0.009	0.002	0.008	0.001	0.058	0.004	**0.257**	**68.0**
2002	0.001	0.162	0.014	0.010	0.002	0.008	0.002	0.058	0.005	**0.261**	**69.2**
2003	0.001	0.164	0.014	0.010	0.002	0.009	0.002	0.062	0.005	**0.268**	**71.0**
2004	0.001	0.154	0.013	0.011	0.002	0.010	0.002	0.063	0.005	**0.260**	**68.9**
2005	0.001	0.154	0.013	0.011	0.002	0.010	0.002	0.059	0.004	**0.255**	**67.6**

Year	Livestock										
	3.A.2.a.i Dairy Cattle	3.A.2.a.ii Other cattle	3.A.2.b Buffalo	3.A.2.C Sheep	3.A.2.d Goats	3.A.2.f Horses	3.A.2.g Asses	3.A.2.h Swine	3.A.2.i Poultry	**Total Gg N_2O**	**Total Gg CO_2-eq**
2006	0.001	0.138	0.011	0.011	0.002	0.009	0.001	0.045	0.003	**0.221**	**58.5**
2007	0.001	0.133	0.011	0.011	0.002	0.009	0.001	0.014	0.003	**0.185**	**49.1**
2008	0.000	0.131	0.010	0.011	0.002	0.009	0.001	0.011	0.003	**0.179**	**47.5**
2009	0.002	0.125	0.010	0.010	0.001	0.009	0.001	0.018	0.003	**0.178**	**47.3**
2010	0.001	0.129	0.010	0.010	0.001	0.009	0.002	0.014	0.003	**0.178**	**47.1**
2011	0.001	0.132	0.010	0.009	0.001	0.009	0.001	0.014	0.003	**0.179**	**47.6**
2012	0.001	0.135	0.010	0.011	0.001	0.009	0.001	0.027	0.003	**0.198**	**52.3**
2013	0.001	0.146	0.010	0.013	0.001	0.009	0.001	0.025	0.003	**0.209**	**55.4**
2014	0.001	0.150	0.011	0.014	0.001	0.009	0.001	0.022	0.003	**0.212**	**56.1**
2015	0.003	0.153	0.011	0.013	0.001	0.009	0.001	0.021	0.004	**0.216**	**57.3**
2016	0.002	0.145	0.011	0.014	0.001	0.009	0.001	0.018	0.004	**0.206**	**54.6**
2017	0.002	0.136	0.011	0.014	0.001	0.009	0.001	0.020	0.004	**0.197**	**52.2**
2018	0.002	0.129	0.011	0.013	0.001	0.009	0.001	0.021	0.004	**0.191**	**50.7**
2019	0.005	0.125	0.011	0.013	0.001	0.009	0.001	0.020	0.005	0.190	50.4
2020	0.006	0.131	0.011	0.014	0.001	0.009	0.001	0.022	0.005	0.200	52.9
2021	0.006	0.130	0.010	0.014	0.001	0.009	0.001	0.020	0.005	0.196	52.1
2022	0.006	0.117	0.010	0.014	0.001	0.009	0.001	0.020	0.005	0.183	48.4

Methodological issues

For cattle, a Tier 2 approach is used. This approach uses the same calculation equation as Tier 1, but country-specific values are used for nitrogen emission standards.

Direct N_2O emissions from manure management are calculated by multiplying the total amount of nitrogen released from each manure management system (for all animal categories) by the emission factor for that type of manure management system. Emissions from all manure management systems are then summed.

The methodology is based on the following formula[53]:

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T \left(N_{(T)} Nex_{(T)} MS_{(T,S)} \right) \right] EF_{3(S)} \right] \frac{44}{28}$$

Where:

$N_2O_{D(mm)}$ Direct N_2O emissions from manure management, kg N_2O/year

$N_{(T)}$ The number of livestock category T in the country

$Nex_{(T)}$ average N excretion per head of category T in the country

$MS_{(T,S)}$ 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 N2O emissions from manure management system S [kg(N_2O-N)/kgN

S Manure Management System

T Livestock Category

44/28 conversion of $(N2O\text{-}N)_{(mm)}$ emissions to $N2O_{(mm)}$ emissions

$Nex_{(T)}$ is calculated by the formula[54]

[53] 2006 IPCC, chapter 10, p. 10.54, equation 10.25

[54] 2006 IPCC, chapter 10, p. 10.57, equation 10.30

$$Nex_{(T)} = N_{rate(T)} \cdot \frac{TAM_{(T)}}{1000} \cdot 365$$

Where:

$N_{rate(T)}$ default N excretion rate, kg N/(1000 kg animal mass)/day

$TAM_{(T)}$ typical animal mass for livestock category T, kg/head

Activity data: Livestock numbers and distribution by category are taken from Tables 5-13, 5-14, and 5-15.

Emission factors: Default emission factors were used to calculate direct N_2O emissions from manure management systems (2006 IPCC, Chapter 10, p. 10.62, Table 10.21).

Table 5-43. N2O emission factors from manure management systems (kg N2O-N/kg N emitted)

AWMS	Solid Storage	Pasture range and paddock	Daily spread	Pasture range and paddock	
				Dairy cattle, non-dairy cattle, buffalo, poultry and swine	Sheep and other animals
EF3, kg (N_2O-N)/kg N	0.005	0.02	0.0	0.02	0.01

For dairy cattle, Nex was calculated using default values for parameters (values for EU countries): $N_{rate(T)}$=0.34, weight=550 kg. For other cattle breeds, Nex was calculated using the age and weight of the cattle categories.

Table 5-44. Nex defined for cattle breeds

Cattle	Dairy Cattle	Georgian Mountain	Mingrelian Red	Brown Caucasian
Nex, kg N/Cattle year	68.3	21.4	30.6	52.0

Nex for the category "Other cattle" was estimated based on the mix of cattle breeds and therefore varied from year to year depending on the herd composition.

$$Nex_i = \frac{\sum_T Nex_{(T)} \; x \; N_{(T,i)}}{N_{(Cattle,\, i)}}$$

Where

Nex_i N excretion for "other cattle" livestock category T

I inventory year

T Indicates the type of Cattle

$Nex_{(T)}$ Nex for Breed T

$N_{(T,i)}$ Number of livestock of breed T in the year i

$N_{(Cattle,\, i)}$ "Other livestock" number in year i

Table 5-45. Nex calculated for "other cattle" in 1990-2022 years

Nex	Breed	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
22	Georgian Mountain	2.9	3.4	3.2	3.4	3.9	4.5	5.2	5.5	5.9	6.7	7.3
31	Mingrelian Red	1.8	2.3	2.2	2.3	2.6	3.0	3.5	3.7	4.0	4.5	4.9
52.0	Brown Caucasian	29.9	26.6	23.7	23.4	25.1	27.2	29.4	29.6	30.0	31.6	32.7
Nex of "Other Cattle"		**34.6**	**32.3**	**29.1**	**29.1**	**31.6**	**34.7**	**38.0**	**38.9**	**39.9**	**42.7**	**44.9**
Nex	Breed	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
22	Georgian Mountain	7.6	8.1	8.6	8.4	8.7	8.2	8.1	8.3	8.3	8.8	9.4
31	Mingrelian Red	5.1	5.4	5.7	5.6	5.8	5.4	5.4	5.5	5.5	5.8	6.2
52.0	Brown Caucasian	32.1	32.2	32.0	29.5	29.0	25.5	24.0	23.2	21.7	21.7	21.7
Nex of "Other Cattle"		**44.8**	**45.8**	**46.3**	**43.5**	**43.5**	**39.1**	**37.5**	**37.1**	**35.4**	**36.4**	**37.3**
Nex	Breed	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022

22	Georgian Mountain	10.0	11.1	11.8	12.5	12.3	11.9	11.7	11.7	12.7	13.0	12.1
31	Mingrelian Red	6.6	7.4	7.8	8.2	8.1	7.8	7.7	7.7	8.4	8.5	8.0
52.0	Brown Caucasian	21.7	22.8	22.7	22.5	20.7	18.6	17.2	15.9	16.1	15.2	13.1
Nex of “Other Cattle”		**38.2**	**41.3**	**42.3**	**43.2**	**41.1**	**38.3**	**36.6**	**35.3**	**37.1**	**36.7**	**33.2**

Emission factors: Average daily nitrogen excretion rates for other livestock are estimated using default values of N_{rate} for the Asian region [2006 IPCC, Chapter 10, p.10.59, Table 10.19] and default values of animal weight for developing countries [2006 IPCC, Chapter 10. p.10.82, Tables 10-A-7 and 10.A-9]. Nex for other animals is presented in Table 5-46.

Table 5-46. Nitrogen excretion rate (Nex) for types of livestock

Livestock	Sheep	Goats	Swine	Buffalo	Horses	Asses	Poultry	layer	Broiler	Turkey	Duck
Weight, kg	28	30	28	380	238	130	0.9	1.8	0.9	6.8	2.7
N_{rate}, kg N/head /day/1000 kg	1.17	1.37	0.42	0.32	0.46	0.46	1.1	1.1	1.1	0.74	0.83
Nex, kg N/head/year	12.0	15.0	4.3	44.4	40.0	21.8	0.4	0.7	0.4	1.8	0.8

IPCC default values for the Asian region were used for the share of manure nitrogen in different management systems [2006 IPCC, Chapter 10, pp. 10.78-10.81, Tables 10A-5-10A-8]. When estimating the nitrogen fraction in different manure management systems, it was assumed that most livestock is managed in family holdings (Table 5-47).

Table 5-47. Share of livestock in family holdings

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Swine	99.4	99.6	99.2	99.2	90.8	90.2	91	94.7	91.3	90.4	83.5	90.8	84.5
Sheep and Goats	96.6	95.7	96.1	96.8	97.6	89.6	96.3	95.9	96.6	97.1	96.8	96.2	95.1
Poultry	76.7	72.6	72.1	72.6	71.6	54.2	50.8	48.8	44.3	35.7	38.3	45.3	40.2

Table 5-48. Share of manure nitrogen (in %) in different management systems

Livestock	Solid Storage	Pasture range and paddock	Drylot	Daily Spread
Dairy cattle	0.45	0.55		
Other cattle	0.45	0.55		
Buffalo		0.50	0.41	0.09
Sheep	0.17	0.83		
Goats	0.17	0.83		
Horses	0.7	0.3		
Asses	0.8	0.2		
Swine			0.54	0.46
Poultry	0.90	0.10		

The distribution of cattle manure by management system was assessed based on a farmer survey (Table 5-50).

Table 5-49. Cattle feeding conditions

	Always in a cattle shed.	Mixed, part of the time (night) in the shed, part of the time on pasture near the farm	Grazing on large areas, if grazing for more than 2 months per year
Share	0.7	87.9	11.4

Table 5-50. Distribution of cattle manure by management systems

MMS	Solid storage	Pasture range and paddock
Share	0.45 (=0.7+87.9)/2	0.55 (=87.9/2+11.4)

Description of any flexibility used

Flexibility is not used

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-specific quality control/quality assurance and validation

For the category "N_2O emissions from livestock manure management", standard quality control and quality assurance procedures were carried out, and forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

Category-specific recalculations, *including explanatory information and justification for recalculations, changes made in response to the review// verification process, and impacts*

Direct N_2O emissions from manure management were recalculated for the years 1990-2017. The significant difference is mainly due to the use of recalculated Nex and changes in the shares of organic nitrogen managed in different manure management systems.

Table 5-51. Recalculated direct N2O emissions from manure management in 1990-2022 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5NC	0.42	0.37	0.28	0.24	0.24	0.23	0.23	0.23	0.23	0.25	0.26	0.26	0.26	0.27
4NC	0.96	0.88	0.71	0.66	0.67	0.69	0.71	0.72	0.73	0.79	0.82	0.83	0.86	0.88
Difference, %	-56	-58	-61	-63	-65	-66	-68	-68	-68	-68	-69	-69	-70	-70
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5NC	0.26	0.26	0.22	0.19	0.18	0.18	0.18	0.18	0.20	0.21	0.21	0.22	0.21	0.20
4NC	0.84	0.85	0.76	0.72	0.74	0.71	0.74	0.73	0.79	0.84	0.91	0.94	0.96	0.90
Difference, %	-69	-70	-71	-74	-76	-75	-76	-76	-75	-75	-77	-77	-78	-78

Planned improvements related to the category, *including improvements identified during the inspection*

No improvements are planned.

5.2.2.3. *Indirect N_2O emissions from manure management (3.C.6)*

Source Category Description

Indirect N_2O emissions are caused by losses from nitrogen volatilization, which are mainly in the form of ammonia (NH3) and nitrogen oxides (NOx). Nitrogen losses begin in animal housing and other places where manure is spread.

Table 5-52. Indirect N2O emissions from manure management in 1990-2022 years

Year	3.A.2.a.i Dairy Cattle	3.A.2.a.ii Other Cattle	3.A.2.b Buffalo	3.A.2.C Sheep	3.A.2.d Goats	3.A.2.f Horses	3.A.2.g Asses	3.A.2.h Swine	3.A.2.i Poultry	**Total Gg N_2O**	**Total Gg CO_2-eq**
1990	0.070	0.110	0.004	0.006	0.0003	0.001	0.0001	0.029	0.044	**0.265**	**70.1**
1991	0.061	0.103	0.003	0.005	0.0003	0.001	0.0001	0.024	0.041	**0.239**	**63.4**
1992	0.043	0.093	0.002	0.004	0.0002	0.001	0.0001	0.016	0.023	**0.182**	**48.2**
1993	0.031	0.092	0.002	0.004	0.0002	0.001	0.0002	0.012	0.024	**0.167**	**44.3**
1994	0.024	0.101	0.002	0.003	0.0002	0.001	0.0002	0.012	0.025	**0.168**	**44.6**
1995	0.016	0.110	0.002	0.003	0.0002	0.001	0.0002	0.012	0.028	**0.173**	**45.9**
1996	0.008	0.121	0.002	0.002	0.0003	0.001	0.0003	0.011	0.030	**0.177**	**46.8**
1997	0.007	0.124	0.002	0.002	0.0003	0.001	0.0003	0.011	0.032	**0.179**	**47.5**
1998	0.005	0.127	0.002	0.002	0.0003	0.002	0.0003	0.012	0.017	**0.167**	**44.3**
1999	0.004	0.136	0.002	0.002	0.0004	0.002	0.0004	0.014	0.017	**0.177**	**47.0**
2000	0.002	0.143	0.002	0.002	0.0004	0.002	0.0004	0.015	0.016	**0.182**	**48.3**
2001	0.001	0.142	0.002	0.002	0.0004	0.002	0.0003	0.015	0.017	**0.183**	**48.4**
2002	0.001	0.146	0.002	0.002	0.0004	0.002	0.0004	0.015	0.018	**0.187**	**49.5**
2003	0.001	0.147	0.002	0.002	0.0004	0.002	0.0004	0.016	0.019	**0.190**	**50.4**
2004	0.000	0.138	0.002	0.003	0.0006	0.002	0.0004	0.016	0.020	**0.183**	**48.5**
2005	0.000	0.139	0.002	0.003	0.0005	0.002	0.0004	0.015	0.015	**0.177**	**47.0**
2006	0.000	0.124	0.002	0.003	0.0004	0.002	0.0003	0.011	0.011	**0.155**	**41.0**
2007	0.001	0.119	0.002	0.003	0.0004	0.002	0.0003	0.0036	0.013	**0.143**	**38.0**
2008	0.000	0.118	0.002	0.003	0.0004	0.002	0.0003	0.0029	0.014	**0.142**	**37.6**
2009	0.001	0.113	0.002	0.002	0.0003	0.002	0.0002	0.0045	0.014	**0.138**	**36.7**
2010	0.000	0.116	0.002	0.002	0.0003	0.002	0.0004	0.0036	0.013	**0.140**	**37.0**
2011	0.000	0.119	0.002	0.002	0.0003	0.002	0.0003	0.0035	0.013	**0.142**	**37.6**
2012	0.001	0.122	0.002	0.003	0.0003	0.002	0.0002	0.007	0.013	**0.148**	**39.3**
2013	0.000	0.131	0.002	0.003	0.0003	0.002	0.0003	0.006	0.014	**0.159**	**42.2**
2014	0.001	0.135	0.002	0.003	0.0003	0.002	0.0002	0.006	0.014	**0.162**	**43.0**
2015	0.002	0.137	0.002	0.003	0.0002	0.002	0.0003	0.005	0.017	**0.169**	**44.8**
2016	0.001	0.131	0.002	0.003	0.0003	0.002	0.0003	0.005	0.017	**0.161**	**42.8**
2017	0.001	0.122	0.002	0.003	0.0002	0.002	0.0003	0.005	0.017	**0.153**	**40.6**
2018	0.001	0.116	0.002	0.003	0.0002	0.002	0.0003	0.005	0.017	**0.147**	**39.0**
2019	0.003	0.112	0.002	0.003	0.0002	0.002	0.0003	0.005	0.019	**0.148**	**39.1**
2020	0.004	0.118	0.002	0.003	0.0002	0.002	0.0003	0.005	0.021	**0.156**	**41.2**
2021	0.004	0.117	0.002	0.003	0.0003	0.002	0.0003	0.005	0.019	**0.152**	**40.4**
2022	0.004	0.106	0.002	0.003	0.0002	0.002	0.0003	0.005	0.018	**0.140**	**37.2**

Methodological issues

The Tier 1 approach is used. Nitrogen volatilization in the form of ammonia and nitrous oxides is calculated by multiplying the amount of nitrogen released from all categories of livestock and managed by each manure management system by the fraction of nitrogen volatilized (IPCC 2006, chapter 10, equation 10.26). This is then summed over all manure management systems. The Tier 1 approach uses nitrogen release data from Tables 5-44, 5-45 and 5-46; and manure management system data from Table 5-50.

According to the 2006 IPCC, due to very limited measurement data on losses due to leaching from various manure management systems, the estimation of nitrogen losses through leaching should only be considered in Tier 2 and Tier 3 approaches.

N losses due to volatilization from manure management were estimated using the following formulas[55]:

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

$$N_{volatilization-MMS} = \sum_S \left[\sum_T \left[(N_{(T)}\ \ Nex_{(T,S)})\ \ MS_{(T,S)}\ \ \left(\frac{Frac_{GASM}}{100}\right)_{(T,S)} \right] \right]$$

Where:

$N_2O_{G(mm)}$ indirect N_2O emissions due to volatilization of N from Manure Management in the country, kg N_2O/year

EF_4 emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N (kg NH_3-N + NOx-N vol)

$N_{volatalization-MMs}$ amount of manure nitrogen that is lost due to volatilisation of NH_3 and NOx, (kg N/year)

$N_{(T)}$ number of head of livestock species/category *T*

$Nex_{(T)}$ annual average N excretion per head of species/category *T*, kg N/head/year

$MS_{(T,S)}$ fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S* (dimensionless)

$Frac_{GasMS}$ percent of managed manure nitrogen for livestock category *T* that volatilises as NH3 and NOx in the manure management system *S*, %

Activity data: Livestock numbers and categories are given in Tables 5-13, 5-14, 5-15, and 5-32.

Emission factors: $Nex_{(T)}$ and $MS_{(T,S)}$ are presented in Tables 5.44, 5.45, 5.46; and 5.50, respectively. For EF_4 default value is used 0.01 (kg N_2O–N) / (kg NH_3–N + NO_x–N volatilized) [2006 IPCC, chapter 11, p.11.24, table 11.3]. $Frac_{GasMS}$ = 0.2 [2006 IPCC, chapter 11, p.11.24, table 11.3]. Default values have been used for the fraction of nitrogen losses due to volatilization from manure management systems. (2006 IPCC, Chapter 10, p. 10.65, Table 10.22).

Table 5-53. Default values of FracGASM (Fraction of N Losses Due to Volatility from Manure Management Systems) and other parameters

Livestock	Solid storage				Drylot		Daily Spread	
	Nex	MS	$Frac_{GASM}$	EF_4	MS	$Frac_{GASM}$	MS	$Frac_{GASM}$
Dairy cattle	68.3	0.45	0.3	0.01		0.3		0.07
Other cattle	57.3	0.45	0.45	0.01		0.3		0.07
Georgian Mountain	21.2	0.45	0.45	0.01		0.3		0.07
Mingrelian Red	30.3	0.45	0.45	0.01		0.3		0.07
Brown Caucasian	51.5	0.45	0.45	0.01		0.3		0.07
Buffalos	44.4	0.00	0.12	0.01	0.41	0.3	0.09	0.07
Sheep	12.0	0.17	0.12	0.01		0.3		0.07
Goats	15.0	0.17	0.12	0.01		0.3		0.07
Horses	40.0	0.70	0.12	0.01		0.3		0.07
Asses	21.8	0.80	0.12	0.01		0.3		0.07
Swines	7.7	0.00	0.45	0.01	0.54	0.45	0.46	0.07
Poultry	0.4	0.90	0.4	0.01		0.3		0.07

[55] 2006 IPCC, chapter 10, p. 10.54, equation 10.26

Description of any flexibility used

Flexibility is not used

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-appropriate quality control and quality assurance and validation

For the category "Indirect N_2O emissions from the manure management", standard quality control and quality assurance procedures were carried out, and forms and checklists were filled in. The activity data and methods used to estimate emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

Category-specific recalculations, *including explanatory information and justification for recalculations, changes made in response to the review/ verification process, and impacts*

Indirect N_2O emissions from manure management were recalculated for the years 1990-2017. As in the case of direct N_2O emissions from manure management, significant differences are mainly due to revised Nex (excreted nitrogen) values and changes in nitrogen fractions under different management systems.

Table 5-54. Recalculated indirect N2O emissions from manure management in 1990-2017 year

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5NC	0.26	0.24	0.18	0.17	0.17	0.17	0.18	0.18	0.17	0.18	0.18	0.18	0.19	0.19
4NC	0.22	0.20	0.16	0.15	0.15	0.15	0.15	0.16	0.16	0.17	0.18	0.18	0.19	0.19
Difference, %	21	19	14	15	14	15	14	14	5	3	1	1	0	-1
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5NC	0.18	0.18	0.15	0.14	0.14	0.14	0.14	0.14	0.15	0.16	0.16	0.17	0.16	0.15
4NC	0.18	0.19	0.17	0.15	0.16	0.15	0.16	0.16	0.17	0.18	0.19	0.20	0.20	0.19
Difference, %	-1	-4	-7	-7	-10	-9	-11	-9	-12	-12	-16	-16	-21	-21

Category-specific planned improvements, *including improvements noted during an inspection*

No improvements are planned.

5.3. Rice cultivation (3.C.7)

Rice is not cultivated in Georgia. (NE).

5.4. Agricultural soils

Nitrous Oxide emissions from agricultural soils consist of direct and indirect sources. Direct emissions are generated from nitrogen that is added to soil from synthetic fertilizers, animal manure, and decomposition of crop residues, as well as from manure released into the field by grazing animals. Emissions from indirect sources arise from the volatilization and leaking of nitrogen from synthetic fertilizers and manure.

5.4.1. *Direct N_2O emissions from soils (3.C.4)*

The methodology for estimating direct N_2O emissions from managed soils includes the following sources of nitrogen: synthetic N fertilizers; organic N fertilizer; N from grazing on pastures livestock manure; N from crop residues decomposition; N mineralization associated with the loss of soil organic matter as a result of land use change or drainage/management of organic soils.

Direct N_2O emissions from soils were calculated using the following formula:[56]:

$$N_2O_{Direct}N = N_2ON_{N\,inputs} + N_2ON_{OS} + N_2ON_{PRP}$$

$$N_2O_{Direct}N = (F_{SN} \; F_{ON} \; F_{CR} \; F_{SOM}) \; EF_1 \; (F_{SN} \; F_{ON} \; F_{CR} \; F_{SOM})_{FR} \, EF_{1FR}$$

$$N_2ON_{OS} = \begin{bmatrix} \left(F_{OS,CG,Temp} EF_{2,CG,Temp}\right) + \left(F_{OS,CG,Trop} EF_{2,CG,Trop}\right) + \\ \left(F_{FOS,F,Temp.NR} EF_{2F,Temp,NR}\right) + \left(F_{FOS,F,Temp.NP} EF_{2F,Temp,NP}\right) + \\ \left(F_{FOS,F,Trop} EF_{2F,Trop,NR}\right) \end{bmatrix}$$

$$N_2ON_{PRP} = \left[\left(F_{PRP,\,CPP} EF_{3PRP,CPP}\right) + \left(F_{PRP,\,SO} EF_{3PRP,SO}\right)\right]$$

Where:

N_2O_{Direct} –N annual direct N_2O–N emissions produced from managed soils, kgN_2O–N/year

N_2O–$N_{N\,inputs}$ annual direct N_2O–N emissions from N inputs to managed soils, kg N_2O–N/year

N_2O–N_{OS} annual direct N_2O–N emissions from managed organic soils, kg N_2O–N/year

N_2O–N_{PRP} annual direct N_2O–N emissions from urine and dung inputs to grazed soils, kgN_2O–N/year

F_{SN} annual amount of synthetic fertiliser N applied to soils, kg N/year

F_{ON} annual amount of animal manure, compost, sewage sludge, and other organic N additions applied to soils, kgN/year

F_{CR} annual amount of N in crop residues (above-ground and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils, kg N/year.

F_{SOM} annual amount of N in mineral soils that are mineralised, in association with loss of soil C from soil organic matter as a result of changes to land use or management, kg N/year

F_{OS} annual area of managed/drained organic soils, ha

F_{PRP} annual amount of urine and dung N deposited by grazing animals on pasture range and paddock, kg N/year

EF_1 emission factor for N_2O emissions from N inputs, kg N_2O–N/(kg N input)

EF_{1FR} emission factor for N_2O emissions from N inputs to flooded rice, kg N_2O–N/(kg N input)

EF_2 emission factor for N_2O emissions from drained/managed organic soils, kg N_2O –N/ha/year

[56] 2006 IPCC, chapter 11, p. 11.7, equation 11.1

EF_{3PRP} emission factor for N_2O emissions from urine and dung N deposited on pasture, range, and paddock by grazing animals, kg N_2O–N/(kg N input)

Note:

The subscripts CG, F, Temp, Trop, NR, and NP refer to Cropland and Grassland, Forest Land, Temperate, Tropical, Nutrient Rich, and Nutrient Poor, respectively.

The subscripts CPP and SO refer to Cattle, Poultry and Pigs, and Sheep and Other animals, respectively.

5.4.1.1. *Synthetic N fertilizers*

Source Category Description

The application of synthetic nitrogen fertilizers adds large amounts of nitrogen to agricultural soils. This nitrogen transforms nitrification and denitrification, resulting in N_2O emissions. In general, the magnitude of emissions associated with fertilizer use depends on many factors, such as the amount and type of nitrogen fertilizer, plant and soil type, climate, and other environmental conditions.

Methodological issues

A Tier 1 approach was used. N_2O emissions were calculated using the formula

$$N_2O_{SN} = F_{SN} \bullet EF_1 \bullet \frac{44}{28}$$

Where:

N_2O_{SN} N_2O emissions from synthetic N fertilizers applied to soil (tons/year);

F_{SN} Amount of N added to the soil from synthetic fertilizers, (kg N/year)

$F_{SN} = M_{Nfert} \bullet PercN$

M_{Nfert} Amount of synthetic fertilizers applied to soil, (kg N/year)

PercN The N content in synthetic fertilizer, %

EF_1 emission factor for N_2O emissions from N inputs, kg N_2O–N/(kg N input)

According to the 2006 IPCC, for the Tier 1 approach, the amount of mineral nitrogen fertilizers applied is not corrected for the amount of NH_3 and NO_x released. This differs from the 1996 IPCC methodology.

Activity data: N fertilizer consumption was calculated as "N fertilizer production + import-export". The data source is the National Statistics Office of Georgia and the Customs Department of the Revenue Service of Georgia. Data on synthetic N fertilizer applied to the soil are given in Table 5-55.

Table 5-55. Amount of synthetic N fertilizers applied to soil (tons/year) in 1990-2022 year

Fertilizer	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Ammonium nitrate	54.5	43.4	39.7	39.4	24.9	32.3	79.1	93.2	56.5	72.7	41.2	51.1	66.5	69.5	41.4	40.0	61.0
Ammonium sulfate	6.3	6.3	6.3	6.3	6.3	6.3	5.1	2.0	5.3	6.6	6.3	6.1	6.3	6.2	6.2	6.2	6.2
Urea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
Fertilizer	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Ammonium nitrate	40.6	50.0	55.6	42.3	36.6	45.7	59.5	40.9	39.2	40.8	30.8	36.6	28.8	31.1	38.6	31.7	
Ammonium sulfate	6.3	1.3	1.9	6.6	6.5	2.6	4.0	6.2	6.4	6.4	4.8	0.9	1.6	5.7	0.4	5.1	
Calcium ammonium nitrate	0.0	0.0	0.0	0.0	0.0	0.7	0.7	1.4	0.7	1.5	1.5	0.4	0.9	0.8	0.5	0.4	
Urea	0.1	0.1	0.4	1.1	0.2	0.5	0.6	2.3	3.7	2.3	2.6	3.4	3.7	6.6	4.2	5.4	

Table 5-56. Nitrogen content in synthetic N fertilizers applied to the soil

Fertilizer	Ammonium nitrate	Ammonium sulfate	Calcium ammonium nitrate	Urea
N content	35%	24%	27%	46%

Emission factor: The IPCC default emission factor EF_1=0.01 kgN_2O-N/kg is used (2006 IPCC, p. 11.11, Table 11.1).

Emission: N_2O emissions from synthetic N fertilizers applied to soil are presented in Table 5-57.

Table 5-57. N2O emissions from synthetic N fertilizers applied to soil in 1990-2022

fertilizer	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Ammonium nitrate, Gg N_2O-N	0.19	0.15	0.14	0.14	0.09	0.11	0.28	0.33	0.20	0.25	0.14	0.18	0.23	0.24	0.15	0.14	0.21
Ammonium sulfate, Gg N_2O-N	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.00	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01
Urea, Gg N_2O-N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Gg N_2O-N	0.21	0.17	0.15	0.15	0.10	0.13	0.29	0.33	0.21	0.27	0.16	0.19	0.25	0.26	0.16	0.16	0.23
Gg N_2O	0.32	0.26	0.24	0.24	0.16	0.20	0.45	0.52	0.33	0.42	0.25	0.30	0.39	0.41	0.25	0.24	0.36
Gg CO_2- equiv.	85.8	69.6	64.2	63.7	42.6	53.4	120.4	137.9	87.7	112.5	66.3	80.7	103.2	107.6	66.6	64.8	95.5
Fertilizer	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Ammonium nitrate, Gg N_2O-N	0.14	0.18	0.19	0.15	0.13	0.16	0.21	0.14	0.14	0.14	0.11	0.13	0.10	0.11	0.14	0.11	
Ammonium sulfate, Gg N_2O-N	0.02	0.00	0.00	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.00	0.00	0.01	0.00	0.01	
Calcium ammonium nitrate, Gg N_2O-N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	
Urea	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.02	0.02	0.03	0.02	0.02	
Total Gg N_2O-N	0.16	0.18	0.20	0.17	0.14	0.17	0.22	0.17	0.17	0.18	0.14	0.15	0.13	0.16	0.16	0.15	
Gg N_2O	0.25	0.28	0.32	0.27	0.23	0.27	0.35	0.27	0.27	0.28	0.22	0.23	0.20	0.25	0.25	0.24	
Gg CO_2- equiv.	65.7	74.4	83.7	70.3	60.2	71.6	93.3	72.9	71.9	73.0	57.5	61.5	52.4	65.2	65.6	62.3	

Description of any flexibility used

Flexibility is not used

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-appropriate quality control and quality assurance and validation

For the subcategory "N_2O emissions from synthetic fertilizers", standard quality control and quality assurance procedures were carried out, and forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both printed and electronic form. In response to the comment made during quality assurance, the percentage of nitrogen was taken into account when calculating emissions, emissions were calculated correctly.

Category-specific recalculation, including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts.

Direct N_2O emissions from inorganic N fertilizers applied to agricultural soils were recalculated for the years 1990-2017. The results are presented in Table 5-58. The significant reduction in N_2O emissions in NC5 is because the type of inorganic N fertilizer applied and its nitrogen content were taken into account.

Table 5-58. Recalculated direct N2O emissions from inorganic N fertilizers applied to agricultural soils in 1990-2022 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC5	0.32	0.26	0.24	0.24	0.16	0.20	0.44	0.50	0.32	0.41	0.25	0.30	0.38	0.40
NC4	1.19	0.98	0.90	0.90	0.61	0.76	1.66	1.87	1.21	1.56	0.93	1.13	1.43	1.49
Difference, %	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NC5	0.25	0.24	0.35	0.25	0.27	0.30	0.26	0.23	0.26	0.34	0.27	0.27	0.27	0.22
NC4	0.94	0.91	1.32	0.92	1.01	1.13	0.99	0.85	0.97	1.27	1.00	0.98	1.00	0.78
Difference, %	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-72	-73	-72

Planned improvements related to the category, *including improvements identified during the inspection*

No improvements are planned.

5.4.1.2. Organic N fertilizer applied to the soil

Source category description

Organic N fertilizer includes animal manure, compost, sewage sludge, and other organic additions applied to the soil. The application of organic nitrogen as fertilizer to the soil can increase the level of nitrification/denitrification and as a result, enhance N_2O emissions from agricultural soils. Typically, manure from manure management systems is fully incorporated into the soil. Emissions from this category do not include emissions from manure spread during grazing, which is included in the category "Pasture range and paddock".

Table 5-59 presents the calculated N_2O emissions from manure applied to soil between 1990 and 2022. The significant change in emissions is mainly due to changes in the distribution of livestock by breeds and the number of swine.

Table 5-59. Calculated N2O emissions from manure applied to soil, 1990-2022 years.

Year	Other Cattle	Dairy cattle	Buffalos	Sheep	Goats	Horses	Asses	Swine	Poultry	**Total Gg N_2O-N**	**Total Gg N_2O**	**Total Gg CO_2-eq**
1990	0.059	0.095	0.002	0.026	0.001	0.083	0.0025	0.000	0.038	**0.31**	**0.48**	**127.7**
1991	0.053	0.083	0.002	0.024	0.001	0.069	0.0023	0.000	0.035	**0.27**	**0.42**	**112.4**
1992	0.044	0.058	0.001	0.019	0.001	0.045	0.0021	0.000	0.020	**0.19**	**0.30**	**79.0**
1993	0.044	0.043	0.001	0.015	0.001	0.034	0.0024	0.000	0.021	**0.16**	**0.25**	**67.4**
1994	0.053	0.033	0.001	0.013	0.001	0.034	0.0027	0.000	0.022	**0.16**	**0.25**	**66.1**
1995	0.064	0.022	0.001	0.011	0.001	0.033	0.0030	0.000	0.024	**0.16**	**0.25**	**66.8**
1996	0.078	0.011	0.001	0.010	0.001	0.031	0.0033	0.000	0.026	**0.16**	**0.25**	**67.4**
1997	0.082	0.009	0.001	0.009	0.001	0.031	0.0035	0.000	0.027	**0.16**	**0.26**	**68.5**
1998	0.087	0.007	0.001	0.009	0.001	0.034	0.0038	0.001	0.014	**0.16**	**0.25**	**66.0**
1999	0.101	0.005	0.001	0.009	0.002	0.039	0.0043	0.001	0.015	**0.18**	**0.28**	**73.4**
2000	0.113	0.002	0.001	0.009	0.002	0.042	0.0044	0.001	0.014	**0.19**	**0.29**	**78.2**
2001	0.113	0.001	0.001	0.009	0.002	0.042	0.0048	0.001	0.015	**0.19**	**0.30**	**78.9**
2002	0.120	0.001	0.001	0.010	0.002	0.042	0.0048	0.001	0.016	**0.20**	**0.31**	**82.0**
2003	0.124	0.001	0.001	0.010	0.002	0.044	0.0053	0.001	0.016	**0.21**	**0.32**	**85.4**
2004	0.111	0.001	0.001	0.011	0.002	0.045	0.0054	0.001	0.017	**0.19**	**0.31**	**81.2**
2005	0.112	0.001	0.001	0.012	0.002	0.043	0.0056	0.001	0.013	**0.19**	**0.30**	**79.0**
2006	0.091	0.000	0.001	0.012	0.002	0.032	0.0054	0.000	0.009	**0.15**	**0.24**	**64.0**

Year	Other Cattle	Dairy cattle	Buffalos	Sheep	Goats	Horses	Asses	Swine	Poultry	**Total Gg N_2O-N**	**Total Gg N_2O**	**Total Gg CO_2-eq**
2007	0.085	0.001	0.001	0.012	0.002	0.010	0.0053	0.0005	0.011	**0.13**	**0.20**	**52.9**
2008	0.084	0.000	0.001	0.012	0.002	0.008	0.0053	0.0004	0.012	**0.12**	**0.19**	**51.5**
2009	0.077	0.001	0.001	0.010	0.001	0.013	0.0050	0.0004	0.012	**0.12**	**0.19**	**50.3**
2010	0.083	0.001	0.001	0.010	0.001	0.010	0.0050	0.0006	0.011	**0.12**	**0.19**	**51.0**
2011	0.088	0.001	0.001	0.010	0.001	0.010	0.0050	0.0004	0.011	**0.13**	**0.20**	**52.6**
2012	0.093	0.001	0.001	0.011	0.001	0.019	0.0050	0.000	0.011	**0.14**	**0.22**	**59.5**
2013	0.110	0.000	0.001	0.013	0.001	0.018	0.0050	0.000	0.012	**0.16**	**0.25**	**67.1**
2014	0.117	0.001	0.001	0.014	0.001	0.016	0.0050	0.000	0.012	**0.17**	**0.26**	**69.7**
2015	0.123	0.002	0.001	0.014	0.001	0.015	0.0050	0.001	0.017	**0.18**	**0.28**	**74.4**
2016	0.113	0.002	0.001	0.015	0.001	0.013	0.0051	0.001	0.018	**0.17**	**0.26**	**70.0**
2017	0.100	0.002	0.001	0.014	0.001	0.014	0.0050	0.000	0.016	**0.15**	**0.24**	**64.0**
2018	0.092	0.002	0.001	0.014	0.001	0.015	0.0049	0.000	0.017	**0.15**	**0.23**	**61.1**
2019	0.087	0.004	0.001	0.014	0.001	0.015	0.0049	0.000	0.000	**0.13**	**0.20**	**52.9**
2020	0.097	0.005	0.001	0.015	0.001	0.016	0.0049	0.000	0.000	**0.14**	**0.22**	**58.1**
2021	0.096	0.005	0.001	0.015	0.001	0.014	0.0049	0.000	0.000	**0.14**	**0.22**	**57.5**
2022	0.080	0.005	0.001	0.014	0.001	0.014	0.0049	0.000	0.000	**0.12**	**0.19**	**50.2**

Methodological issues

Emissions are calculated by multiplying the amount of organic nitrogen applied to agricultural soils by the non-volatile fraction (which can transform to form N_2O) and the emission factor:

$$N_2O_{ON} = F_{ON} EF_1$$

$$F_{ON} = F_{AM} + F_{SEW} + F_{COMP} + F_{OOA}$$

Where:

F_{ON} total annual amount of organic N fertiliser applied to soils other than by grazing animals, kg N/year

EF_1 N_2O emission factor for applied organic nitrogen, kg N_2O–N/(kg N applied)

F_{AM} amount of animal manure N applied to soils, kg N/year

F_{SEW} amount of total sewage N applied to the soil during the year, kg N/year

F_{COMP} Amount of nitrogen from compost applied to the soil during the year, kg N/year

F_{OOA} Annual amount of other organic additives used as fertilizer (e.g., waste, guano, brewery waste, etc.), kg N/year

In Georgia, sewage, compost and other organic additions are not actually used as N fertilizer. Accordingly, F_{SEW}, F_{COMP} and F_{OOA} are not considered.

The annual amount of animal manure applied to the soil is calculated using the formula:[57]:

$$F_{AM} = N_{MMSAvb} \ [1 - (Frac_{FEED} + Frac_{FUEL} + Frac_{CNST})]$$

Where:

F_{AM} Nitrogen from animal manure applied to soil during the year, kg N/year

$N_{MMS\,Avb}$ amount of managed manure N available for soil application, feed, fuel or construction, kg N/year

$Frac_{FEED}$ fraction of managed manure used for feed

$Frac_{FUEL}$ fraction of managed manure used for fuel

$Frac_{CNST}$ fraction of managed manure used for construction

[57] 2006 IPCC, Chapter 11, p. 11.13, Equation 11.4

In Georgia, only a small amount of manure is used as fuel or feed, and it is not used at all for construction.

The following equations are used to estimate the amount of managed manure N available for soil application:[58]:

$$N_{MMSAvb} = \sum_{S}\left\{\sum_{T}\left[\left(N_{(T)}\ \ Nex_{(T)}\ \ MS_{(T,S)}\right)\ \ (1 - \frac{Frac_{lossMS}}{100}\right]\right\}$$

$$Frac_{LossMS} = Frac_{GAS} + Frac_{LEACH} + FRAC_{N2} + EF_3$$

$$FRAC_{N2} = RN_{2(N2O)} * EF_3$$

Where:

$N_{(T)}$ Number of livestock Category T

$Nex_{(T)}$ Average annual nitrogen excretion per head of animal category T, kgN/animal/year

$MS_{(T,S)}$ The share of nitrogen excreted by each animal species T during the year that is managed/processed by the manure management system S (dimensionless)

$Frac_{LossMS}$ Amount of nitrogen from animal category T that is lost during manure management in management system S, %

S Manure Management System

T Livestock categories

$Frac_{GAS}$ The share of nitrogen lost through volatilization from managed manure.

$Frac_{LEACH}$ The share of nitrogen lost from managed manure as a result of leaching and runoff

$FRAC_{N2}$ share of nitrogen (as N_2) lost from managed manure

EF_3 emission factor for direct N2O emissions from manure management system *S*

$RN_{2(N2O)}$ = 3 (2019 IPCC, chapter 10, p. 10.99, Table 10.23 (New)

Table 5-60. Calculated $Frac_{LossMS}$

MMS	Category	$Frac_{GAS}$	$Frac_{LEACH}$	$FRAC_{N2}$	EF_3	**$Frac_{LossMS}$**
Solid Storage	Other Cattle	0.45	0.02	0.03	0.01	**0.51**
	Dairy Cattle	0.30	0.02	0.03	0.01	**0.36**
	Buffalo	0.12	0.02	0.03	0.01	**0.18**
	Sheep	0.12	0.02	0.03	0.01	**0.18**
	Goats	0.12	0.02	0.03	0.01	**0.18**
	Horses	0.45	0.02	0.03	0.01	**0.51**
	Asses	0.12	0.02	0.03	0.01	**0.18**
	Swine	0.12	0.02	0.03	0.01	**0.18**
	Poultry	0.40	0.02	0.03	0.01	**0.46**
Daily Spread	Other Cattle	0.07	-	-	-	**0.07**
	Dairy Cattle	0.07	-	-	-	**0.07**
	Buffalo	0.07	-	-	-	**0.07**
	Sheep	0.07	-	-	-	**0.07**
	Goats	0.07	-	-	-	**0.07**
	Horses	0.07	-	-	-	**0.07**
	Asses	0.07	-	-	-	**0.07**

[58] 2006 IPCC, Chapter 10, p. 10.65, equation 10.34);
2019 IPCC, Chapter 10, p. 10.94, equation 10.34a (New); 2019 IPCC, Chapter 10, p. 10.95, equation 10.34b (New)

MMS	Category	$Frac_{GAS}$	$Frac_{LEACH}$	$FRAC_{N2}$	EF_3	**$Frac_{LossMS}$**
	Swine	0.07	-	-	-	**0.07**
	Poultry	0.07	-	-	-	**0.07**
Drylot	Other Cattle	0.30	0.035	0.06	0.02	**0.415**
	Dairy Cattle	0.30	0.035	0.06	0.02	**0.415**
	Buffalo	0.30	0.35	0.06	0.02	**0.73**
	Sheep	0.30	0.35	0.06	0.02	**0.73**
	Goats	0.30	0.35	0.06	0.02	**0.73**
	Horses	0.45	0.035	0.06	0.02	**0.565**
	Asses	0.30	0.35	0.06	0.02	**0.73**
	Swine	0.30	0.35	0.06	0.02	**0.73**
	Birds	NA	0.035	0.06	0.02	**0.115**

According to the IPCC 2006, for the Tier 1 approach, the amount of organic nitrogen fertilizer applied to the soil is not corrected for the amount of NH_3 and NO_x Fugitive after application to the soil. This is a difference from the 1996 IPCC methodology.

Activity data: the data about animals number are the same as those used for enteric fermentation (Tables 5-13, 5-14, 5-15, and 5-32).

Emission factor: The 2006 IPCC defaultemission factor EF_1=0.01 kg N_2O-N/kgN was used (2006 IPCC, Chapter 11, p.11.1, Table 11.1). Nitrogen excretion rates (Nex) by livestock type are given in Tables 5.45 and 5.46.

Description of any flexibility used

Flexibility is not used

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of results, the same approach was used for the entire period considered, in accordance with the recommendations in the 2006 IPCC Guidelines.

Category-specific quality control/quality assurance and validation

For the sub-category "Organic N fertilizer applied to the soil", standard quality control and quality assurance procedures were carried out, forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

Category specific recalculation, *including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts.*

Direct N_2O emissions from organic N fertilizers applied to agricultural soils have been recalculated for the period 1990-2017. The recalculated N_2O emissions from organic N fertilizers applied are given in Table 5-62. The results show that emissions decreased by 9%-38% between 1990-2017. The decrease in N_2O emissions in NC5 (excluding 1990-1991) is due to the adjusted values of Nex and changes in the shares of organic fertilizer nitrogen in different management systems.

Table 5-61. Recalculated N2O emissions from organic N fertilizers in 1990-2017 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC5	0.48	0.42	0.30	0.25	0.25	0.25	0.25	0.26	0.25	0.28	0.29	0.30	0.31	0.32

NC4	0.45	0.42	0.33	0.30	0.30	0.31	0.31	0.32	0.32	0.34	0.35	0.36	0.37	0.38
Difference, %	7	2	-9	-15	-17	-18	-19	-19	-21	-18	-16	-16	-16	-15
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NC5	0.31	0.30	0.24	0.20	0.19	0.19	0.19	0.20	0.22	0.25	0.26	0.28	0.26	0.24
NC4	0.37	**0.37**	0.33	0.31	0.31	0.30	0.31	0.31	0.33	0.36	0.38	0.40	0.40	0.38
Difference, %	-16	-19	-26	-35	-38	-37	-38	-36	-33	-29	-32	-30	-35	-37

Category-specific planned improvements, *including improvements noted during an inspection*

No improvements are planned.

5.4.1.3. *Emissions from animal manure on pastures*

Source Category Description

This category includes emissions from manure deposited on pastures by grazing animals. The nitrogen in manure undergoes transformation, during which N_2O is formed. N_2O emissions from manure produced by grazing animals are presented in Table 5-62.

Table 5-62. N2O Emissions from manure excreted by grazing animals on soils in 1990-2022 years

Year	Dairy cattle	Other cattle	Buffalo	Sheep	Goats	Horses	Asse	Swine	Poultry	**Total gg N_2O-N**	**Total Gg N_2O**	**Total gg CO_2-eq**
1990	0.36	0.30	0.02	0.15	0.01	0.00	0.000	0.00	0.00	**0.84**	**1.32**	**349.8**
1991	0.32	0.27	0.01	0.14	0.01	0.00	0.000	0.00	0.00	**0.75**	**1.18**	**312.0**
1992	0.22	0.22	0.01	0.11	0.01	0.00	0.000	0.00	0.00	**0.57**	**0.90**	**238.4**
1993	0.16	0.22	0.01	0.09	0.00	0.00	0.000	0.00	0.00	**0.49**	**0.77**	**204.9**
1994	0.12	0.26	0.01	0.07	0.00	0.00	0.000	0.00	0.00	**0.48**	**0.75**	**199.7**
1995	0.08	0.32	0.01	0.07	0.01	0.00	0.000	0.00	0.00	**0.49**	**0.77**	**204.4**
1996	0.04	0.39	0.01	0.06	0.01	0.00	0.000	0.00	0.00	**0.51**	**0.80**	**212.7**
1997	0.03	0.41	0.01	0.05	0.01	0.00	0.000	0.00	0.00	**0.52**	**0.81**	**215.6**
1998	0.03	0.44	0.01	0.05	0.01	0.00	0.000	0.00	0.00	**0.54**	**0.84**	**223.3**
1999	0.02	0.50	0.01	0.05	0.01	0.00	0.000	0.00	0.00	**0.60**	**0.95**	**251.1**
2000	0.01	0.56	0.01	0.05	0.01	0.00	0.000	0.00	0.00	**0.65**	**1.03**	**271.8**
2001	0.01	0.57	0.01	0.06	0.01	0.00	0.000	0.00	0.00	**0.65**	**1.03**	**272.7**
2002	0.00	0.60	0.01	0.06	0.01	0.00	0.000	0.00	0.00	**0.69**	**1.08**	**286.8**
2003	0.00	0.62	0.01	0.06	0.01	0.01	0.001	0.00	0.00	**0.71**	**1.12**	**296.6**
2004	0.00	0.55	0.01	0.07	0.01	0.01	0.001	0.00	0.00	**0.65**	**1.03**	**271.7**
2005	0.00	0.56	0.01	0.07	0.01	0.01	0.001	0.00	0.00	**0.66**	**1.04**	**274.6**
2006	0.00	0.46	0.01	0.07	0.01	0.01	0.000	0.00	0.00	**0.55**	**0.87**	**229.8**
2007	0.00	0.42	0.01	0.07	0.01	0.01	0.000	0.00	0.00	**0.52**	**0.82**	**217.0**
2008	0.00	0.42	0.01	0.07	0.01	0.01	0.000	0.00	0.00	**0.51**	**0.80**	**212.9**
2009	0.01	0.39	0.01	0.06	0.01	0.00	0.000	0.00	0.00	**0.47**	**0.74**	**196.7**
2010	0.00	0.41	0.01	0.06	0.01	0.00	0.000	0.00	0.00	**0.49**	**0.78**	**205.4**
2011	0.00	0.44	0.01	0.06	0.01	0.00	0.000	0.00	0.00	**0.52**	**0.81**	**215.2**
2012	0.00	0.47	0.01	0.07	0.01	0.00	0.000	0.00	0.00	**0.56**	**0.87**	**231.8**
2013	0.00	0.55	0.01	0.08	0.01	0.00	0.000	0.00	0.00	**0.65**	**1.02**	**270.8**
2014	0.00	0.58	0.01	0.09	0.01	0.00	0.000	0.00	0.00	**0.69**	**1.09**	**288.7**
2015	0.01	0.62	0.01	0.08	0.01	0.00	0.000	0.00	0.00	**0.73**	**1.14**	**302.7**
2016	0.01	0.56	0.01	0.09	0.01	0.00	0.000	0.00	0.00	**0.68**	**1.07**	**283.2**
2017	0.01	0.50	0.01	0.08	0.01	0.00	0.000	0.00	0.00	**0.61**	**0.96**	**253.6**
2018	0.01	0.46	0.01	0.08	0.01	0.00	0.000	0.00	0.00	**0.57**	**0.89**	**235.6**
2019	0.02	0.43	0.01	0.08	0.01	0.00	0.000	0.00	0.00	**0.55**	**0.87**	**229.8**
2020	0.02	0.48	0.01	0.09	0.01	0.00	0.000	0.00	0.00	**0.61**	**0.96**	**254.4**
2021	0.02	0.48	0.01	0.09	0.01	0.00	0.000	0.00	0.00	**0.61**	**0.96**	**253.5**

Year	Dairy cattle	Other cattle	Buffalo	Sheep	Goats	Horses	Asse	Swine	Poultry	**Total gg N_2O-N**	**Total Gg N_2O**	**Total gg CO_2-eq**
2022	0.02	0.40	0.01	0.09	0.01	0.00	0.000	0.00	0.00	**0.52**	**0.82**	**217.4**

Methodological issues

For each species of grazing animal, emissions from manure were calculated by multiplying the number of animals by the corresponding nitrogen excretion value and the share of manure nitrogen that can be converted to nitrous oxide.

The methodology is based on the following formula[59]:

$$N_2O - N_{PRP} = \left[\left(F_{PRP,CPP}\ EF_{3PRP,CPP}\right) + \left(F_{PRP,SO}\ EF_{3PRP,SO}\right)\right]$$

$$F_{PRP} = \sum_T \left[\left(N_{(T)}\ \ Nex_{(T)}\right)\ \ MS_{(T,PRP)}\right]$$

Where:

F_{PRP} annual amount of urine and dung N deposited on pastures by grazing animals, kg N/year

EF_{3PRP} N2O emission factor for N_2O emissions from animals manure deposited on pastures. The lower index CPP corresponds to cattle, poultry and swine, and the lower index SO to sheep and other animals.

$N_{(T)}$ number of head of livestock species/category *T*

$Nex_{(T)}$ annual average N excretion per head of species/category T, kg N/animal/year

$MS_{(T,PRP)}$ fraction of total annual N excretion for each livestock species/category *T* that is deposited on pasture.

T The species of animals

Activity data: The data on animal population are the same as those used to estimate emissions from enteric fermentation (Tables 5-13, 5-14 and 5-15). The average annual nitrogen excretion rates for livestock are taken from Tables 5-45 and 5-46. The share of total N excreted per year on pastures for each animal species T is given in Table 5-48.

Emission factors: The 2006 IPCC default values are used: $EF_{3PRP,\ CPP}$ = 0.02 [kg N_2O–N/kg N] for cattle (dairy, non-dairy) and buffalo, poultry and swine and $EF_{3PRP,SO}$ = 0.01 (kg N_2O–N/kg N) for sheep and "other animals" [2006 IPCC, chapter 11, p.11.11, table 11.1].

Description of any flexibility used

Flexibility is not used

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-specific quality control and quality assurance and validation

For the sub-category "Emissions from animal manure on pastures", standard quality control and quality assurance procedures were carried out, forms and checklists were filled

[59] 2006 IPCC, chapter 11,p. 11.7, equation 11.1 ; 2006 IPCC, chapter 11, p. 11.13, equation 11.5

in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

Category specific recalculation, *including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts.*

Recalculated emissions from animal manure deposited on pastures are presented in Table 5-63. The difference is due to the use of adjusted data on the share of manure in management systems.

Table 5-63. Recalculated emissions from animal manure deposited on pastures in 1990-2022 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5NC	1.32	1.18	0.90	0.77	0.75	0.77	0.80	0.81	0.84	0.95	1.03	1.03	1.08	1.12
4NC	1.64	1.51	1.21	1.08	1.04	1.06	1.06	1.07	1.05	1.13	1.17	1.20	1.24	1.27
Difference, %	-19	-22	-26	-28	-28	-27	-25	-24	-20	-16	-12	-14	-13	-12
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5NC	1.03	1.04	0.87	0.82	0.80	0.74	0.78	0.81	0.87	1.02	1.09	1.14	1.07	0.96
4NC	1.26	1.26	1.13	1.09	1.11	1.05	1.07	1.06	1.15	1.24	1.32	1.37	1.39	1.32
Difference, %	-19	-18	-23	-25	-28	-29	-28	-23	-24	-18	-18	-17	-23	-27

Category-related planned improvements, *including improvements noted during an inspection*

No improvements are planned.

5.4.1.4. Decomposition of crop residues

Description of source-category

After harvesting, part of the agricultural crop residues decomposes in the field. The plant mass remaining in the field is a source of nitrogen. As a result of the transformation, Nitrous oxide is formed. N_2O emissions from the decomposition of agricultural residues are presented in Table 5-64.

Table 5-64. N2O emission from agricultural crop residues decomposition

Year	Emissions	
	Gg N_2O	Gg CO_2-eq
1990	0.16	42.3
1991	0.13	35.6
1992	0.12	31.0
1993	0.09	24.9
1994	0.10	27.0
1995	0.10	27.7
1996	0.14	36.0
1997	0.19	49.1
1998	0.13	35.4
1999	0.17	43.9
2000	0.10	27.7
2001	0.17	44.6
2002	0.15	39.2
2003	0.16	42.5
2004	0.15	38.6
2005	0.17	44.3
2006	0.08	20.6

Year	Emissions	
	Gg N_2O	Gg CO_2-eq
2007	0.09	24.1
2008	0.10	26.1
2009	0.08	21.4
2010	0.05	14.2
2011	0.08	22.4
2012	0.08	21.3
2013	0.10	26.7
2014	0.09	22.7
2015	0.09	24.3
2016	0.09	24.0
2017	0.07	18.0
2018	0.08	21.0
2019	0.08	20.4
2020	0.08	21.9
2021	0.09	22.8
2022	0.09	23.9

Methodological issues

The 2006 IPCC Tier 1 approach was used to calculate emissions. The annual amount of nitrogen in crop residues (FCR), is given by the equation[60]:

$$N_2ON_{N\ inputs} = F_{CR}\ EF_i$$

$$F_{CR} = \sum_T \left\{ \begin{array}{l} Ccrop_{(T)}\ \left(Area_{(T)} - Area\ burnt_{(T)}\ C_f\right)\ Frac_{Renew(T)} \\ \left[R_{AG(T)}\ N_{AG(T)}\ \left(1 - Frac_{Remove(T)}\right) + R_{BG(T)}\ N_{BG(T)}\right] \end{array} \right\}$$

Where:

F_{CR} annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually, kg N/year.

EF_1 emission factor for N_2O emissions from N inputs, kg N_2O–N /(kg N input)

$Crop_{(T)}$ harvested annual dry matter yield for crop *T*, (kg dry matter)/ha.

$$Crop_{(T)} = Yield\ Fresh_{(T)}\ \ DRY$$

$Yield\_Fresh_{(T)}$ harvested fresh yield for crop *T*, , kg fresh weight/ha

DRY dry matter fraction of harvested crop *T*, kg dry matter/kg fresh weight

$Area_{(T)}$ total annual area harvested of crop *T*, ha/year

$Area\ burnt_{(T)}$ annual area of crop *T* residues burnt, ha/year

C_f Combustion factor (dimensionless)

$Frac_{Renew(T)}$ fraction of total area under crop *T* that is renewed annually.

$R_{AG(T)}$ Ratio of above-ground residues dry matter ($A_{GDM(T)}$) to harvested yield ($Crop_{(T)}$), kg dry matter/(kg dry matter))[61]

$$R_{AG(T)} = AG_{DM(T)}\ 1000 / Crop_{(T)};\ A_{GDM(T)} = (Crop_{(T)}/1000)\ slope_{(T)} + intercept_{(T)}$$

$N_{AG(T)}$ N content of above-ground residues for crop *T*, kg N/(kg dry matter)

$Frac_{Remove(T)}$ fraction of above-ground residues of crop *T* removed annually for purposes such as feed,

bedding and construction, kg N/kg crop N).

$R_{BG(T)}$ ratio of below-ground residues to harvested yield for crop *T*, (kg dry matter)/(kg dry matter)

$$R_{BG(T)} = R_{BG\text{-}BIO(T)} \cdot [(A_{GDM(T)} \cdot 1000 + Crop_{(T)}) / Crop_{(T)}]$$

$N_{BG(T)}$ N content of below-ground residues for crop *T*, kg N/kg dry matter

T Crop type

Activity data: The source of data on agricultural crop production is the statistical publications of the National Statistic Office of Georgia.

Table 5-65. Agricultural crop production in 1990-2022 years

Crop	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Wheat	257.7	210.3	190.7	114.0	89.3	76.5	107.4	291.8	144.6	226.1	89.4	306.5	199.7	225.4	185.8	190.1	69.7
Barley	117.8	101.1	75.1	39.5	32.0	33.6	50.0	45.4	20.2	50.8	30.1	98.9	57.5	48.3	61.3	65.4	30.6
Maize	270.2	242.5	220.0	242.8	342.8	386.5	490.9	546.3	420.2	490.5	295.9	288.6	400.1	461.9	410.6	421.3	217.4
Oats	11.7	12.1	9.9	6.9	6.3	4.6	30.0	8.0	3.5	3.3	2.0	9.5	4.2	6.2	4.8	2.8	1.3
Potatoes	293.8	254.3	210.8	248.6	296.9	353.3	285.6	353.0	380.0	417.0	302.0	396.0	405.6	430.1	400.5	432.2	168.7
Dry beans	9.5	5.5	6.0	6.4	10.2	14.3	12.0	10.1	9.2	9.3	5.1	10.0	10.6	12.1	16.5	33.7	7.6
Crop	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	

[60] 2006 IPCC, Chapter 11, p. 11.14, Equation 11.6

[61] 2006 IPCC, Chapter 11, Table 11.2, p. 11.17

Wheat	74.9	80.3	53.9	48.4	96.8	80.7	81.0	47.5	125.6	126.6	97.9	107.1	100.6	102.4	135.9	156.8	
Barley	40.3	49.3	19.9	23.3	30.3	20.7	35.0	26.7	40.9	47.2	43.9	57.7	53.5	45.4	58.1	58.8	
Maize	295.8	328.2	291.0	141.1	269.6	267.0	363.9	347.2	231.4	243.7	142.5	194.2	207.1	255.0	233.0	152.9	
Oats	1.6	2.9	4.2	2.0	0.7	1.6	3.4	5.6	5.8	6.5	3.7	4.7	3.0	2.3	3.2	2.0	
Potatoes	229.2	193.4	216.8	228.8	273.9	252.0	296.6	216.2	206.2	249.0	180.1	237.5	194.7	208.6	234.7	198.9	
Dry beans	10.5	11.6	10.2	5.8	8.9	9.6	10.5	8.7	5.8	5.8	5.7	5.8	5.9	5.2	4.2	2.9	

Emission factors: The 2006 IPCC default value EF_1=0.01 kg(N_2O-N)/(kg N applied) is used for the emission factor. For annual crops, $Frac_{Renew}$ = 1. There are no data on $Frac_{Remove}$, so $Frac_{Remove(T)}$ = 0. Other parameters required to estimate the amount of nitrogen added to soil from crop residues are taken from IPCC 2006 [2006 IPCC, chapter 11, p. 11.17, table 11.2, chapter 2, p. 49, Table 2.6] and 2019 IPCC (chapter 2, p. 2.56, table 2.6).

Table 5-66. Input factors required to estimate nitrogen added to soil from crop residues

Crop	Dry matter fraction of harvested product, kg dry matter)/(kg fresh weight	N content of above-ground residues, kg N/kg dry matter	Ratio of belowground residues to above-ground biomass, (kg dry matter)/(kg dry matter)	N content of below-ground residues, kg N/ kg dry matter	Inclination	Resistance	Combustion factro CF
Wheat	0.89	0.006	0.24	0.009	1.51	0.52	0.9
Barley	0.89	0.007	0.22	0.014	0.98	0.59	0.85
Maize	0.87	0.006	0.22	0.007	1.03	0.61	0.8
Oats	0.89	0.007	0.25	0.008	0.91	0.89	0.85
Potatoes	0.22	0.019	0.20	0.014	0.10	1..06	0.85
Dry beans	0.90	0.01	0.19	0.01	0.36	0.68	0.85

Description of any flexibility used

Flexibility is not used.

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-specific quality control and quality assurance and validation

Standard quality control and quality assurance procedures were carried out, and forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

Category-specific recalculation, *including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts.*

The recalculated N_2O emissions as a result of crop residue decomposition are presented in Table 5-67. The decrease in emissions is due to the use of revised values of the parameters included in the calculations.

Table 5-67. Recalculated N2O emissions from crop residues decomposition in 1990-2017 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5NC	0.16	0.13	0.12	0.09	0.10	0.10	0.14	0.19	0.13	0.17	0.10	0.17	0.15	0.16
4NC	0.20	0.17	0.14	0.11	0.13	0.12	0.14	0.21	0.16	0.19	0.13	0.17	0.17	0.18
Difference, %	-20	-21	-16	-15	-22	-13	-3	-12	-16	-13	-20	-1	-13	-11
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5NC	0.15	0.17	0.08	0.09	0.10	0.08	0.05	0.08	0.08	0.10	0.09	0.09	0.09	0.07
4NC	0.16	0.21	0.08	0.10	0.10	0.09	0.07	0.11	0.11	0.13	0.11	0.12	0.12	0.09
Difference, %	-9	-20	-3	-9	-1	-10	-24	-23	-27	-22	-22	-24	-25	-25

Category-specific planned improvements, *including improvements noted during an inspection*

No improvements are planned.

5.4.2. *Indirect N2O emissions from soils (3.C.5)*

Part of the nitrogen added to agricultural soils from synthetic and organic fertilizers, as well as from grazing animal manure, is transported off-site either through volatilization and subsequent deposition, or through leaking, erosion, and flushing. Nitrogen that is removed from soils in this way provides additional nitrogen for further nitrification and denitrification processes, resulting in the formation of Nitrous Oxide. The N_2O formation from such nitrogen can take years, especially when the nitrogen leaks into groundwater.

Table 5-68. Indirect N2O emissions from managed soils in 1990-2022 years

Year	Deposition of N Volatilised from Managed Soils		Nitrogen leaching and runoff		Total indirect N_2O emissions	
	Gg N_2O	Gg CO_2- eq	Gg N_2O	Gg CO_2- eq	Gg N_2O	Gg CO_2- eq
1990	0.29	76.0	0.36	95.2	0.65	171.1
1991	0.25	66.9	0.31	83.1	0.57	150.0
1992	0.19	51.1	0.24	64.8	0.44	115.9
1993	0.17	44.4	0.22	57.2	0.38	101.7
1994	0.15	40.9	0.19	50.8	0.35	91.7
1995	0.16	42.3	0.20	53.7	0.36	96.0
1996	0.19	49.7	0.26	69.5	0.45	119.2
1997	0.20	51.7	0.28	73.8	0.47	125.5
1998	0.18	47.0	0.24	62.8	0.41	109.7
1999	0.20	53.9	0.28	73.4	0.48	127.4
2000	0.20	52.3	0.25	66.4	0.45	118.7
2001	0.20	54.1	0.26	70.1	0.47	124.2
2002	0.22	58.6	0.29	77.6	0.51	136.2
2003	0.23	60.8	0.30	80.6	0.53	141.4
2004	0.20	53.8	0.26	68.1	0.46	121.8
2005	0.20	53.4	0.25	67.5	0.46	121.0
2006	0.18	48.9	0.25	65.8	0.43	114.8
2007	0.16	42.5	0.21	55.2	0.37	97.6
2008	0.16	42.5	0.21	56.3	0.37	98.8
2009	0.16	41.2	0.21	55.8	0.37	97.0
2010	0.15	40.8	0.20	53.8	0.36	94.6
2011	0.15	40.9	0.20	52.9	0.35	93.8
2012	0.17	45.6	0.22	59.4	0.40	105.0
2013	0.20	53.7	0.27	70.9	0.47	124.6
2014	0.20	54.2	0.26	69.2	0.47	123.4
2015	0.21	56.3	0.27	71.5	0.48	127.8
2016	0.20	53.8	0.26	68.8	0.46	122.6
2017	0.18	47.9	0.23	60.4	0.41	108.4
2018	0.17	45.8	0.22	58.4	0.39	104.2
2019	0.16	42.7	0.20	54.0	0.37	96.7
2020	0.18	47.8	0.23	61.1	0.41	108.8
2021	0.18	47.6	0.23	61.0	0.41	108.6
2022	0.16	42.1	0.21	54.3	0.36	96.4

5.4.2.1. N_2O From Atmospheric Deposition of N Volatilised from Managed Soils

Description of source-category

When synthetic or organic nitrogen fertilizers are applied to managed soils, part of the nitrogen is lost through volatilization as ammonia and nitrogen oxides. The volatilized nitrogen is then redeposited in soils and waters and may undergo further transformations through nitrification and denitrification, leading to N_2O emissions. The amount of volatilized nitrogen depends on several factors, such as the type of fertilizer, technology, timing of application, soil type, precipitation, temperature, soil pH, etc.

Methodological issues

The IPCC 2006 Tier 1 approach was used to estimate N_2O emissions from atmospheric deposition of N volatilised from managed soils. N_2O emissions from atmospheric deposition of volatilized nitrogen were calculated using the equation[62]:

$$N_2O_{ATD}N = [(F_{SN} \quad Frac_{GASF}) + (F_{ON} + F_{PRP}) \quad Frac_{GASM})] \quad EF_4$$

Where:

$N_2O_{ATD}N$ annual amount of N_2O–N produced from atmospheric deposition of N volatilised from
managed soils, (kgN_2O–N/year)

F_{SN} Annual amount of N synthetic fertilizer applied to the soil, kg N/year

$Frac_{GASF}$ fraction of synthetic fertiliser N that volatilises as NH_3 and NOx, kg N volatilized/(kg of N
applied), {[kg(NH_3-N) and (NOx–N)]/kgN applied}.

F_{ON} annual amount of managed animal manure, compost, sewage sludge, and other organic N additions applied to soils. kg N/year.

F_{PRP} annual amount of urine and dung N deposited by grazing animals on pasture, range, and paddock, kgN/year

$Frac_{GASM}$ fraction of applied organic N fertiliser materials (F_{ON}) and urine and dung N deposited by grazing animals (FPRP) that volatilises as NH_3 and NOx, kg N volatilized/(kg of N applied or deposited).

EF_4 emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N–N_2O/(kg NH_3–N + NOx–N volatilised)]

$$N_2O_{(ATD)} = N_2O_{(ATD)}-N \quad 44/28$$

Activity data: The amount of nitrogen added to the soil from synthetic and organic N fertilizers, as well as from grazing animals' manure on pastures, is presented in Table 5-69.

Table 5-69. Amount of nitrogen added to soil from synthetic and organic N fertilizers, as well as from manure of grazing animals, 1990-2022

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
F_{SN} Gg N	20.6	16.7	15.4	15.3	10.2	12.8	28.9	33.1	21.1	27.0	15.9	19.4	24.8	25.8	16.0	15.6	22.9
F_{ON}, Gg N	30.7	27.0	19.0	16.2	15.9	16.0	16.2	16.5	15.9	17.6	18.8	18.9	19.7	20.5	19.5	19.0	15.4
F_{PRP}, Gg N	50.2	44.9	34.7	29.5	28.1	28.4	29.0	29.0	30.0	33.6	36.1	36.4	38.3	39.6	37.0	37.4	31.9
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
F_{SN} Gg N	15.8	17.9	20.1	16.9	14.5	17.2	22.4	17.5	17.3	17.5	13.8	14.8	12.6	15.7	15.8	15.0	

[62] 2006 IPCC, Chapter 11, p 11.21, equation 11.9

F_{ON}, Gg N	12.7	12.4	12.1	12.2	12.6	14.3	16.1	16.7	17.9	16.8	15.4	14.7	12.7	14.0	13.8	12.1
F_{PRP}, Gg N	30.4	29.8	27.3	28.2	29.3	31.8	37.1	39.6	41.1	39.0	35.3	32.9	34.7	36.3	34.7	31.2

Emission factors: 2006 IPCC default values are used: EF_4 =0.01 kg(N_2O-N)/kg N [IPCC 2006, chapter 11, p. 11.24, table 11.3). $Frac_{GASF}$ = 0.10 (kg N volatilized)/(kg N applied) and $Frac_{GASM}$ = 0.2 kg [(NH_3–N)+(NOx–N)]/(kg N applied) [IPCC 2006, chapter 11, p. 11.24, table 11.3).

Description of any flexibility used

Flexibility is not used.

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-specific appropriate quality control/quality assurance and validation

For the sub-category "Atmospheric Deposition of N Volatilised from Managed Soils", standard quality control and quality assurance procedures were carried out, and forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

Category-specific recalculation, *including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts.*

Indirect N_2O emissions from Atmospheric Deposition of N Volatilised from Managed Soils were recalculated for the period 1990-2017. Compared to the results recorded in the previous inventory cycle, changes made in the current inventory cycle resulted in a significant downward trend, mainly due to the updated values for the amount of inorganic N fertilizers.

Table 5-70. Recalculated N2O emissions from Atmospheric Deposition of N Volatilised from Managed Soils in 1990-2017 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5NC	0.29	0.25	0.19	0.17	0.15	0.16	0.19	0.20	0.18	0.20	0.20	0.20	0.22	0.23
4NC	0.33	0.30	0.25	0.23	0.20	0.22	0.29	0.31	0.25	0.29	0.25	0.27	0.30	0.31
Difference, %	-14	-15	-21	-26	-23	-26	-35	-36	-30	-30	-21	-23	-26	-25
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5NC	0.20	0.20	0.18	0.16	0.16	0.16	0.15	0.15	0.17	0.20	0.20	0.21	0.20	0.18
4NC	0.26	0.26	0.27	0.23	0.24	0.24	0.24	0.22	0.25	0.28	0.27	0.28	0.28	0.26
Difference, %	-22	-21	-32	-31	-34	-36	-35	-31	-30	-28	-25	-24	-29	-29

Category-specific planned improvements, *including improvements noted during an inspection*

No improvements are planned.

5.4.2.2. *N_2O emissions from nitrogen leaching and runoff*

Description of source-category

When nitrogen from synthetic fertilizers or manure is applied to the soil, part of this nitrogen is lost through leaching or runoff. The amount of nitrogen loss depends on many factors, such as the method, timing, and rate of nitrogen application, plant type, soil structure, runoff, landscape, etc. Some of this lost nitrogen may then transform and thus form N_2O outside the application site.

Methodological issues

N_2O emissions from nitrogen leaching and runoff are calculated using the 2006 IPCC Tier 1 approach. N_2O emissions from leaching and runoff are calculated using the following equation:[63]:

$$N_2O_LN = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM})\ Frac_{LEACH-(H)}\ EF_5$$

Where:

$N_2O_{(L)}$–N annual amount of N_2O–N produced from leaching and runoff of N additions to managed

soils, kg N_2O–N/year

F_{SN} Annual amount of synthetic N fertilizer applied to soil, kg N/year

F_{ON} annual amount of managed animal manure, compost, sewage sludge, and other organic N additions applied to soils, kg N/year

F_{PRP} annual amount of urine and dung N deposited by grazing animals, kg N/year

F_{CR} amount of N in crop residues (above- and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually, kg N/year

F_{SOM} annual amount of N mineralised in mineral soils associated with loss of soil C from soil organic matter as a result of changes to land use or management, kgN/year. In Georgia, N_2O emissions from this source category occur only on a very small scale.

$Frac_{LEACH-(H)}$ fraction of all N added to/mineralised in managed that is lost through leaching and runoff kg N/(kg of N additions)

EF_5 emission factor for N_2O emissions from N leaching and runoff, kg N_2O–N/(kg N leached and runoff).

Activity data: The amount of nitrogen present in synthetic and organic fertilizers, released from animal manure during grazing, and produced during the decomposition of agricultural waste are presented in the relevant tables.

Emission factors: $Frac_{LEACH-(H)}$ =0.30 (kg N/(kg N applied) [IPCC 2006, chapter 11, p. 11.24, table. 11.3]. The 2006 IPCC default emission factor is used as: EF_5= 0.0075 kg N_2O–N/(kg N leached and runoff).

Description of any flexibility used

Flexibility is not used

Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

Category-specific quality control/quality assurance and validation

[63] 2006 IPCC, chapter 2, equation 1.10, p/ 11.21

For the category "N_2O emissions from nitrogen leaching and runoff" standard quality control and quality assurance procedures were performed, and forms and checklists were filled in. Activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

Category-specific recalculation, *including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts.*

Indirect N_2O emissions from the source category "Nitrogen leaching and runoff" were recalculated for the period 1990-2017. Compared to the results recorded in the previous inventory cycle, changes made in the current inventory cycle resulted in a significant downward trend, mainly due to the use of updated values for synthetic N fertilizers**.**

Table 5-71. Indirect N2O emissions from the source category "Nitrogen leaching and runoff" recalculated for 1990-2017 years

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5NC	0.36	0.31	0.24	0.22	0.19	0.20	0.26	0.28	0.24	0.28	0.25	0.26	0.29	0.30
4NC	1.72	1.50	1.28	1.19	1.01	1.11	1.67	1.84	1.41	1.67	1.29	1.44	1.64	1.71
Difference, %	-79	-79	-81	-82	-81	-82	-84	-85	-83	-83	-81	-82	-82	-82
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5NC	0.26	0.25	0.25	0.21	0.21	0.21	0.20	0.20	0.22	0.27	0.26	0.27	0.26	0.23
4NC	1.35	1.36	1.47	1.21	1.28	1.32	1.22	1.16	1.28	1.52	1.39	1.42	1.43	1.24
Difference, %	-81	-81	-83	-83	-83	-84	-83	-83	-82	-82	-81	-81	-82	-82

Planned improvements related to the category, *including improvements identified during the inspection*

No improvements are planned.

5.5. Prescribed burning of savannas (Cleaning of the soil with established burning) (3.E)

NO.

5.6. Biomass burning in croplands

5.6.1. Description of source-category

This category includes the burning of agricultural residues in open fields in Georgia. Although the burning of agricultural residues in open fields is restricted/prohibited by legislation in Georgia, this practice continues.

Only non-CO_2 emissions are considered, assuming that CO_2 emissions will be balanced by CO_2 absorption as a result of subsequent vegetation regrowth within one year (2006 IPCC, Chapter 2, page 2.40).

Table 5-72. Non-CO2 greenhouse gas emissions as a result of biomass burning in croplands, in 1990-2022 years

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
L_{fire} – Gg CO	2.72	2.32	1.96	1.60	1.28	1.15	1.25	1.63	0.96	1.92	0.79
L_{fire} – Gg CH_4	0.08	0.07	0.06	0.05	0.04	0.03	0.04	0.05	0.03	0.06	0.02
L_{fire} – Gg N_2O	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
L_{fire} – Gg NO_X	0.07	0.06	0.05	0.04	0.03	0.03	0.03	0.04	0.03	0.05	0.02
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
L_{fire} – Gg CO	2.66	1.68	1.82	1.72	1.97	1.18	1.67	1.67	1.08	0.99	2.06
L_{fire} – Gg CH_4	0.08	0.05	0.05	0.05	0.06	0.03	0.05	0.05	0.03	0.03	0.06

L_{fire} – Gg N_2O	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.002
L_{fire} – Gg NO_X	0.07	0.05	0.05	0.05	0.05	0.03	0.05	0.05	0.03	0.03	0.06
Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
L_{fire} – Gg CO	1.67	1.76	1.38	2.54	2.55	2.16	2.46	2.26	2.16	2.65	2.85
L_{fire} – Gg CH_4	0.05	0.05	0.04	0.07	0.07	0.06	0.07	0.07	0.06	0.08	0.08
L_{fire} – Gg N_2O	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
L_{fire} –Gg NO_X	0.05	0.05	0.04	0.07	0.07	0.06	0.07	0.06	0.06	0.07	0.08

5.6.2 Methodological issues

Non-CO_2 emissions from burning of agricultural residues were estimated using the 2006 IPCC Tier 1 approach. The equation used is[64]:

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

Where:

L fire Non-CO_2 emissions from burning of agricultural residues in croplands, tons/year

A Area of burned field, ha

M_B Mass of fuel available for combustion, tons/ha

M_B = Average crop yield (tons/ha) • Residue to yield ratio • Dry matter fraction

C_f Combustion factor (the fraction of fuel that is actually burned), dimensionless

G_{ef} Emission factor, g/kg dry mass burned

Activity data

Crop residue burning occurs mainly in the Shiraki Valley of Dedoplistskaro Municipality. According to the study "Cost-Benefit Analysis of Agricultural Burning Practices in Dedoplistskaro Municipality, Georgia," approximately 10,000 hectares of arable land are burned annually.[65].

Emission factors

Default emission factors (gram/kg dry mass burnt) for non-CO_2 gases are given in Table 5-73 (2006 IPCC, Chapter 2, Table 2.5, p. 2.47):

Table 5-73. Default emission factors

gas	CO	CH_4	N_2O	NO_X
(G_{ef}) emission factors, gram gas/kg burnt dry mass	92	2.7	0.07	2.5

Dry matter fraction = 0.89 (2006 IPCC, Chapter 11, Table 11.2, page 11.17). For wheat, the ratio of residue to yield = 1.3 (IPCC Good Practice Guidelines for National Greenhouse Gas Inventories, IPCC GPG, Table 4.16, page 4.58). Cf = 0.90 (2006 IPCC, Chapter 2, Table 2.6, page 2.49).

5.6.3. Description of any flexibility used

Flexibility is not used

5.6.4. Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

[64] 2006 IPCC, chapter 2, equation 2.27, p. 2.42

[65] https://biodivers-southcaucasus.org/uploads/files/81206850_R_Westerberg_CBA%20Shiraki_2015-2016.pdf

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

5.6.5. Category-appropriate quality control and assurance and verification

For the sub-category "Burning of biomass in croplands", standard quality control and quality assurance procedures were carried out, forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both printed and electronic form. During quality assurance, a note was made that "the formula for calculating the M_B parameter was omitted. The error has been corrected, and the formula for calculating M_B has been added to the methodology.

5.6.6. Category specific recalculations, including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts.

Recalculated emissions (in Gg CO_2-eq) of non-CO_2 greenhouse gases from the combustion of agricultural residues are given in Table 5-74. The large difference between the emissions is due to the use of different methodologies (The Fifth National Communication uses the methodology from the 2006 IPCC, while the Fourth National Communication uses the methodology from the 1996 IPCC).

Table 5-74. The Recalculated emissions (in Gg CO2-eq) of non-CO2 greenhouse gases from the burning of agricultural residues in 1990-2022.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5NC	2.8	2.4	2.0	1.6	1.3	1.2	1.3	1.7	1.0	2.0	0.8	2.7	1.7	1.9
4NC	14.9	12.8	11.3	9.3	11.4	11.4	13.6	19.0	13.1	16.8	9.4	16.2	14.9	16.5
Difference, %	-81	-81	-82	-82	-89	-90	-91	-91	-93	-88	-91	-83	-88	-89
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5NC	1.8	2.0	1.2	1.7	1.7	1.1	1.0	2.1	1.7	1.8	1.4	2.6	2.6	2.2
4NC	15.0	15.6	7.3	9.2	9.9	8.1	5.3	8.9	8.3	10.5	7.9	7.9	9.5	6.7
Difference, %	-88	-87	-83	-81	-83	-86	-81	-76	-79	-83	-82	-67	-73	-67

5.6.7. Planned improvements related to the category, including improvements identified during the inspection

No improvements are planned.

5.7. Liming (3.C.2)

NE not estimated.

5.8. Urea application (3.C.3)

5.8.1. Description of source-category

CO_2 is produced by adding urea to the soil as a fertilizer. Urea $CO(NH_2)_2$ is converted to ammonium (NH4+), hydroxyl ion (OH-), and bicarbonate (HCO3-) in the presence of water and urease enzymes. The bicarbonate formed is converted to CO_2 and water, similar to the reaction that occurs when lime is added to the soil.

CO_2 emissions from urea applied to agricultural soils in 2001-2022 are presented in Table 5-75. The results show that CO_2 emissions from urea application increased approximately 48-times between 2005 and 2022.

Table 5-75. CO2 emissions from urea applied to agricultural soils in 2001-2022

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011

Emission, gg CO_2	-	-	-	-	0.08	0.15	0.10	0.09	0.26	0.80	0.16
Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Emission, Gg CO_2	0.36	0.47	1.69	2.68	1.66	1.91	2.48	2.73	4.83	3.11	3.95

5.8.2. *Methodological issues*

CO_2 emissions from urea application to agricultural soils were calculated using the 2006 IPCC Tier 1 methodology. The amount of urea used is multiplied by an emission factor.[66]

$$CO_2 = M \bullet EF \bullet \frac{44}{12}$$

Where:

CO_2 Annual CO_2 emissions from urea application to soils, tonnes CO_2/year

M Amount of urea consumed during the year, tonnes of urea/year

EF Emission factor, a tonne of C/tonne of urea

Activity data: urea is not produced in Georgia. Activity data on the application of urea as fertilizer to soils were obtained indirectly, based on information provided by the Customs Department of the Revenue Service of Georgia on the import and export of urea. Annual urea consumption was assumed to be equal to total urea imports minus exports. The activity data on amount of urea used in agriculture are the same as those used to calculate N_2O emissions.

Table 5-76. Import, export, and consumption of Urea as a fertilizer in 2003-2022 year

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Urea import, tons	1	2	113	201	136	118	353	1,089	241	493
Urea export, tons									17	
Urea consumption, tons/year	1	2	113	201	136	118	353	1,089	224	493
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Urea import, tons	646	2,303	3,661	2,268	2,608	3,384	3,719	6,594	4,240	5,391
Urea export, tons			0.4	1.1	0.0	0.0	0.3	1.1	0.0	6.5
Urea consumption, tons/year	646	2,303	3,660	2,267	2,608	3,384	3,719	6,593	4,240	5,384

Emission factor: The 2006 IPCC default emission factor used for urea is 0.20 ton C/ton urea.

5.8.3. *Description of any flexibility used*

Flexibility is not used

5.8.4. *Uncertainty assessment and time series consistency*

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

5.8.5. *Category-appropriate quality control and assurance and verification*

For the category "Urea application", standard quality control and quality assurance procedures were carried out, forms and checklists were filled in. The activity data and methods

[66] 2006 IPCC, chapter 11, p. 11.32, equation 11.13

used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

5.8.6. Category-specific recalculations, including explanatory information and justification for recalculations, changes made in response to the verification/review process, and impacts

CO_2 emissions from Urea application" were calculated for the first time.

5.9.7. Planned improvements related to the category, including improvements identified during the inspection

No improvements are planned.

Chapter 6. Land use, land-use change and forestry (CRT sector 4)

6.1. Sector overview and general information

The greenhouse gas inventory in the LULUCF (Land Use, Land-use Change and Forestry) sector was prepared in accordance with the 2006 IPCC Guidelines for the period 1990-2022, namely, the old (1990-2017) emission/absorption figures were updated, and new calculations were carried out for the period 2018-2022.

The sector includes six sub-sectors: Forest Land (3B1); Cropland (3B2); Grassland (3B3); Wetlands (3B4); Settlements (3B5); and Other Land (3B6).

The greenhouse gas inventory in the sector was conducted according to the definitions[67] of land use categories defined by the methodology and its corresponding Georgian legislation on the lands defined.

Specifically, regarding the definition of the abovementioned six categories of land use in Georgia: According to Georgian legislation, a land plot can be of the agricultural and non-agricultural category (except for Forest Land). Land plots with the agricultural category are: pasture, hay meadow, arable (occupied with perennial crops, orchard, vegetable garden) and homestead land.

Pasture - a plot of agricultural land covered with herbaceous plants and/or shrub vegetation (natural or cultivated), which is used for grazing (feeding) animals, with or without an agricultural building and/or auxiliary building on it, or a plot of land which, taking into account its soil-climatic conditions and natural-geographical location, can be used for this purpose;

Hay meadow - a plot of agricultural land covered with herbaceous plants and/or shrub vegetation (natural or cultivated), which is used for the preparation of hay, haylage, silage, herbaceous flower or other supplementary animal feed, with or without an agricultural building and/or auxiliary building on it, or a plot of land which, taking into account its soil-climatic conditions and natural-geographical location, can be used for this purpose;

Arable land (including those occupied by perennial crops) – a plot of agricultural land used for growing agricultural crops, with or without an agricultural building and/or auxiliary building on it, or a plot of land that, taking into account its soil-climatic conditions and natural-geographical location, can be used for this purpose;

Homestead land plot - a plot of agricultural land, which, in accordance with the document establishing the right, has been issued for the arrangement of a homestead and/or household, with or without an individual residential house (built, under construction or demolished), an farm building and/or an auxiliary building; a plot of land for which a document confirming the right is not found (not issued or lost), in addition, a report issued by the municipality confirms that this land plot has been issued for the arrangement of a homestead and/or household and its area in a valley does not exceed 1.25 ha, and in a high-mountainous settlement determined in accordance with the Law of Georgia "On the Development of High-Mountain Regions" - 5 ha;

Non-agricultural land is all land that does not fall into the category of agricultural land, including settlements.

[67] IPCC 2006, Chapter 3 - Consistent Representation Of Lands; 3.2 Land-Use Categories

Wetlands, according to the Law[68] on the Creation and Management of Protected Areas of Kolkheti, are: swamps, boggy lands, peatlands or water reservoirs - natural, artificial, permanent, temporary, lotic, non-lotic, fresh, less saline or saline, including sea water, the depth of which during the ebb does not exceed 6 meters; according to the Law of Georgia [69]on Water, swamps belong to surface waters.

Wetlands of international importance in Georgia are: Kolkheti Swamps (including Imnati, Nabada, Churi Swamps, Paliastomi Lake and surrounding areas) and Ispani Swamp (including Kobuleti Reserve and Nature Reserve).

As for the category of forest and forest land, it is regulated by the Forest Code of Georgia under Georgian legislation. Before the adoption of the new Forest Code, the definition of a forest was presented as follows: "Forest area – an area of 0,3 ha or more, represented by trees 2 meters or more high or a set of woody shrub plants 1.5 meters or more high, the projection of the trunks of which is 30% or more of the area". Later, according to the new Code[70] adopted in 2020, a forest was defined as follows: "An area of land not less than 10 m wide and at least 0.5 ha, covered with one or more species of forest-forming woody plants, where the density of tree stands per unit area is not less than 0,1 frequency".

Unfortunately, at this stage, there is no mechanism in Georgia to record changes in land use categories to monitor land use changes. The state agency that can record changes in land use during land registration is the National Agency of Public Registry. At this stage, it does not have a statutory obligation to record and summarize changes in land use annually. Therefore, it cannot provide us with statistical data.

Based on the above, a land use change matrix was created based on currently available data, which is mainly based on data from the Statistics Office of Georgia. Specifically, a land use matrix was created based on statistical publications published for 1997, 2000 and annually from 2004, including 2023 (see Table 6-1).

Table 6-1. Indicators of changes in land use (1990-2022), thousand hectares.

Year	Land use categories						Total area of Georgia
	3B1	3B2	3B3	3B4	3B5	3B6	
	Forest land	Cropland	Grassland	Wetlands	Settlements	Other lands	
1990	2,988.4	1,129.3	1,923.5	155.7	181.7	300.9	6,679.5
1991	2,988.4	1,123.3	1,923.5	155.7	181.7	306.9	6,679.5
1992	2,988.4	1,117.3	1,923.5	155.7	181.7	312.9	6,679.5
1993	2,988.4	1,111.3	1,923.5	155.7	181.7	318.9	6,679.5
1994	2,988.4	1,105.3	1,923.5	155.7	181.7	324.9	6,679.5
1995	2,988.4	1,099.4	1,923.5	155.7	181.7	330.9	6,679.5
1996	2,988.4	1,093.4	1,923.5	155.7	181.7	336.8	6,679.5
1997	2,988.4	1,087.4	1,923.5	155.7	181.7	342.8	6,679.5
1998	2,988.4	1,081.4	1,938.0	155.7	217.3	298.7	6,679.5
1999	2,988.4	1,075.4	1,938.0	155.7	217.3	304.7	6,679.5
2000	2,988.4	1,069.4	1,938.0	155.7	217.3	310.7	6,679.5
2001	2,988.4	1,065.5	1,938.0	155.7	217.3	314.6	6,679.5
2002	2,988.4	1,061.6	1,940.4	155.7	228.4	305.0	6,679.5
2003	2,988.4	1,057.7	1,940.4	155.7	228.4	308.9	6,679.5
2004	2,988.4	1,050.6	1,940.4	155.7	228.4	316.0	6,679.5

[68] https://faolex.fao.org/docs/pdf/geo137728.pdf#
[69] Law of Georgia on Water, https://matsne.gov.ge/ka/document/view/33448?publication=27
[70] https://matsne.gov.ge/ka/document/view/4874066?publication=6

2005	2,988.4	1,043.5	1,940.4	155.7	228.4	323.1	6,679.5
2006	2,988.4	1,036.4	1,940.4	155.7	228.4	330.2	6,679.5
2007	2,988.4	1,029.3	1,940.4	155.7	228.4	337.3	6,679.5
2008	2,988.4	1,022.2	1,940.4	155.7	228.4	344.4	6,679.5
2009	2,988.4	1,015.1	1,940.4	155.7	228.4	351.5	6,679.5
2010	2,988.4	1,008.0	1,940.4	155.7	228.4	358.6	6,679.5
2011	2,988.4	1,000.9	1,940.4	155.7	228.4	365.7	6,679.5
2012	2,988.4	993.8	1,940.4	155.7	228.4	372.8	6,679.5
2013	2,988.4	986.7	1,940.4	155.7	228.4	379.9	6,679.5
2014	2,988.4	979.6	1,940.4	155.7	228.4	387.0	6,679.5
2015	2,988.4	972.5	1,940.4	155.7	228.4	394.1	6,679.5
2016	2,988.4	965.4	1,940.4	155.7	228.4	401.2	6,679.5
2017	2,988.4	958.3	1,940.4	155.7	228.4	408.3	6,679.5
2018	2,988.4	951.2	1,940.4	155.7	228.4	415.4	6,679.5
2019	2,988.4	944.1	1,940.4	155.7	228.4	422.5	6,679.5
2020	2,988.4	937.0	1,940.4	155.7	228.4	429.6	6,679.5
2021	3,100.5	929.7	1,940.4	155.7	228.4	324.8	6,679.5
2022	3,100.5	922.4	1,940.4	155.7	228.4	332.1	6,679.5

The increase in forest area in the table in recent years is based on data from the National Forest Inventory (NFI). The first-ever National Forest Inventory (NFI) conducted in Georgia in 2019-2023, which was conducted by the Ministry of Environment and Agriculture with the support of GIZ, clarified forest areas throughout Georgia. In addition, various updated forest indicators were obtained. It should be noted that despite the increased forest area, 34.5% of Georgia's forest area is degraded, which amounts to a total of 807,178 hectares (excluding occupied territories).

The forest inventory showed that the largest share of degraded areas falls on low-density planted forests, and one of the main problems is the deterioration of forest quality as a result of unsystematic cutting of wood, which leads to its degradation.

The spread of pests and diseases also has a negative impact on the condition of forests.

Damage causes in percentages:

15.6% – Phyto and Ento diseases

38.8% – Low-frequency planted forest

36.1% – Deterioration of forest quality due to unsystematic cutting of wood

7.8% – Illegal grazing on forest lands

1.0% – Forest fires

0.7% – Damage from other/unknown causes

The results revealed 5 woody species that react negatively to environmental factors and are represented by the largest number of dried individuals.

The most damaged are Colchian boxwood – 91.5% of the total plantings; common chestnut – damaged by 17.6%; Caucasian pine – 8.7%; Georgian oak – 8% and Oriental spruce – 6.8%.

6.1.1. *Greenhouse gas emissions trend*

The LULUCF (Land use, land use change and Forestry) sector greenhouse gas inventory was conducted in four sub-sectors: in three key source categories: forest land, arable land, grassland, and wetland. Table 6-2 presents the carbon dioxide emissions for each sub-sector, as well as the total emissions calculated for the sector as a whole for the period 1990-2022. The sub-sectors were identified as key source categories according to the IPCC methodological guidelines[71]. The annex provides a decision-making framework, separately for each of the three sub-sectors. As a rule, good practice in calculations involves carrying out calculations for key categories using higher-level approaches (Tier 6-2 and 6-3). Due to the lack of relevant data in the country at this stage, it was carried out in the LULUCF (Land use, land use change and forests) sector mainly according to Tier 1. At the same time, a list of data needed for further improvement was determined.

The calculation methodology, activity data and emission factors are described in detail in the relevant chapters below. CO2 emissions to the atmosphere given in the report tables are indicated by a (+) sign, while CO2 absorption from the atmosphere are indicated by a (-) sign.

Table 6-2 shows that since 1990, the largest change in emissions has been observed on arable land, in particular on land covered with perennial crops. In particular, if in 1990 carbon dioxide emissions amounted to -1041 Gg CO_2, in 2022 emissions amounted to -757.5 Gg CO_2.

The pasture subsector (3B2) is a carbon dioxide emitter in all assessed years, which is due to the degradation of pastures. As a result of intensive, unregulated exploitation of pastures, the scale of carbon accumulation in the soil is negligible, which makes this subsector a carbon dioxide emitter. Emissions from this subsector are stable within the range of 816.2-765.2 thousand $GgCO_2$.

As for forest lands, they are carbon "collectors" in all assessed years, and the dynamics of carbon dioxide absorption fluctuates within the range of -6904.3/-6693.5 $GgCO_2$ annually.

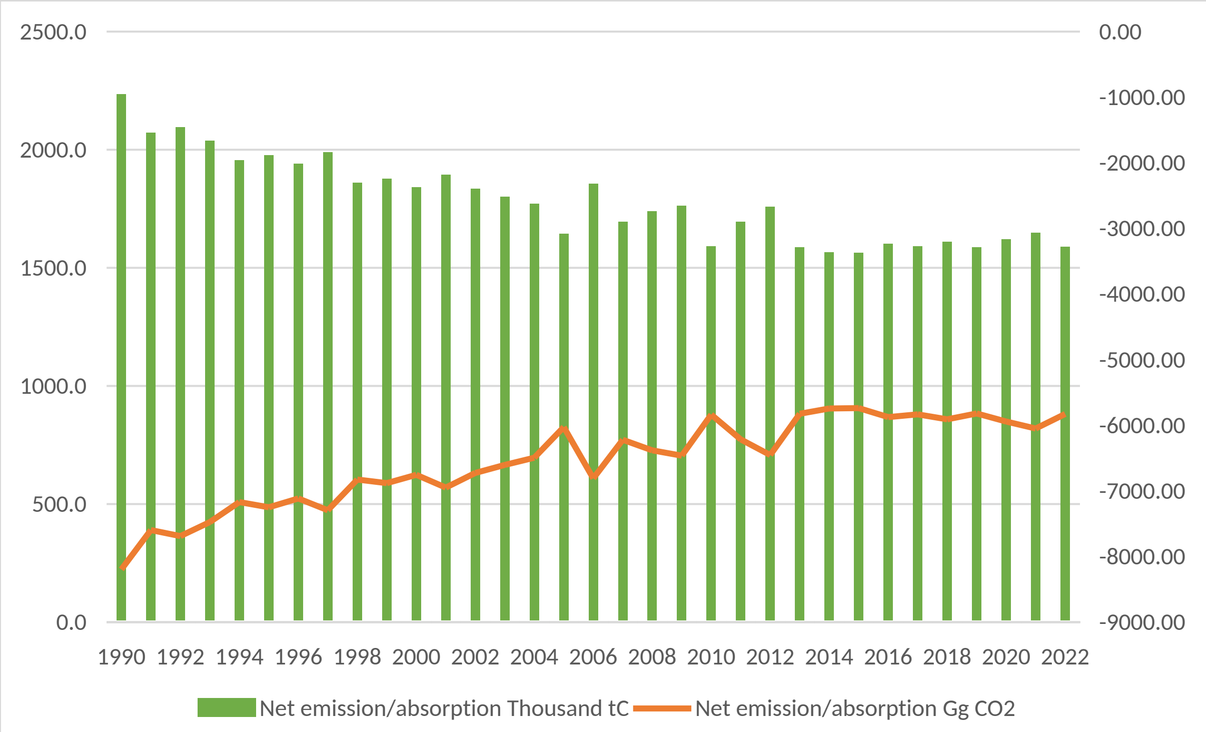
Table 6-2. Results of the LULUCF (Land use, land use change and forests) sector greenhouse gas inventory for 1990-2022

Year	Forest lands		croplands				Grassland		wetlands		Net emission/absorption	
			Perennial crops		cropland							
	Thousand tons C	$ggCO_2$	Thousand tons C	gg CO_2	Thousand tons C	gg CO_2	Thousand tons C	gg CO_2	Thousand tons C	gg CO2	Thousand tons C	gg CO_2
1990	1,883.00	-6,904.30	283.90	-1,041.00	187.90	-688.90	-119.70	438.90	4.30	15.77	2,239.40	-8,179.53
1991	1,893.50	-6,942.80	269.00	-986.30	131.80	-483.30	-222.60	816.20	4.30	15.77	2,076.00	-7,580.43
1992	1,929.20	-7,073.70	254.10	-931.70	136.00	-498.70	-222.60	816.20	4.30	15.77	2,101.00	-7,672.13
1993	1,899.20	-6,963.70	239.20	-877.10	122.70	-449.90	-222.60	816.20	4.30	15.77	2,042.80	-7,458.73
1994	1,893.50	-6,942.80	224.30	-822.40	60.20	-220.70	-222.60	816.20	4.30	15.77	1,959.70	-7,153.93
1995	1,914.60	-7,020.20	209.40	-767.80	75.60	-277.20	-222.60	816.20	4.30	15.77	1,981.30	-7,233.23
1996	1,897.00	-6,955.70	194.50	-713.20	71.40	-261.80	-222.60	816.20	4.30	15.77	1,944.60	-7,098.73
1997	1,950.00	-7,150.00	179.60	-658.50	82.30	-301.80	-222.60	816.20	4.30	15.77	1,993.60	-7,278.33
1998	1,837.40	-6,737.10	164.60	-603.50	76.80	-281.60	-217.10	796.00	4.30	15.77	1,866.00	-6,810.43

[71] CHAPTER 4; METHODOLOGICAL CHOICE AND IDENTIFICATION OF KEY CATEGORIES. https://www.ipcc nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_4_Ch4_MethodChoice.pdf

1999	1,852.20	-6,791.40	149.70	-548.90	91.80	-336.60	-217.10	796.00	4.30	15.77	1,880.90	-6,865.13
2000	1,836.80	-6,734.90	134.80	-494.30	87.60	-321.20	-217.10	796.00	4.30	15.77	1,846.40	-6,738.63
2001	1,869.20	-6,853.70	119.90	-439.60	123.10	-451.40	-217.10	796.00	4.30	15.77	1,899.40	-6,932.93
2002	1,818.00	-6,666.00	105.00	-385.00	128.40	-470.80	-217.10	796.00	4.30	15.77	1,838.60	-6,710.03
2003	1,779.90	-6,526.30	90.10	-330.40	148.00	-542.70	-217.10	796.00	4.30	15.77	1,805.20	-6,587.63
2004	1,742.20	-6,388.10	75.20	-275.70	162.30	-595.10	-208.70	765.20	4.30	15.77	1,775.30	-6,477.93
2005	1,632.60	-5,986.20	60.30	-221.10	159.40	-584.50	-208.70	765.20	4.30	15.77	1,647.90	-6,010.83
2006	1,776.80	-6,514.90	45.40	-166.50	243.40	-892.50	-208.70	765.20	4.30	15.77	1,861.20	-6,792.93
2007	1,616.40	-5,926.80	30.50	-111.80	258.30	-947.10	-208.70	765.20	4.30	15.77	1,700.80	-6,204.73
2008	1,649.30	-6,047.40	15.50	-56.80	284.30	-1042.40	-208.70	765.20	4.30	15.77	1,744.70	-6,365.63
2009	1,708.90	-6,266.00	0.60	-2.20	261.60	-959.20	-208.70	765.20	4.30	15.77	1,766.70	-6,446.43
2010	1,654.40	-6,066.10	-14.30	52.40	160.40	-588.10	-208.70	765.20	4.30	15.77	1,596.10	-5,820.83
2011	1,774.90	-6,508.00	-29.20	107.10	157.90	-579.00	-208.70	765.20	4.30	15.77	1,699.20	-6,198.93
2012	1,853.50	-6,796.20	-44.10	161.70	159.10	-583.40	-208.70	765.20	4.30	15.77	1,764.10	-6,436.93
2013	1,719.90	-6,306.30	-59.00	216.30	136.10	-499.00	-208.70	765.20	4.30	15.77	1,592.60	-5,808.03
2014	1,715.50	-6,290.20	-73.90	271.00	133.50	-489.50	-208.70	765.20	4.30	15.77	1,570.70	-5,727.73
2015	1,705.00	-6,251.70	-88.80	325.60	157.30	-576.80	-208.70	765.20	4.30	15.77	1,569.10	-5,721.93
2016	1,746.60	-6,404.20	-103.70	380.20	168.00	-616.00	-208.70	765.20	4.30	15.77	1,606.50	-5,859.03
2017	1,741.40	-6,385.10	-118.70	435.20	176.80	-648.30	-208.70	765.20	5.47	20.06	1,596.27	-5,812.94
2018	1,770.90	-6,493.30	-133.60	489.90	182.80	-670.30	-208.70	765.20	6.58	24.13	1,617.98	-5,884.37
2019	1,759.70	-6,452.20	-148.50	544.50	184.60	-676.90	-208.70	765.20	9.64	35.35	1,596.74	-5,784.05
2020	1,823.40	-6,685.80	-176.00	645.30	181.90	-667.00	-208.70	765.20	10.60	38.87	1,631.20	-5,903.43
2021	1,868.90	-6,852.60	-191.30	701.40	180.70	-662.60	-208.70	765.20	10.25	37.58	1,659.85	-6,011.02
2022	1,825.50	-6,693.50	-206.60	757.50	178.90	-656.00	-208.70	765.20	7.11	26.07	1,596.21	-5,800.73

Figure 6-1. Emissions trend in the forest sector in 1990-2022 years



6.1.2. *Country-specific approaches*

As already mentioned, the sectoral greenhouse gas inventory report includes six land use categories, where the CO_2 absorption and emission volumes are determined separately according to the changes in each land use category and are calculated using the following equation:

$$\Delta C_{AFOLU} = \Delta C_{FL} + \Delta C_{CL} + \Delta C_{GL} + \Delta C_{WL} + \Delta C_{SL} + \Delta C_{OL}$$

where:

ΔC_{AFOLU} = Changes in carbon stocks in the sector.

ΔC_{FL} = Forest lands

ΔC_{CL} = Cropland

ΔC_{GL} = Grassland

ΔC_{WL} = Wetlands

ΔC_{SL} = Settlements

ΔC_{OL} = Other lands

The greenhouse gas inventory of Georgia is limited to only 4 subsectors (). The greenhouse gas inventory methodology is based on the principles of the so-called "best practice", which implies progress towards a high level of calculations, one of the prerequisites for achieving which is the increase in research potential in the relevant fields and the involvement of those agencies that have the ability to systematize the collection of data necessary for calculations and the provision of statistical indicators to the inventory group and, most importantly, the provision of information. At this stage, obtaining data remains problematic, sometimes there is no data at all, which makes it impossible to move from the first to the second level of calculations (see Table 6-3).

According to the methodological guidelines, land use is divided into two classes, managed and unmanaged lands. Managed lands - all areas on which human intervention occurs to perform production, environmental or social functions. Calculations are not performed on unmanaged lands. In the greenhouse gas inventory conducted in the LULUCF (Land use, land use change and forests) sector, all lands are managed and therefore included in the calculations.

Table 6-3. Land use, land use change and forests: methodological levels used in the sector.

Land use categories	CO_2		CH_4		N_2O		NOx		CO	
	Method used	Emission factor	Method used	Emission factor	Method used	Emission factor	Method used	Emission factor	Method used	Emission factor
3B1 Forest lands	D,T2	D, PS	D,T1	D	D,T1	D	D,T1	D	D,T1	D
3B2 Cropland	D,T1	D,PS	NE	NE	NE	NE	NE	NE	NE	NE
3B3 Grassland	D,T1	D,PS	NE	NE	NE	NE	NE	NE	NE	NE
3B4 Wetlands	D,T1	D	NE	NE	NE	NE	NE	NE	NE	NE
3B5 Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3B6 Other lands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

D: IPCC default, T1-T3: IPCC Tier 1-3, PS: plant specific.

6.2. Lands (LULUCF 3B)

6.2.1. *Forest lands (LULUCF 3B1)*

Preserved forest lands (LULUCF 3B1a)

Source category description and calculated emissions

The inventory of greenhouse gases in forest lands was carried out for the entire forest area of Georgia, regardless of their management regime. Namely, the calculation also includes forests located in protected areas, where (for example, IUCN-classified reserves) forest use activities are prohibited by Georgian legislation. The exceptions are Abkhazia and Tskhinvali regions of Georgia, where the government of Georgia is prevented from exercising the de facto jurisdiction due to the occupation by the Russian Federation, which are not included in the calculation due to the lack of relevant data.

Using the activity data and emission factors required for the greenhouse gas inventory, emissions and absorptions were calculated and worksheets were filled in. Based on the results, the volumes of carbon dioxide emissions and absorptions are given in Table 6-4.

Table 6-4. Results of the greenhouse gas inventory conducted on forest lands (emission/absorption rates)

	Annual increase in carbon stocks in biomass (including belowground biomass) ton C year^{-1}	Carbon losses as a result of roundwood production, ton C year^{-1}	Carbon losses as a result of firewood production, ton C year^{-1}	Carbon losses due to other causes (e.g. fires), ton year^{-1}	Annual reduction in carbon stocks due to biomass loss, ton C year^{-1}	Annual change in carbon stocks in living biomass, thousands of tons C year^{-1}
1990	-2,092,031.3	27,094.8	181,920.5	1.2	209,016.5	-1,883.0
1991	-2,092,031.3	25,742.2	172,837.9	1.1	198,581.2	-1,893.5

1992	-2,092,031.3	21,108.0	141,725.4	NE	162,833.4	-1,929.2
1993	-2,092,031.3	24,993.5	167,813.2	0.2	192,806.9	-1,899.2
1994	-2,092,031.3	25,737.3	172,804.3	2.0	198,543.6	-1,893.5
1995	-2,092,031.3	22,999.9	154,423.5	0.7	177,424.1	-1,914.6
1996	-2,092,031.3	25,281.9	169,746.8	7.2	195,035.9	-1,897.0
1997	-2,092,031.3	18,421.2	123,683.7	0.5	142,105.4	-1,949.9
1998	-2,092,031.3	33,009.0	221,627.3	1.4	254,637.7	-1,837.4
1999	-2,092,031.3	31,092.3	208,759.9	2.0	239,854.2	-1,852.2
2000	-2,092,031.3	33,084.0	222,134.2	5.0	255,223.2	-1,836.8
2001	-2,092,031.3	28,878.5	193,897.2	9.3	222,785.0	-1,869.2
2002	-2,092,031.3	35,515.6	238,458.9	30.9	274,005.4	-1,818.0
2003	-2,092,031.3	40,463.9	271,683.4	2.2	312,149.5	-1,779.9
2004	-2,092,031.3	45,349.4	304,485.6	5.6	349,840.6	-1,742.2
2005	-2,092,031.3	59,557.8	399,882.8	1.1	459,441.7	-1,632.6
2006	-2,092,031.3	40,858.9	274,335.8	12.8	315,207.5	-1,776.8
2007	-2,092,031.3	61,652.3	413,947.6	8.4	475,608.3	-1,616.4
2008	-2,092,031.3	57,251.9	384,399.8	1,080.7	442,732.4	-1,649.3
2009	-2,092,031.3	49,653.8	333,386.5	88.1	383,128.4	-1,708.9
2010	-2,092,031.3	56,723.4	380,853.5	26.7	437,603.6	-1,654.4
2011	-2,092,031.3	41,112.2	276,034.6	1.5	317,148.3	-1,774.9
2012	-2,092,031.3	30,907.7	207,520.6	148.0	238,576.3	-1,853.5
2013	-2,092,031.3	48,240.8	323,897.2	7.5	372,145.5	-1,719.9
2014	-2,092,031.3	48,804.4	327,680.9	17.7	376,503.0	-1,715.5
2015	-2,092,031.3	50,161.9	336,794.9	114.2	387,071.0	-1,705.0
2016	-2,092,031.3	44,776.6	300,638.6	3.1	345,418.3	-1,746.6
2017	-2,092,031.3	45,381.1	304,697.0	530.3	350,608.4	-1,741.4
2018	-2,092,031.3	41,633.4	279,531.0	4.6	321,169.0	-1,770.9
2019	-2,092,031.3	43,080.1	289,247.5	32.2	332,359.8	-1,759.7
2020	-2,089,486.0	34,489.8	231,570.8	12.3	266,072.9	-1,823.4
2021	-2,113,655.8	31,725.1	213,006.8	5.8	244,737.7	-1,868.9
2022	-2,113,655.8	37,306.1	250,483.0	333.0	288,122.1	-1,825.5

Figure 6-2. Trend in net emissions from forest lands

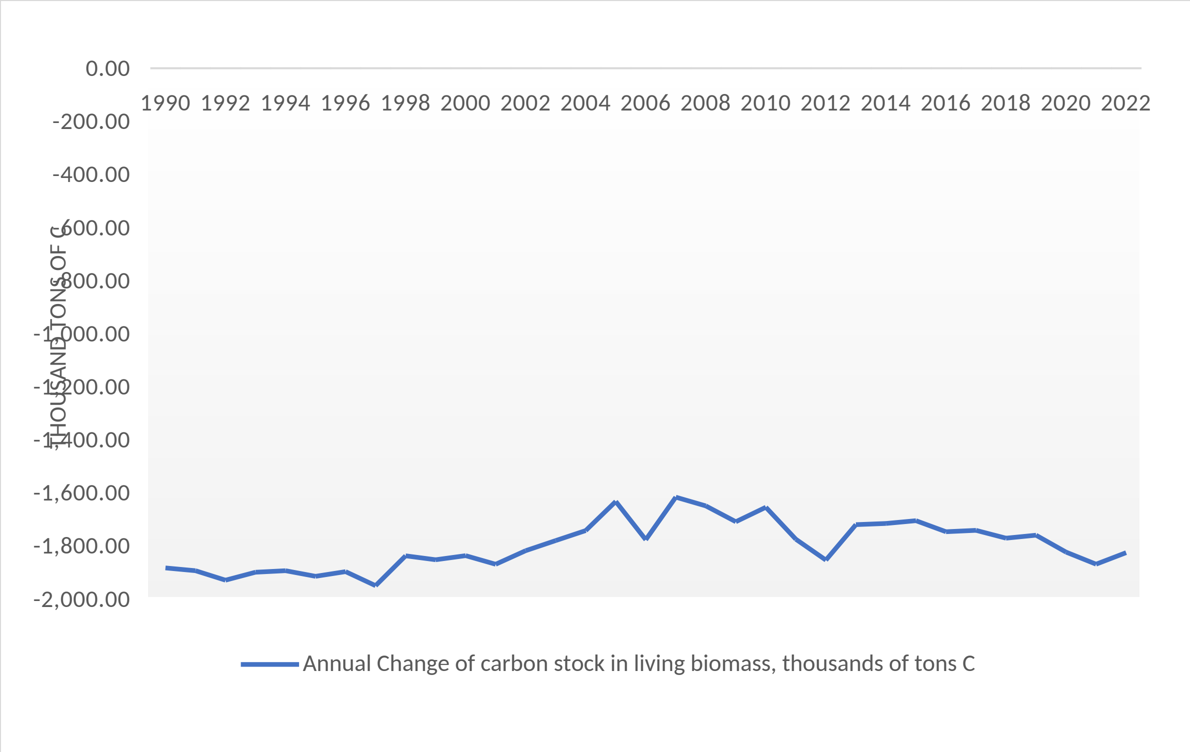


Table 6-5. Emissions of greenhouse gases other than carbon dioxide from forest fires

Year	Greenhouse gas emissions,10^{-3} gg				Year	Greenhouse gas emissions 10^{-3} gg			
	CH_4	CO	N_2O	NO_X		CH_4	CO	N_2O	NO_X
1990	2.01	29.07	0.02	0.16	**2007**	5.18	74.88	0.06	0.4
1991	0.61	8.78	0.01	0.05	**2008**	1.81	26.21	0.02	0.14
1992	NE	NE	NE	NE	**2009**	124.37	1,796.42	1.52	9.67
1993	5.51	79.56	0.07	0.43	**2010**	0.24	3.42	0	0.02
1994	48.37	698.61	0.59	3.76	**2011**	362.17	5,231.36	4.43	28.17
1995	1.42	20.48	0.02	0.11	**2012**	2.01	29.07	0.53	0.16
1996	32.4	468	0.4	2.52	**2013**	30.06	434.19	0.37	2.34
1997	15.31	221.13	0.19	1.19	**2014**	0.28	4.1	0	0.02
1998	31.21	450.74	0.38	2.43	**2015**	12.07	174.4	0.15	0.94
1999	6.76	97.67	0.08	0.53	**2016**	2.01	29.07	0.09	0.16
2000	18.93	273.49	0.23	1.47	**2017**	58.51	845.09	0.72	4.55
2001	2.01	29.07	0.15	0.16	**2018**	2.01	29.07	0.2	0.16
2002	36.88	532.64	0.45	2.87	**2019**	11.15	161.02	0.14	0.87
2003	4.21	60.84	0.05	0.33	**2020**	78.97	1,140.66	0.97	6.14
2004	5.18	74.88	0.06	0.4	**2021**	5.18	74.88	0.06	0.4
2005	1.81	26.21	0.02	0.14	**2022**	1.81	26.21	0.02	0.14
2006	124.37	1,796.42	1.52	9.67					

Methodology

As already noted, the calculations were conducted according to the methodological[72] guidelines of the 2006 IPCC Guidelines. In particular, calculations for forest lands were conducted using the biomass carbon Gain-Loss method.

Gain-Loss method (EQUATION 2.7):

$$\mathbf{\Delta C = \Delta C_G - \Delta C_L}$$

In which:

ΔC = annual change in carbon stocks in biomass (the sum of above-ground and below-ground biomass

terms in Equation 2.3) for each land sub-category, considering the total area, tonnes C yr^{-1};

ΔC_G = annual increase in carbon stocks due to biomass growth for each land sub-category, considering

the total area, tonnes C yr^{-1};

ΔC_L = annual decrease in carbon stocks due to biomass loss for each land sub-category, considering the

total area, tonnes C yr^{-1}

- The calculation of carbon increment to biomass was performed using the second level (EQUATION 2.9):

$$\mathbf{\Delta C_G = A \bullet G_{TOTAL} \bullet CF}$$

$$G_{TOTAL} = I_V \bullet BCEF_I \bullet (1+ R)$$

where:

A - area of land remaining in the same land-use category, ha

G_{TOTAL} - mean annual biomass growth, tonnes d. m. ha^{-1} yr^{-1}

CF- carbon fraction of dry matter, tonne C (tonne d.m.)$^{-1}$

I_V - average net annual increment, m^3 ha^{-1} yr^{-1}

$BCEF_I$ - biomass conversion and expansion factor for conversion of net annual increment in volume to above-ground biomass growth, tonnes above-ground biomass growth (m3 net annual increment)$^{-1}$

R- ratio of below-ground biomass to above-ground biomass, tonne d.m. below-ground biomass (tonne

d.m. above-ground biomass)

- Annual decline in carbon stocks due to biomass losses (EQUATION 2.11; EQUATION 2.12; EQUATION 2.13);

$$\mathbf{>\Delta C_L = L_{wood-removals} + L_{fuelwood} + L_{disturbance}}$$

$L_{wood-removals} = H \bullet BCEF_R \bullet (1+ R) \bullet CF$

$L_{fuelwood} = [\{FG_{trees} \bullet BCEF_R \bullet (1+ R)\} + FG_{part} \bullet D] \bullet CF$

$L_{disturbance} = A_{disturbance} \bullet B_W \bullet (1+R)\ CF \bullet fd$

WHERE:

H- annual wood removals, roundwood, m3 yr^{-1};

$BCEF_R$= biomass conversion and expansion factor for conversion of removals in merchantable volume to total biomass removals, tonnes biomass removal (m3 of removals)$^{-1}$;

R- ratio of below-ground biomass to above-ground biomass, in tonne d.m. below-ground biomass

[72] CHAPTER 2; GENERIC METHODOLOGIES APPLICABLE TO MULTIPLE LANDUSE CATEGORIES; https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_02_Ch2_Generic.pdf

(tonne d.m. above-ground biomass)$^{-1}$; CF- carbon fraction of dry matter, tonne C (tonne d.m.) $^{-1}$;

FG_{trees}- annual volume of fuelwood removal of whole trees, m^3 yr^{-1} ;D- basic wood density, tonnes d.m. m^{-3}

$A_{disturbance}$ – area affected by disturbances, ha yr^{-1};

B_W- average above-ground biomass of land areas affected by disturbances, tonnes d.m. ha^{-1};

Fd- fraction of biomass lost in disturbance;

L_{fire} Calculated using the method for calculating greenhouse gas emissions from forest fires (2006 IPCC GL, v.4, Ch.2, equation 2.27):

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

where:

L_{fire}- Amount of greenhouse gas emissions from the fire, tonnes of each GHG e.g., CH4, N2O, etc;

A - area burned by the fire, ha;

M_B - Mass of fuel available for combustion, tonnes ha^{-1};

C_f - combustion factor, dimensionless;

G_{ef} - Emission factor, g kg^{-1} dry matter burnt.

Considering that the National Forest Inventory (NFI) was conducted for the first time in Georgia and we were able to use the relevant data available to the maximum extent possible, until a repeat National Forest Inventory is conducted, it is impossible to use the carbon stock difference method in the calculations. The inventory of forest lands was conducted using the addition/deduction method, namely, the biomass addition/deduction method was used. Biomass addition data was obtained based on data from the National Forestry Agency, while the reduction data (various cuttings, fires) was obtained from the Statistics Office.

Activity data

Table 6-6 shows the forested areas in Georgia for 1990-2022. To increase the accuracy of the calculations, the calculations were carried out separately for forests in the eastern dry and western humid climate areas of Georgia. Since the data of the National Statistics Office does not provide a distribution of forest area by region, the data on forest distribution by climatic zones was taken from the National Forest Inventory data (Table 6-7).

Table 6-6. Forest areas, thousand hectares

Year	Forest area	Including Abkhazia region, Georgia	Tskhinvali region, Georgia	Other forests under state management (National Forestry Agency; Protected Areas; Adjara Forestry Agency, etc.)
1990	2,988.4[1]	508.8[1]	99.3[1]	2,380.3[1]
1991	2,988.4	508.8	99.3	2,380.3
1992	2,988.4	508.8	99.3	2,380.3
1993	2,988.4	508.8	99.3	2,380.3
1994	2,988.4	508.8	99.3	2,380.3
1995	2,988.4	508.8	99.3	2,380.3
1996	2,988.4	508.8	99.3	2,380.3

1997	2,988.4	508.8	99.3	2,380.3
1998	2,988.4	508.8	99.3	2,380.3
1999	2,988.4	508.8	99.3	2,380.3
2000	2,988.4	508.8	99.3	2,380.3
2001	2,988.4	508.8	99.3	2,380.3
2002	2,988.4	508.8	99.3	2,380.3
2003	2,988.4	508.8	99.3	2,380.3
2004	2,988.4	508.8	99.3	2,380.3
2005	2,988.4	508.8	99.3	2,380.3
2006	2,988.4	508.8	99.3	2,380.3
2007	2,988.4	508.8	99.3	2,380.3
2008	2,988.4	508.8	99.3	2,380.3
2009	2,988.4	508.8	148.0	2,331.6
2010	2,988.4	508.8	148.0	2,331.6
2011	2,988.4	508.8	148.0	2,331.6
2012	2,988.4	508.8	148.0	2,331.6
2013	2,988.4	508.8	148.0	2,331.6
2014	2,988.4	508.8	148.0	2,331.6
2015	2,988.4	508.8	148.0	2,331.6
2016	2,988.4	508.8	148.0	2,331.6
2017	2,988.4	508.8	148.0	2,331.6
2018	2,988.4	508.8	148.0	2,331.6
2019	2,988.4	508.8	148.0	2,331.6
2020	2,988.4	508.8	148.0	2,331.6
2021	3,100.5[2]	547.6[2]	148.0[2]	2,404.9[2]
2022	3,100.5	547.6	148.0	2,404.9

[1]Natural Resources and Environmental Protection of Georgia, Statistical Collection; https://www.geostat.ge/ka/single-categories/109/sakartvelos-bunebrivi-resursebi-da-garemos-datsva
[2]National Forest Inventory https://mepa.gov.ge/Ge/Page/NFI

As already mentioned, the annual stability of forest area is determined by the fact that clear-cutting is not carried out in Georgia in most cases and, therefore, after various types of fellings allowed in the country (mainly maintenance fellings), the felled area is not freed from forest cover. All forest lands in the country are managed and as a result, all forested areas are included in the calculations.

Table 6-7. Managed forests (National Forestry Agency, Protected Areas, Adjara Forestry Agency), thousand hectares

Year	Total forest areas	Western Georgia (relatively humid climate)	Eastern Georgia (relatively dry climate)
1990	2,380.3	1,428.18	952.1
1991	2,380.3	1,428.18	952.1
1992	2,380.3	1,428.18	952.1
1993	2,380.3	1,428.18	952.1
1994	2,380.3	1,428.18	952.1
1995	2,380.3	1,428.18	952.1

1996	2,380.3	1,428.18	952.1
1997	2,380.3	1,428.18	952.1
1998	2,380.3	1,428.18	952.1
1999	2,380.3	1,428.18	952.1
2000	2,380.3	1,428.18	952.1
2001	2,380.3	1,428.18	952.1
2002	2,380.3	1,428.18	952.1
2003	2,380.3	1,428.18	952.1
2004	2,380.3	1,428.18	952.1
2005	2,380.3	1,428.18	952.1
2006	2,380.3	1,428.18	952.1
2007	2,380.3	1,428.18	952.1
2008	2,380.3	1,428.18	952.1
2009	2,331.6	1,398.96	932.6
2010	2,331.6	1,398.96	932.6
2011	2,331.6	1,398.96	932.6
2012	2,331.6	1,398.96	932.6
2013	2,331.6	1,398.96	932.6
2014	2,331.6	1,398.96	932.6
2015	2,331.6	1,398.96	932.6
2016	2,331.6	1,398.96	932.6
2017	2,331.6	1,398.96	932.6
2018	2,331.6	1,398.96	932.6
2019	2,331.6	1,398.96	932.6
2020	2,331.6	1,398.96	932.6
2021	2,404.9	1,442.94	962.0
2022	2,404.9	1,442.94	962.0

Data on timber resources obtained from forest cutting in Georgia for 1990-2022 are obtained from annual publications published by the National Statistics office of Georgia (Table 6-8). It is worth noting that only indicators of timber resources obtained from legal and illegal cutting are available in statistical collections; it is impossible to separately identify roundwood and firewood timber required for calculations. Only in the felling data received from the National Forestry Agency (only data for 2011-2022 is available) is it possible to identify timber separately in this way. Timber produced in forests managed by the National Forestry Agency accounts for the largest share (80%) of the total felling rate in Georgia. Therefore, with the help of the agency's data, the percentage of roundwood and firewood in the fellings was determined, separately for conifers and deciduous trees.

Table 6-8. Volumes of timber produced by conifers and deciduous trees

	roundwood	Including coniferous	Deciduous	Firewood	Including coniferous	Deciduous
1990	55,626.0	48,617.0	7,009.0	341,704.0	54,673.0	287,031.0
1991	52,849.0	46,190.0	6,659.0	324,644.0	51,943.0	272,701.0
1992	43,336.0	37,875.0	5,460.0	266,205.0	42,593.0	223,612.0
1993	51,313.0	44,847.0	6,465.0	315,205.0	50,433.0	264,773.0
1994	52,839.0	46,181.0	6,658.0	324,581.0	51,933.0	272,648.0
1995	47,218.0	41,269.0	5,950.0	290,056.0	46,409.0	243,647.0
1996	51,904.0	45,364.0	6,540.0	318,838.0	51,014.0	267,824.0
1997	37,819.0	33,054.0	4,765.0	232,317.0	37,171.0	195,146.0
1998	67,767.0	59,229.0	8,539.0	416,286.0	66,606.0	349,680.0
1999	63,833.0	55,790.0	8,043.0	392,116.0	62,739.0	329,378.0

2000	67,923.0	59,364.0	8,558.0	417,238.0	66,758.0	350,480.0
2001	59,288.0	51,818.0	7,470.0	364,200.0	58272.0	305,928.0
2002	72,914.0	63,727.0	9,187.0	447,901.0	71,664.0	376,237.0
2003	83,073.0	72,606.0	10,467.0	510,308.0	81,649.0	428,658.0
2004	93,103.0	81,372.0	11,731.0	571,920.0	91,507.0	480,413.0
2005	122,273.0	106,867.0	15,406.0	751,106.0	120,177.0	630,929.0
2006	83,884.0	73,315.0	10,569.0	515,289.0	82,446.0	432,843.0
2007	126,574.0	110,625.0	15,948.0	777,524.0	124,404.0	653,120.0
2008	117,539.0	102,729.0	14,810.0	722,023.0	115,524.0	606,500.0
2009	101,940.0	89,096.0	12,844.0	626,205.0	100,193.0	526,012.0
2010	116,454.0	101,781.0	14,673.0	715,363.0	114,458.0	600,905.0
2011	87,456.0	76,436.0	11,019.0	537,229.0	85,957.0	451,272.0
2012	67,764.0	59,226.0	8,538.0	416,268.0	66,603.0	349,665.0
2013	102,675.0	89,738.0	12,937.0	630,720.0	100,915.0	529,805.0
2014	100,196.0	87,571.0	12,625.0	615,488.0	98,478.0	517,010.0
2015	102,983.0	90,007.0	12,976.0	632,607.0	101,217.0	531,390.0
2016	92,104.0	80,499.0	11,605.0	565,781.0	90,525.0	475,256.0
2017	93,527.0	81,743.0	11,784.0	574,525.0	91,924.0	482,601.0
2018	86,886.0	75,939.0	10,948.0	533,730.0	85,397.0	448,333.0
2019	90,149.0	78,791.0	11,359.0	553,775.0	88,604.0	465,171.0
2020	75,604.0	66,078.0	9,526.0	464,425.0	74,308.0	390,117.0
2021	70,843.0	61,917.0	8,926.0	435,178.0	69,628.0	365,550.0
2022	82,323.0	71,950.0	10,373.0	505,696.0	80,911.0	424,785.0

Is this all the action data that the formula needs to calculate? It would be better if you listed the action data at the beginning of this paragraph. For example, don't we have the composition of forests? Do we only divide them into deciduous and coniferous?

Emission factors

As for the emission factor indicators used in the equations, mainly second-level calculations have been performed and, accordingly, the relevant data from the National Forest Inventory have been used to obtain the indicators. The tables below provide emission factor indicators, indicating the source of their receipt.

Table 6-9. Emission factor indices and sources of receipt used in the equations

Emission coefficients	The indicator used in the calculations	Source of receipt
CF- carbon content in dry mass, ton C (ton d.m.) $^{-1}$	0.47	IPCC 2006, FOREST LAND, (Table 4.3)
I_V - Average annual increment, m3 /ha/year	Western Georgia - 2.1 Eastern Georgia 1.7	LEPL National Forestry Agency, see Appendix, Table 2
$BCEF_I$	0.58	National Forest Inventory of Georgia, by species dominated in forest and IPCC 2006, Vol. 4 FOREST LAND, (Table 4.5) See Appendix, Table 3

$BCEF_R$	0.91	National Forest Inventory of Georgia, by species domkinated in forest and IPCC 2006, Vol. 4 FOREST LAND, (Table 4.5) See Appendix, Table 4
R- The ratio of the mass of tree roots (belowground biomass) to the sprout (aboveground biomass)	0.25	National Forest Inventory of Georgia, by species dominated in the forest and IPCC 2006, Vol. 4 FOREST LAND, (Table 4.4) See Appendix, Table 5

Table 6-10. Forest fires recorded in Georgia, 1990-2022

	Number of cases	Fire-ravaged areas, ha	Damage caused
1990	1	14.2	1,856.0 USD
1991	1	10.0	131.0 USD
1992	Not recorded		
1993	7	34.0	3.5 USD
1994	10	341.2	285.1 USD
1995	1	7.0	260.5 USD
1996	7	200.0	15,066.9 USD
1997	11	108.0	8,498.0 USD
1998	31	308.2	17,327.0 USD
1999	13	37.1	7,325.5 USD
2000	34	85.0	11,326 .0 USD
2001	28	148.0	20,900.0 USD
2002	36	607.0	23,000.0 USD
2003	5	52.0	1,200.0 USD
2004	21	32.0	20,600.0 USD
2005		26.0	1,000.0 USD
2006		93.0	35,000.0 USD
2007	6	3.9	Windfallen timber were burnt in the forest, eastern Georgia.
2008	31	1,277.5	950.9 hectares of forest burned in Borjomi, the rest is fallen timber in various locations
2009	7	717.4	0.5 ha burned 27.0 cubic meters in Borjomi, the rest were low fires.
2010	21	371.0	Low fires
2011	7	7	Low fires
2012	12	198.8	94.0 ha of pine forest was damaged, the rest of the windfallen was burned.
2013	35	87.6	1.3 hectares of pine forest burned, the rest of the windfallen was burned.
2014	66	722.3	16.1 ha of pine forest burned, the rest of the windfallen was burned.
2015	72	205.4	Mixed forest was damaged on 122.2 ha, the rest was windfallen timber
2016	42	183.5	Low fires
2017	55	1,299.9	464.7 hectares were burned and trees and plants were damaged, the rest were low fires.

2018	12	34.2	Trees and plants were damaged on 15.3 hectares, and the undergrowth was destroyed. The rest were low fires
2019	92	860.9	70.0 ha of forest burned in Eastern Georgia, 4.8 ha of acacia in Western Georgia, the rest were low fires
2020	118	834.6	11.0 ha of forest burned in the west, 42.0 ha burned in the east, the rest were low fires
2021	44	470.8	Low fires
2022	48	940.1	304.0ha burned, the rest were low fires.

Calculations in the subcategory Land converted to forest land (also 3B1b) (Cropland converted to forest land (also 3B1bi); Grassland converted to forest land (also 3B1bii); Wetlands converted to forest land (also 3B1biii); Settlements converted to forest land (also 3B1biv); Other lands converted to forest land (also 3B1bv)) were not performed due to the lack of relevant statistical or other data.

6.3. Cropland (LULUCF 3B2)

6.3.1. *Preserved Cropland (LULUCF 3B2a)*

Source category description and calculated emissions

The category of cropland includes all agricultural lands (including areas covered with perennial crops), as well as all fallow lands on which no work is temporarily being carried out.

Perennial plantations include orchards, vineyards, and various types of plantations. The category of cropland also includes lands on which annual crops are grown for the purpose of their subsequent use as pastures.

The amount of carbon stored in cropland depends on the species grown, management practices, and climatic conditions. Annual crops (cereals, vegetables) are harvested annually, so there is no long-term carbon storage in aboveground biomass. In the case of perennial crops (in orchards, vineyards, etc.), carbon accumulation occurs annually, which allows for the creation of long-term carbon stocks.

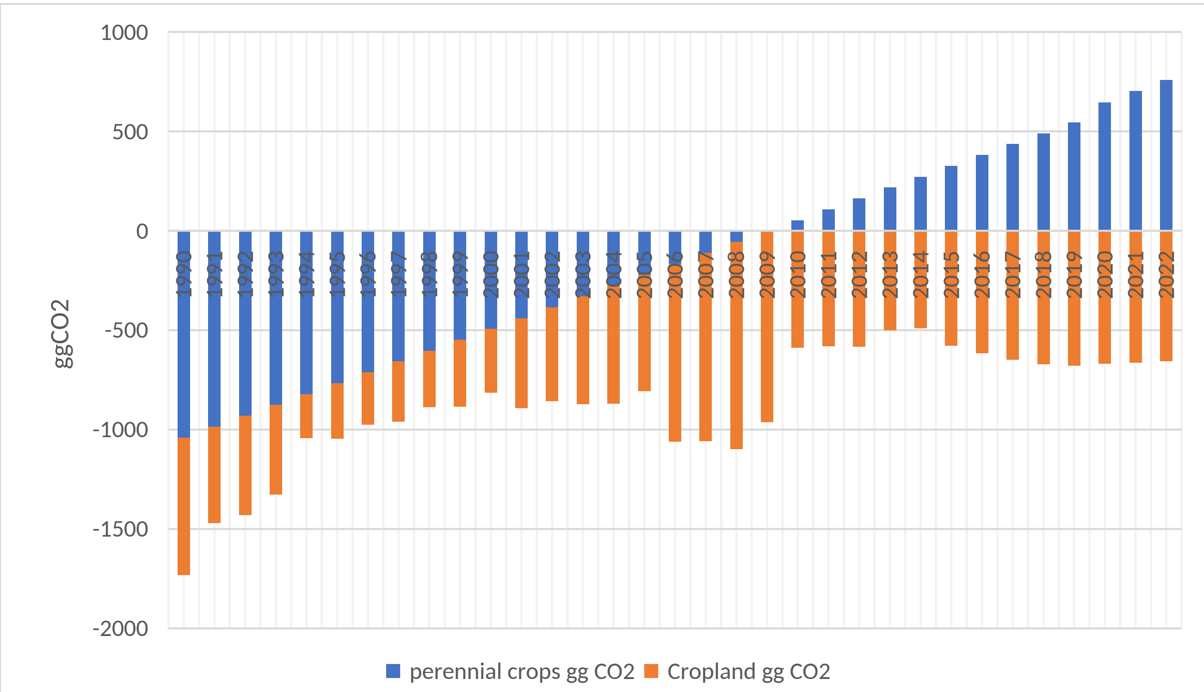
As for changes in carbon stocks in soils, it depends on land management practices, namely soil tillage, drainage, and the use of organic and mineral fertilizers.

Table 6-11. Results of greenhouse gas inventory on Cropland, including areas covered with perennial crops (1990-2022)

Year	Cropland					
	Perennial plants		Cropland		Net accumulation	
	Thousand ton C	gg CO_2	Thousand ton C	gg CO_2	Thousand ton C	gg CO_2
1990	283.9	-1,041.0	187.9	-688.9	471.8	-1,729.9
1991	269.0	-986.3	131.8	-483.3	400.8	-1,469.6
1992	254.1	-931.7	136.0	-498.7	390.1	-1,430.4
1993	239.2	-877.1	122.7	-449.9	361.9	-1,327.0
1994	224.3	-822.4	60.2	-220.7	284.5	-1,043.1
1995	209.4	-767.8	75.6	-277.2	285.0	-1,045.0
1996	194.5	-713.2	71.4	-261.8	265.9	-975.0
1997	179.6	-658.5	82.3	-301.8	261.9	-960.3
1998	164.6	-603.5	76.8	-281.6	241.4	-885.1

1999	149.7	-548.9	91.8	-336.6	241.5	-885.5
2000	134.8	-494.3	87.6	-321.2	222.4	-815.5
2001	119.9	-439.6	123.1	-451.4	243.0	-891.0
2002	105.0	-385.0	128.4	-470.8	233.4	-855.8
2003	90.1	-330.4	148.0	-542.7	238.1	-873.1
2004	75.2	-275.7	162.3	-595.1	237.5	-870.8
2005	60.3	-221.1	159.4	-584.5	219.7	-805.6
2006	45.4	-166.5	243.4	-892.5	288.8	-1,059.0
2007	30.5	-111.8	258.3	-947.1	288.8	-1,058.9
2008	15.5	-56.8	284.3	-1042.4	299.8	-1,099.2
2009	0.6	-2.2	261.6	-959.2	262.2	-961.4
2010	-14.3	52.4	160.4	-588.1	146.1	-535.7
2011	-29.2	107.1	157.9	-579.0	128.7	-471.9
2012	-44.1	161.7	159.1	-583.4	115.0	-421.7
2013	-59.0	216.3	136.1	-499.0	77.1	-282.7
2014	-73.9	271.0	133.5	-489.5	59.6	-218.5
2015	-88.8	325.6	157.3	-576.8	68.5	-251.2
2016	-103.7	380.2	168.0	-616.0	64.3	-235.8
2017	-118.7	435.2	176.8	-648.3	58.1	-213.1
2018	-133.6	489.9	182.8	-670.3	49.2	-180.4
2019	-148.5	544.5	184.6	-676.9	36.1	-132.4
2020	-176.0	645.3	181.9	-667.0	5.9	-21.7
2021	-191.3	701.4	180.7	-662.6	-10.6	38.8
2022	-206.6	757.5	178.9	-656.0	-27.7	101.5

Figure 6-3. Greenhouse gas emissions trend in cropland, including areas covered with perennial crops



Methodology

The equation below forms the basis[73] for calculating carbon stocks and emissions for cropland that does not change category and remains in the same category (3B2a):

[73] Good Practice Guidance for Land Use, Land-Use Change and Forestry, Chapter 3, Cropland, EQUATION 3.3.1. http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

$$\Delta C_{CC} = \Delta C_{CC_{LB}} + \Delta C_{CC_{soils}},$$

where:

ΔCCC is the change in carbon stocks on cropland remaining in the same category), ton C/year;

Δ CCCLB - Change in carbon stocks in biomass, ton C/year;

Δ CCCsoils Change in soil carbon stocks, ton C/year.

According to the methodology, the cropland sector includes areas covered by perennial crops, for which changes in carbon stocks in biomass are mainly calculated. Carbon is stored in the biomass of perennial crops, such as orchards, tea plantations, etc. As for annual crops, since the area is completely freed from biomass when they are harvested, it is assumed that carbon accumulation does not occur in the long term and, therefore, calculations are not performed for them.

The changes in carbon stocks in the biomass of perennial crops are calculated using the methodology for the forestry sector, namely the equation for calculating changes in carbon stocks in forest biomass from the subsector "Forest land, maintained as forest land" (3B1a). It should be noted that according to the methodology, unlike forest land (3B1), calculations in perennial crops are made only for above-ground biomass (no calculations are made for below-ground biomass).

For perennial crops (orchards), calculations were performed according to the first level, using coefficients given in the IPCC 2006 methodology, adapted to the climatic zones of Georgia. The calculation was performed using the following method: the annual increase in biomass on areas covered by perennial crops is subtracted from the annual decrease in biomass caused by the annual reduction in the area of crops.

As for calculating carbon accumulation in soil, it is carried out for both mineral and organic soils.

According to the methodology, soil carbon stocks are measured at a standard depth of 30 cm, which excludes the underlying bulk (dead organic matter) and inorganic matter (carbonate minerals). According to Level 1 and 2 calculations, there are no changes in the carbon stocks in dead organic and inorganic matter, and calculations are not performed for them.

As already mentioned, arable lands have no surface carbon stocks (they are incorporated into the soil as a result of cultivation) or are represented in insignificant volumes. The volumes of change in soil carbon stocks are calculated using the following formula[6]:

$$\Delta C_{CC_{soils}} = \Delta C_{CC_{mineral}} \cdot \Delta C_{CC_{organic}}$$

Where:

$\Delta C_{CC_{soils}}$ - Annual change in carbon stock in soils, tonnes C yr^{-1};

$\Delta C_{CC_{mineral}}$ - Annual change in carbon stock in mineral soils, tonnes C yr^{-1};

$\Delta C_{CC_{organic}}$ - Annual loss of carbon from drained organic soils, tonnes C yr^{-1}

Mineral soils

The calculation methodology for mineral soils is based on determining changes in soil carbon stocks over a specified period as a result of changes in soil cultivation methods:

$$\Delta C_{CC_{Mineral}} = [(SOC_0 - SOC_{(0-T)})] / D,$$

$$SOC = SOC_{REF} \bullet F_{LU} \bullet F_{MG} \bullet F_I \bullet A$$

where:

$\Delta C_{CC_{mineral}}$ = annual change in carbon stocks in mineral soils, tonnes C yr^{-1}

SOC_0- soil organic carbon stock in the last year of an inventory time period, tonnes C

$SOC_{(0-T)}$ - soil organic carbon stock at the beginning of the inventory time period, tonnes C

D- Time dependence of stock change factors which is the default time period for transition between

equilibrium SOC values, yr. Commonly 20 years.;

A - Land area, ha;

SOC_{REF}- the reference carbon stock, tonnes C ha^{-1} ;

F_{LU} - stock change factor for land-use systems or sub-system for a particular land-use, dimensionless FMG - stock change factor for management regime, dimensionless; FI - stock change factor for input of organic matter, dimensionless.

Activity Data

The areas occupied by Cropland (including perennial crops) in Georgia for the period 1990-2022 are given in the table below.

Table 6-12. Cropland (including perennial crops), thousand hectares

	Cropland, Total,	Covered with perennial plants	Cropland		
			Total	Cultivated lands	Uncultivated, fallow lands
1990	1,129.3	348.2[1]	781.1[2]	701.9[2]	79.2[2]
1991	1,123.3	341.1	782.2	453.1	329.1
1992	1,117.3	334.0	783.3	452.8	330.5
1993	1,111.3	326.9	784.4	597.5	186.9
1994	1,105.3	319.8	785.5	616.1	169.4
1995	1,099.4	312.7	786.7	594.7	192.0
1996	1,093.4	305.6	787.8	610.8	177.0
1997	1,087.4	298.5	788.9	597.5	191.4
1998	1,081.4	291.4	790.0	616.1	173.9
1999	1,075.4	284.3	791.1	594.7	196.4
2000	1,069.4	277.2	792.2	610.8	181.4
2001	1,065.5	270.1	795.4	564.5	230.9
2002	1,061.6	263.0	798.6	577.0	221.6
2003	1,057.7	255.9	801.8	561.7	240.1
2004	1,050.6	248.8	801.8	534.0	267.8
2005	1,043.5	241.7	801.8	539.6	262.2
2006	1,036.4	234.6	801.8	330.2	471.6
2007	1,029.3	227.5	801.8	297.2	504.6
2008	1,022.2	220.4	801.8	239.3	562.5
2009	1,015.1	213.3	801.8	289.7	512.1
2010	1,008.0	206.2	801.8	256.7	545.1
2011	1,000.9	199.1	801.8	262.4	539.4

2012	993.8	192.0	801.8	259.6	542.2
2013	986.7	184.9	801.8	310.7	491.1
2014	979.6	177.8	801.8	316.6	485.2
2015	972.5	170.7	801.8	263.7	538.1
2016	965.4	163.6	801.8	240.0	561.8
2017	958.3	156.5	801.8	220.3	581.5
2018	951.2	149.4	801.8	207.1	594.7
2019	944.1	142.3	801.8	203.0	598.8
2020	937.0	135.2	801.8	209.0	592.8
2021	929.7	127.9	801.8	211.8	590.0
2022	922.4	120.6	801.8	215.7	586.1
Data source: [1]FAOSTAT (Food and agriculture data); [2]From 1990 to 2022: Environmental Protection and Natural Resources of Georgia (Statistical Collections)					

The data on perennial crops in the table are taken from the relevant FAOSTAT tables. Statistical data for 1990-2022 are not fully available; in particular, data for 1990, 1991 and 2021 are not available, and there is also a sharp difference between annual indicators. Nevertheless, a linear decreasing trend is observed over the years. Therefore, the initial (1992) and final (2021) indicators were taken and interpolation and extrapolation were performed using the following formula:

$$y(x)=b+(x-a)*(d-b)/(c-a).$$

The remaining data in the table (Cropland, including Cultivated lands and Uncultivated, fallow lands) are obtained according to statistical collections published by the National Statistics Service of Georgia.

Emission factors

To calculate the change in carbon stock in perennial crops (plantations, orchards, etc.), due to the lack of emission factor indicators for this subcategory in Georgia, data for the temperate climate zone were taken from the IPCC methodological guidelines (TABLE 5.1 DEFAULT COEFFICIENTS FOR ABOVE-GROUND WOODY BIOMASS AND HARVEST CYCLES IN CROPPING SYSTEMS CONTAINING PERENNIAL SPECIES). In particular, the volume of carbon accumulation in the aboveground biomass of plants is 2.1 tC/ha per year, while 63 t of carbon is accumulated in 1 ha of perennial plants (according to the methodology, this value is acceptable for both moderately warm humid and dry climates). Losses are calculated based on the annual decrease in the area covered by vegetation (die or felling of vegetation). In this case, it is assumed that the previously existing carbon stocks in the liberated areas have been completely released into the atmosphere. The carbon gain in perennial vegetation (1 ha = 2.1 tC/year) is subtracted from the carbon losses (1 ha = 63 tC), which are caused by the decrease in area.

The reference carbon stock index for agricultural lands in Georgia was obtained from the LEPL Agricultural Research Center under the Ministry of Environmental Protection and Agriculture. According to the data obtained, the grasslands of Western Georgia - 77.8 tCha; grasslands of Eastern Georgia - 81.1 tCha; croplands of Western Georgia - 82.8 tCha; croplands of Eastern Georgia - 81.2 tCha (see Appendix Fig. 1). Since the statistical indicators of arable land are not divided into western and eastern Georgia, to obtain a single average number, the data from the Georgian Household Census by the National Statistical Service were used and a single weighted indicator was calculated (see Appendix, Figure 1 and Table 6), which is equal to 79 tC/ha.

The calculations for the cultivated soils in the subsector were carried out using the following method: at the initial stage, tillage lands on mineral soils for annual crops until 2006, average carbon supply, with deep tillage (SOC_{REF} =79; F_{LU} =0.80; F_{MG}=1; F_I =1). For subsequent years, tillage lands for annual crops, average carbon supply, with shallow tillage (SOC_{REF} =79; F_{LU} =0.80; F_{MG}=1.02; F_I =1). For fallow lands, the corresponding coefficient is used - F_{LU} =0.93.

Calculations in the subcategories: land converted to cropland (also 3B2b); forest land converted to cropland (also 3B2bi); grasslands converted to cropland (also 3B2bii); wetlands converted to cropland (also 3B2biii); settlements converted to cropland (also 3B2biv); other land converted to cropland (also 3B2bv) were not performed due to the lack of relevant statistical or other data.

6.4. Grassland (LULUCF 3B3)

6.4.1. *Preserved grasslands (LULUCF 3B3a)*

Source category description and calculated emissions

According to the IPCC methodology, grasslands include both pastures and hayfields. The pasture management regime involves the intensity of cattle grazing on the areas, the application of fertilizers to the area, the irrigation of pastures, and other agricultural measures. Pastures can also be used as hay, which completely changes the pasture management system. Pastures are negatively affected by unsystematic grazing, fires and soil erosion, which is reflected in the decrease in carbon stocks. In the case when the scale of the negative impact is large and carbon accumulation does not occur, pastures are a source of emissions.

Carbon stocks in pastures are affected by human activities and natural events. Annual biomass accumulation in pastures can reach large volumes, but as a result of rapid runoff (grazing, mowing, fires, etc.), the above-ground biomass stock per 1 ha of area usually does not exceed a few tons.

The calculations were carried out at the first level. In this case, the methodology stipulates that the calculations are carried out only on carbon stocks in the soil. Taking this into account, the calculation was carried out similarly, according to the equation given for croplands, only the coefficients were taken from the table for grassland:

Table 6-13. Emission rates in grasslands (mineral soils)

Grassland (pastures and hay meadows)		
	Thousand ton C	**gg CO_2**
1990	-119.7	438.9
1991	-222.6	816.2
1992	-222.6	816.2
1993	-222.6	816.2
1994	-222.6	816.2
1995	-222.6	816.2
1996	-222.6	816.2
1997	-222.6	816.2
1998	-217.1	796.0
1999	-217.1	796.0
2000	-217.1	796.0
2001	-217.1	796.0

2002	-217.1	796.0
2003	-217.1	796.0
2004	-208.7	765.2
2005	-208.7	765.2
2006	-208.7	765.2
2007	-208.7	765.2
2008	-208.7	765.2
2009	-208.7	765.2
2010	-208.7	765.2
2011	-208.7	765.2
2012	-208.7	765.2
2013	-208.7	765.2
2014	-208.7	765.2
2015	-208.7	765.2
2016	-208.7	765.2
2017	-208.7	765.2
2018	-208.7	765.2
2019	-208.7	765.2
2020	-208.7	765.2
2021	-208.7	765.2
2022	-208.7	765.2

Methodology

As mentioned, the methodology for conducting a cadastre on meadows is similar to the methodology defined for arable lands. As already mentioned, arable lands do not have surface carbon stocks (they are incorporated into the soil as a result of cultivation) or are represented in insignificant volumes. The volumes of change in carbon stocks in the soil are calculated by the following formula:

$$\Delta C_{CC}soils = \Delta C_{CC}mineral. \Delta C_{CC}organic. \Delta C_{CC}lime$$

Mineral Soils

The calculation methodology for mineral soils is based on determining changes in soil carbon stocks over a specified period as a result of changes in soil cultivation methods:

$$\Delta C_{CC_{Mineral}} = [(SOC_{O} - SOC_{(O-T)})] / D,$$

$SOC = SOC_{REF} \bullet F_{LU} \bullet F_{MG} \bullet F_{I} \bullet A$

Where

$\Delta C_{CC_{mineral}}$= annual change in carbon stocks in mineral soils, tonnes C yr-1;

SOC_{O}- soil organic carbon stock in the last year of an inventory time period, tonnes C;

$SOC_{(O-T)}$ - soil organic carbon stock at the beginning of the inventory time period, tonnes C;

D- Time dependence of stock change factors which is the default time period for transition between

equilibrium SOC values, yr. Commonly 20 years;

A - land area, ha;

SOC_{REF}- the reference carbon stock, tonnes C ha^{-1} ;

F_{LU} - stock change factor for land-use systems or sub-system for a particular land-use, dimensionless ;

F_{MG} - stock change factor for management regime, dimensionless ;

F_I - stock change factor for input of organic matter, dimensionless.

Activity Data

Since there are two different management regimes in grasslands, namely pastures and hayfields, the carbon stocks in soils for pastures and hayfields were calculated separately. Accordingly, the areas of both were identified separately (see Table 6-14):

Table 6-14. Area of grassland, by hay meadows and pastures.

	Grassland, thousand hectares	Hay meadows, thousand hectares	Pasture, thousand hectares
1990[1]	1,923.5[1]	148.6[1]	1,774.9[1]
1991	1,923.5	148.6	1,774.9
1992	1,923.5	148.6	1,774.9
1993	1,923.5	148.6	1,774.9
1994	1,923.5	148.6	1,774.9
1995	1,923.5	148.6	1,774.9
1996	1,923.5	148.6	1,774.9
1997	1,923.5	148.6	1,774.9
1998[2]	1,938.0[2]	142.3[2]	1,795.7[2]
1999	1,938.0	142.3	1,795.7
2000	1,938.0	142.3	1,795.7
2001	1,938.0	142.3	1,795.7
2002	1,940.4	143.8	1,796.6
2003	1,940.4	143.8	1,796.6
2004	1,940.4	143.8	1,796.6
2005[3]	1,940.4[3]	143.8[3]	1,796.6[3]
2006	1,940.4	143.8	1,796.6
2007	1,940.4	143.8	1,796.6
2008	1,940.4	143.8	1,796.6
2009	1,940.4	143.8	1,796.6
2010	1,940.4	143.8	1,796.6
2011	1,940.4	143.8	1,796.6
2012	1,940.4	143.8	1,796.6
2013	1,940.4	143.8	1,796.6
2014	1,940.4	143.8	1,796.6
2015	1,940.4	143.8	1,796.6
2016	1,940.4	143.8	1,796.6
2017	1,940.4	143.8	1,796.6
2018	1,940.4	143.8	1,796.6
2019	1,940.4	143.8	1,796.6
2020	1,940.4	143.8	1,796.6
2021	1,940.4	143.8	1,796.6
2022	1,940.4	143.8	1,796.6
Data source: [1]1990-From 1997 to 1999: Environmental Protection and Natural Resources of Georgia (Statistical Collections), Tbilisi, 1997; [2]From 1998 to 2004: Natural Resources and Environmental Protection of Georgia, Statistical Collection, Tbilisi, 2005; [3]From 2005 to 2022: FAOSTAT (Food and agriculture data).			

Emission Factor

As already mentioned, the reference carbon stock index for agricultural meadows in Georgia was obtained from the Agricultural Research Center of the Ministry of Environmental Protection and Agriculture. According to the data obtained, for grasslands in Western Georgia

- 77.8 tC/ha; grasslands in Eastern Georgia - 81.1 tC/ha; since the statistical indicators of grasslands are not divided into Western and Eastern Georgia, therefore, to obtain a single average number, the data from the National Statistics Service of Georgia's household census were used and a single weighted index was calculated (see Appendix Figure 1 and Table 6), which is equal to 81 tC/ha.

Since significant degradation of pastures is observed in Georgia, a coefficient corresponding to severe degradation was adopted for the pasture management regime (FMG).

Hayfields, compared to pastures, experience less degradation and are therefore stable. Accordingly, other (less degradation) coefficients were taken for them.

In particular, during the cadastre of pastures, the following was taken:

$SOC_O = 81$; $F_{LU} = 1$; $F_{MG} = 0.95$; $F_I = 1$;

During the cadastre of the meadows, the following was taken:

$SOC_O = 81$; $F_{LU} = 1$; $F_{MG} = 1$; $F_I = 1$.

Calculations in the subcategories: land converted to grassland (also 3B3b); forest land converted to grassland (also 3B3bi); cropland converted to grassland (also 3B3bii); wetlands converted to grassland (also 3B3biii); settlements converted to grassland (also 3B3biv); other land converted to grassland (also 3B3bv) were not performed due to the lack of relevant statistical or other data.

6.5. Wetlands (LULUCF 3B4)

6.5.1. *Preserved wetlands (LULUCF 3B4a)*

Wetlands include areas that are covered or substantially saturated with water throughout the year. They also do not fall into the subsectors of forest land, grassland, rangeland, or settlements.

The methodology divides this subsector into “excess areas left in the same category” and “areas of other categories converted into wetlands.” Calculations were conducted to account for emissions from peat production on wetlands.

The majority of peatlands in Georgia belong to the lowland type (89.9%) and some to the transitional and mixed type (10.1%). There are 46 known peat deposits in Georgia, the total area of which exceeds 17 thousand hectares, and the reserves amount to 826 114 thousand cubic meters[74]. 67% of peat deposits are located on the Colchis Lowland along the Black Sea.

It is important to note that since 1997, the Sphagnum peatlands of Kolkheti have been protected by the Ramsar Convention. Approximately 60% of Georgia's peatlands are located and protected in the Kolkheti National Park. Moreover, the most important, unique and rare, the world's largest and oldest "Imnatis" peatland, one of the two percolation peatlands in the world (the first is the Kobuleti State Reserve - Ispani2) fed solely by atmospheric precipitation based on hydrogenetics, is located in the Kolkheti National Park, which is actually the main argument for the creation of the national park. Due to this uniqueness, Kolkheti occupies a special place on the world's peatland map.

[74] Irakli Mikadze, Assessment of Georgia's Peat Resources, 2016.

Table 6-15. Emissions from and outside peatlands

Year	Peat deposit, ha	Emissions generated during extraction, tC	Peat extracted from the deposit, tons of peat	Emissions generated outside the mine, TC	Total emissions, thousand tons of C	Emission, GgCO2 eq.
1990	1.93	2.12	10,757.00	4,302.80	4.30	15.77
1991	1.93	2.12	10,757.00	4,302.80	4.30	15.77
1992	1.93	2.12	10,757.00	4,302.80	4.30	15.77
1993	1.93	2.12	10,757.00	4,302.80	4.30	15.77
1994	1.93	2.12	10,757.00	4,302.80	4.30	15.77
1995	1.93	2.12	10,757.00	4,302.80	4.30	15.77
1996	1.93	2.12	10,757.00	4,302.80	4.30	15.77
1997	1.93	2.12	10,757.00	4,302.80	4.30	15.77
1998	1.93	2.12	10,757.00	4,302.80	4.30	15.77
1999	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2000	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2001	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2002	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2003	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2004	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2005	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2006	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2007	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2008	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2009	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2010	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2011	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2012	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2013	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2014	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2015	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2016	1.93	2.12	10,757.00	4,302.80	4.30	15.77
2017	2.54	2.79	13,678.60	5,471.44	5.47	20.06
2018	3.25	3.58	16,435.20	6,574.08	6.58	24.13
2019	4.42	4.86	24,088.87	9,635.55	9.64	35.35
2020	5.35	5.89	26,475.54	10,590.22	10.60	38.87
2021	5.02	5.52	25,618.24	10,247.30	10.25	37.58
2022	3.79	4.17	17,761.87	7,104.75	7.11	26.07
	37.88		199,357.32			

The latest data for 2022, shown in the table, is lower than in other years due to the small amount of peat extracted that year.

Methodology

The estimation of CO2 emissions from peat deposits has two main elements: emissions from the extraction phase of the peat deposit and emissions outside the extraction site, e.g. from the use of peat in horticulture (non-energy use). For calculations, see the following equation[75] :

$$CO_2\text{–}C_{WW_{peat}} = CO_2\text{–}C_{WW_{peat_{off-site}}} + CO_2\text{–}C_{WW_{peat_{on-site}}}$$

where:

$CO_2\text{–}C_{WWpeat}$ CO2-C emissions from managed peatlands, GgCO2/year

$CO_2\text{–}C_{WW\ peat\ on\text{-}site}$ CO2-C emissions from managed peatlands in GgCO2/year

$CO_2\text{–}C_{WW\ peat\ off\text{-}site}$ CO2-C emissions from peat consumed outside managed peatlands GgCO2/year

The calculations were performed using the Tier 1 method. The following equation[76] was used to determine emissions from peatland operations.

$$CO_2\text{–}C_{WW_{peat_{on-site}}} = \left[\frac{(A_{peatRich} \bullet EF_{CO_{2\ peatRich}}) + (A_{peatPoor} \bullet EF_{CO_{2\ peatPoor}})}{1000}\right] + \Delta C_{WW_{peat_B}}$$

where:

$CO_2\text{–}C_{WW\ peat\ on\text{-}site}$ CO_2–C Emissions from managed peatlands, GgC/year

$A_{peatRich}$ Area of nutrient-rich peat soils managed for peat extraction (all phases of production), ha

$A_{peatPoor}$ Area of nutrient-poor peat soils managed for peat extraction (all stages of production), ha

$EF_{CO_2 peatRich}$ CO2 emission factors for nutrient-rich peat soils managed for peat extraction or abandoned after peat extraction, tonnes C ha-1 yr-1

$EF_{CO_2 peatPoor}$: CO2 emission factors for nutrient-poor peat soils managed for peat extraction or abandoned after peat extraction, tonnes C ha-1 yr-1

$\Delta C_{WW\ peat\ B}$: CO2–C emission during vegetation clearing on peatlands as a result of changes in carbon stocks in biomass, Gg C yr-1

Activity Data

Georgian peat is characterized by a very low degree of decomposition and an acidic reaction, so it is not used directly as a fertilizer. To increase the degree of decomposition of peat, organic and mineral substances are added to it and then peat fertilizers and peat composts are prepared from it. In addition, peat in Georgia is successfully used for making peat pots and for mulching the soil.

Peat extraction in Georgia is subject to licensing. Table 7 in the appendix presents data obtained from the National Agency of Mineral Resources of Georgia and based on them calculations were made for the years 2010-2022. It was not possible to find data on permits issued for peat extraction or direct extraction before 2010. It should also be noted that the

[75] IPCC 2006, WETLANDS, (Table 7.3)
[76] IPCC 2006, WETLANDS, (Table 7.4)

extraction volumes did not change between 2010 and 2016, and therefore it was assumed that the production volumes would not change between 1990 and 2010. Moreover, according to archival materials, peat extraction in Georgia was historically carried out on a small scale.

Emission Factors

Since the calculations were carried out at the first level, the emission factor indicators are taken from the table for temperate climate countries in the methodological guidelines (see Table 6-16).

Table 6-16. Emission factor indicators[77]

Emission Factors For CO_2–C And Associated Uncertainty For Lands Managed For Peat Extraction		
Nutrient – Rich $EFCO_2peatRich$	1.1	tonnes C ha^{-1} yr^{-1}
Conversion Factors For CO2–C For Volume And Weight Production Data		
Nutrient –Rich	0.40	tonnes C (tonne air-dry peat)$^{-1}$

6.6. Settlements (LULUCF 3B5)

6.6.1. *Preserved settlements lands (LULUCF 3B5a)*

The category of settlements includes all areas occupied by the population, including transport infrastructure and settlements of all sizes. Basically, for this category, the cadastre is carried out for perennial plants in settlements (on roadsides, in yards, etc.). The guidelines note the scarcity of data availability and therefore do not provide standard data for countries by climatic zones.

In Georgia, it was not possible to obtain the complete data necessary for the calculations, namely: the area covered by woody plants in all settlements (cities, towns and villages) by year (ha), as well as the annual carbon addition in these plantations (tons C/year) and the average age of woody plants included in the cover (years). It is only possible to use the greening data provided in the Sustainable Energy Development Action Plans of several self-governing cities of Georgia, which is insufficient to show the overall picture across Georgia. Therefore, due to incomplete possession of the said data, calculations were not conducted.

6.7. Other (LULUCF 3B6)

6.7.1. *Other lands preserved (LUUCF 3B6a)*

The category of other lands includes all areas that are devoid of vegetation: rocks, glaciers, etc. and that do not correspond to any of the land categories discussed above. According to the guidelines, calculations are not performed for this category, since it is assumed that these areas are typical unmanaged areas. As for areas converted into other lands, since there are no statistical data on the volumes of areas converted into other lands from different categories of lands (forest lands, wetlands, etc.) for Georgia, therefore, due to the lack of data, calculations were not performed for this category either.

[77] IPCC 2006 GL, Vol.4, Ch.7 WETLANDS, TABLE 7.4; TABLE 7.5

6.8. Harvested wood products (LULUCF 3D1)

Category description

There are several different methodologies for estimating the amount of carbon dioxide stored and released in manufactured wood products. A significant portion of wood produced from forest lands, agricultural lands, and other land use categories remains the same wood for varying periods of time.

Calculations were not performed in this category due to unavailability of data. It should be noted that FAOSTAT tables do not contain data from 1961 onwards.

7.1. Sector overview and background information

Sector 5 “Waste” includes greenhouse gas (CO2, CH4, and N2O) emissions from solid waste disposal, biological treatment of solid waste, waste incineration, and open burning, as well as emissions as a result of the treatment and discharge of household and industrial wastewater. Emissions are estimated based on the methodologies of the 2006 IPCC Guidelines. The source categories for this sector are: 4A “Solid waste disposal,” 4B “Biological treatment of solid waste,” 4C “Waste incineration and open burning,” and 4D “Wastewater treatment and discharge.”

7.1.1 Greenhouse gas emissions trend

GHG emissions from the waste sector were calculated for the years 2018–2022 and, to ensure time series consistency, were recalculated for the previous, 1990–2017 years. The results are presented in Tables 7-1, 7-2, and 7-3.

Table 7-1. GHG emissions from the Waste Sector in 1990–2022 years

Year	Gg CH_4					Gg N_2O			Gg CO_2
	4A Solid waste disposal	4.D.1 Domestic wastewater	4.D.2 Industrial wastewater	4.B.1 Composting	**Total**	4.D.1 Domestic wastewater	4.B.1 Composting	Total	4.C.1 Incineration
1990	28.12	10.14	3.72		**41.98**	0.19		**0.192**	
1991	30.19	10.18	1.80		**42.18**	0.19		**0.193**	
1992	32.18	10.18	1.39		**43.75**	0.19		**0.193**	
1993	34.09	9.95	2.40		**46.45**	0.20		**0.202**	
1994	35.88	9.13	0.49		**45.51**	0.20		**0.202**	
1995	37.62	8.87	0.23		**46.72**	0.21		**0.209**	
1996	39.21	8.62	0.28		**48.12**	0.20		**0.204**	
1997	40.65	8.40	0.53		**49.59**	0.20		**0.198**	
1998	41.97	8.28	0.26		**50.51**	0.20		**0.199**	
1999	43.20	8.21	0.95		**52.36**	0.20		**0.200**	
2000	44.49	8.13	0.92		**53.53**	0.20		**0.201**	
2001	45.72	8.06	1.09		**54.87**	0.20		**0.200**	
2002	46.83	8.00	0.32		**55.15**	0.20		**0.198**	
2003	47.70	7.88	0.29		**55.86**	0.20		**0.199**	
2004	48.48	7.76	0.95		**57.18**	0.20		**0.201**	
2005	49.28	7.63	1.25		**58.16**	0.20		**0.199**	
2006	50.10	7.51	1.69		**59.30**	0.20		**0.195**	
2007	50.90	7.39	1.53		**59.82**	0.19		**0.191**	
2008	51.65	7.27	1.79		**60.72**	0.19		**0.189**	
2009	52.36	7.24	1.64		**61.24**	0.19		**0.191**	
2010	53.01	7.18	1.59		**61.78**	0.19		**0.192**	
2011	54.28	7.13	1.91		**63.32**	0.19		**0.193**	
2012	55.12	7.07	1.95	0.002	**64.14**	0.19	0.000	**0.194**	
2013	55.81	7.03	1.43	0.012	**64.29**	0.19	0.001	**0.196**	
2014	56.40	7.03	1.49	0.023	**64.94**	0.20	0.002	**0.199**	
2015	56.83	7.04	1.08	0.037	**64.98**	0.19	0.003	**0.198**	

Year	Gg CH_4					Gg N_2O			Gg CO_2
	4A Solid waste disposal	4.D.1 Domestic wastewater	4.D.2 Industrial wastewater	4.B.1 Composting	**Total**	4.D.1 Domestic wastewater	4.B.1 Composting	Total	4.C.1 Incineration
2016	57.18	7.05	0.85	0.047	**65.13**	0.20	0.004	**0.199**	
2017	57.47	7.04	1.01	0.055	**65.58**	0.20	0.004	**0.202**	0.73
2018	57.57	7.48	1.19	0.062	**66.30**	0.20	0.005	**0.203**	0.85
2019	58.09	7.86	1.39	0.064	**67.42**	0.20	0.005	**0.206**	1.01
2020	58.55	8.26	1.54	0.064	**68.41**	0.20	0.005	**0.207**	1.51
2021	58.98	8.69	1.84	0.064	**69.57**	0.21	0.005	**0.210**	2.14
2022	59.37	9.00	1.62	0.066	**70.05**	0.20	0.005	**0.202**	2.02

Table 7-2. Greenhouse gas emissions from the waste sector (in Gg CO2-eq) in 1990–2022 years

Year	CH_4, Gg CO_2-eq					N_2O, Gg CO_2-eq			CO_2	Gg CO_2-eq
	4.A Solid waste disposal	4.D.1 Domestic wastewater	4.D.2 Industrial wastewater	4.B.1 Composting	**Total**	4.D.1 Domestic wastewater	4.B.1 Composting	Total	4.C.1 Incineration	
1990	787.4	284.0	**63.1**	**0.0**	**1,134.4**	50.8	0.0	**50.8**	0	**1,185.2**
1991	845.3	285.2	11.8	0.0	**1,142.3**	51.1	0.0	**51.1**	0	**1,193.3**
1992	901.1	284.9	6.6	0.0	**1,192.7**	51.2	0.0	**51.2**	0	**1,243.9**
1993	954.6	278.5	8.1	0.0	**1,241.3**	53.6	0.0	**53.6**	0	**1,294.9**
1994	1,004.8	255.8	2.3	0.0	**1,262.8**	53.6	0.0	**53.6**	0	**1,316.4**
1995	1,053.4	248.3	1.2	0.0	**1,303.0**	55.3	0.0	**55.3**	0	**1,358.3**
1996	1,097.9	241.5	1.4	0.0	**1,340.8**	53.9	0.0	**53.9**	0	**1,394.7**
1997	1,138.3	235.3	2.5	0.0	**1,376.0**	52.6	0.0	**52.6**	0	**1,428.6**
1998	1,175.2	231.9	1.6	0.0	**1,408.6**	52.7	0.0	**52.7**	0	**1,461.4**
1999	1,209.6	229.8	3.5	0.0	**1,442.9**	53.1	0.0	**53.1**	0	**1,496.0**
2000	1,245.7	227.6	3.7	0.0	**1,477.1**	53.4	0.0	**53.4**	0	**1,530.4**
2001	1,280.1	225.8	4.2	0.0	**1,510.0**	52.9	0.0	**52.9**	0	**1,562.9**
2002	1,311.3	223.9	2.2	0.0	**1,537.4**	52.4	0.0	**52.4**	0	**1,589.8**
2003	1,335.5	220.5	2.2	0.0	**1,558.3**	52.8	0.0	**52.8**	0	**1,611.1**
2004	1,357.4	217.2	4.7	0.0	**1,579.2**	53.2	0.0	**53.2**	0	**1,632.4**
2005	1,379.8	213.8	6.2	0.0	**1,599.7**	52.8	0.0	**52.8**	0	**1,652.5**
2006	1,402.7	210.4	8.5	0.0	**1,621.6**	51.7	0.0	**51.7**	0	**1,673.3**
2007	1,425.1	207.0	9.5	0.0	**1,641.6**	50.6	0.0	**50.6**	0	**1,692.2**
2008	1,446.3	203.7	8.9	0.0	**1,658.8**	50.2	0.0	**50.2**	0	**1,709.0**
2009	1,466.1	202.7	15.4	0.0	**1,684.1**	50.6	0.0	**50.6**	0	**1,734.7**
2010	1,484.3	201.1	16.4	0.0	**1,701.8**	50.8	0.0	**50.8**	0	**1,752.6**
2011	1,519.9	199.7	20.3	0.0	**1,739.9**	51.1	0.0	**51.1**	0	**1,791.1**
2012	1,543.3	197.9	21.4	0.1	**1,762.6**	51.3	0.0	**51.3**	0	**1,813.9**
2013	1,562.7	196.8	19.4	0.3	**1,779.3**	51.6	0.2	**51.8**	0	**1,831.2**
2014	1,579.2	196.7	21.7	0.7	**1,798.2**	52.2	0.5	**52.7**	0	**1,850.9**
2015	1,591.3	197.0	18.7	1.0	**1,808.0**	51.6	0.7	**52.4**	0	**1,860.4**
2016	1,601.2	197.4	18.6	1.3	**1,818.5**	51.9	0.9	**52.8**	0	**1,871.3**
2017	1,609.1	197.2	20.2	1.6	**1,828.1**	52.4	1.1	**53.5**	0.7	**1,882.4**
2018	1,611.9	209.4	21.8	1.7	**1,844.8**	52.7	1.2	**53.9**	0.9	**1,899.6**
2019	1,626.7	220.2	22.2	1.8	**1,870.9**	53.2	1.3	**54.5**	1.0	**1,926.4**
2020	1,639.5	231.2	21.7	1.8	**1,894.2**	53.6	1.3	**54.9**	1.5	**1,950.6**
2021	1,651.4	243.4	23.4	1.8	**1,920.0**	54.4	1.3	**55.6**	2.1	**1,977.8**

Year	CH_4, Gg CO_2-eq					N_2O, Gg CO_2-eq			CO_2	Gg CO_2-eq
	4.A Solid waste disposal	4.D.1 Domestic wastewater	4.D.2 Industrial wastewater	4.B.1 Composting	**Total**	4.D.1 Domestic wastewater	4.B.1 Composting	Total	4.C.1 Incineration	
2022	1,662.3	252.0	24.1	1.8	**1,940.3**	52.2	1.3	**53.5**	2.0	**1,995.9**

The share of waste sector categories emissions in the sector's emissions is presented in Table 7-3. Methane is the dominant greenhouse gas, and from categories dominant is methane emissions from solid waste disposal.

Table 7-3. Share of Waste Sector categories emissions in the sector's emissions

Year	CH_4					N_2O			CO_2	Gg CO_2-eq
	4.A Solid waste disposal	4.D.1 Domestic wastewater	4.D.2 Industrial wastewater	4.B.1 Composting	**Total**	4.D.1 Domestic wastewater	4.B.1Composting	Total	4.C.1Incineration	
1990	66.4	24.0	5.3	0.0	**95.7**	4.3	0.0	**4.3**	0.0	**100**
1991	70.8	23.9	1.0	0.0	**95.7**	4.3	0.0	**4.3**	0.0	**100**
1992	72.4	22.9	0.5	0.0	**95.9**	4.1	0.0	**4.1**	0.0	**100**
1993	73.7	21.5	0.6	0.0	**95.9**	4.1	0.0	**4.1**	0.0	**100**
1994	76.3	19.4	0.2	0.0	**95.9**	4.1	0.0	**4.1**	0.0	**100**
1995	77.6	18.3	0.1	0.0	**95.9**	4.1	0.0	**4.1**	0.0	**100**
1996	78.7	17.3	0.1	0.0	**96.1**	3.9	0.0	**3.9**	0.0	**100**
1997	79.7	16.5	0.2	0.0	**96.3**	3.7	0.0	**3.7**	0.0	**100**
1998	80.4	15.9	0.1	0.0	**96.4**	3.6	0.0	**3.6**	0.0	**100**
1999	80.9	15.4	0.2	0.0	**96.5**	3.5	0.0	**3.5**	0.0	**100**
2000	81.4	14.9	0.2	0.0	**96.5**	3.5	0.0	**3.5**	0.0	**100**
2001	81.9	14.4	0.3	0.0	**96.6**	3.4	0.0	**3.4**	0.0	**100**
2002	82.5	14.1	0.1	0.0	**96.7**	3.3	0.0	**3.3**	0.0	**100**
2003	82.9	13.7	0.1	0.0	**96.7**	3.3	0.0	**3.3**	0.0	**100**
2004	83.2	13.3	0.3	0.0	**96.7**	3.3	0.0	**3.3**	0.0	**100**
2005	83.5	12.9	0.4	0.0	**96.8**	3.2	0.0	**3.2**	0.0	**100**
2006	83.8	12.6	0.5	0.0	**96.9**	3.1	0.0	**3.1**	0.0	**100**
2007	84.2	12.2	0.6	0.0	**97.0**	3.0	0.0	**3.0**	0.0	**100**
2008	84.6	11.9	0.5	0.0	**97.1**	2.9	0.0	**2.9**	0.0	**100**
2009	84.5	11.7	0.9	0.0	**97.1**	2.9	0.0	**2.9**	0.0	**100**
2010	84.7	11.5	0.9	0.0	**97.1**	2.9	0.0	**2.9**	0.0	**100**
2011	84.9	11.2	1.1	0.0	**97.1**	2.9	0.0	**2.9**	0.0	**100**
2012	85.1	10.9	1.2	0.0	**97.2**	2.8	0.0	**2.8**	0.0	**100**
2013	85.3	10.7	1.1	0.0	**97.2**	2.8	0.0	**2.8**	0.0	**100**
2014	85.3	10.6	1.2	0.0	**97.2**	2.8	0.0	**2.8**	0.0	**100**
2015	85.5	10.6	1.0	0.1	**97.2**	2.8	0.0	**2.8**	0.0	**100**
2016	85.6	10.5	1.0	0.1	**97.2**	2.8	0.1	**2.8**	0.0	**100**
2017	85.5	10.5	1.1	0.1	**97.1**	2.8	0.1	**2.8**	0.0	**100**
2018	84.9	11.0	1.1	0.1	**97.1**	2.8	0.1	**2.8**	0.0	**100**
2019	84.4	11.4	1.2	0.1	**97.1**	2.8	0.1	**2.8**	0.1	**100**
2020	84.1	11.9	1.1	0.1	**97.1**	2.7	0.1	**2.8**	0.1	**100**
2021	83.5	12.3	1.2	0.1	**97.1**	2.7	0.1	**2.8**	0.1	**100**
2022	83.3	12.6	1.2	0.1	**97.2**	2.6	0.1	**2.7**	0.1	**100**

7.1.2. *Methodological issues*

Emissions from the categories Solid Waste Disposal (4.A), Biological Treatment of Solid Waste (4.B), Waste Incineration and Open Burning (4.C), Domestic Wastewater Treatment and Discharge (4.D.1), and Industrial Wastewater Treatment and Discharge (4.D.2) were estimated using the Tier 1 methodological approach and default values of emission factors, as well as using the Tier 2 methodological approach and country-specific (national) emission factors for category "solid waste disposal". The methods used to estimate emissions by category are given in Table 7-4. A more detailed description is available in the subsections.

Table 7-4. Methods and emission factors used in calculating GHG emissions from the Waste Sector

Category code and name	CO_2		CH_4		N_2O	
	Method	EF	Method	EF	Method	EF
4.A Solid waste Disposal			T2	CS, D		
4.B Biological Treatment of Solid Waste			T1	D	T1	D
4.C Incineration and Open Burning of Waste	T1	D				
4.D.1 Domestic Wastewater Treatment and Discharge			T1	D	T1	D
4.D.2 Industrial Wastewater Treatment and Discharge			T1	D		

EF – Emission Factor, T1 –Tier 1; T2 – Tier 2; CS – Country Specific; D – Default

7.1.3 Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines. Details are provided in the subsections.

7.1.4 Category-specific quality control/quality assurance and verification

Standard quality control and quality assurance procedures were carried out for all categories, and forms and checklists were filled in. Activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. Verification and quality control procedures were implemented to identify errors in data entry and emissions assessment processes. The quality assurance procedure was carried out to ensure compliance with methodological and guideline instructions, as reflected in the special forms developed for quality assurance. In accordance with the recommendations in the 2006 IPCC Guidelines, the national emission factors and parameters used to estimate greenhouse gas emissions are taken mainly from official reference sources and, in part, based on expert assessments.

Changes were made to tables 7-1 - 7-3 to correct errors identified during quality control. An error was found during quality assurance when comparing the calculated emissions with the values provided in the second biennial update report (BUR2). The error has been corrected, and instead of BUR2, the comparison was made with the emissions reported in the Fourth National Communication(FNC).

7.1.5 *Category-specific recalculation, including explanatory information and justification for recalculations, changes made is response to the review/verification process and impacts*

Greenhouse gas emissions from the waste sector were recalculated using updated activity data for 1990–2017 and updated national emission factors and parameters. Compared to the previous inventory cycle (as part of the Fourth National Communication of Georgia to the UNFCCC), recalculations revealed both increases and decreases in greenhouse gas emissions by category (Table 7-5). The increase in emissions from the waste sector as a whole is mainly due to the change in the global warming potential (GWP) for methane (GWP = 21 in the Fourth National Communication and GWP = 28 in the Fifth National Communication). The recalculation results for specific categories are provided in the relevant subsections.

Table 7-5. Comparison of recalculated emissions (in Gg) with the corresponding values in Fourth National Communication of Georgia (FNC) to the UNFCCC.

Year	CH_4 / Solid waste disposal	Previous inventory within FNC	Difference, %	CH_4 / Domestic wastewater	Previous inventory within FNC	Difference, %	CH_4 / Industrial wastewater	Previous inventory within FNC	Difference, %	N_2O / Domestic wastewater	Previous inventory within FNC	Difference, %	**Waste sector, Gg CO_2-eq**	**Waste sector, Previous inventory within FNC, Gg CO_2-eq**	**Difference, %**
1990	28.12	31.15	-9.7	10.14	11.45	-11.4	2.25	8.84	-74.5	0.19	0.18	8.0	**1,185**	**1,135**	**4.4**
1991	30.19	32.78	-7.9	10.18	11.50	-11.4	0.42	5.83	-92.8	0.19	0.18	8.0	**1,193**	**1,108**	**7.7**
1992	32.18	34.27	-6.1	10.18	11.48	-11.4	0.24	4.47	-94.7	0.19	0.18	8.0	**1,244**	**1,110**	**12.1**
1993	34.09	35.63	-4.3	9.95	11.22	-11.3	0.29	3.34	-91.4	0.20	0.19	8.0	**1,295**	**1,112**	**16.4**
1994	35.88	36.94	-2.8	9.13	10.29	-11.3	0.08	1.96	-95.8	0.20	0.19	8.0	**1,316**	**1,091**	**20.7**
1995	37.62	38.18	-1.5	8.87	9.99	-11.2	0.04	2.52	-98.2	0.21	0.19	8.0	**1,358**	**1,124**	**20.8**
1996	39.21	39.27	-0.2	8.62	9.71	-11.2	0.05	3.12	-98.4	0.20	0.19	8.0	**1,395**	**1,153**	**21.0**
1997	40.65	40.25	1.0	8.40	9.46	-11.1	0.09	3.76	-97.7	0.20	0.18	8.0	**1,429**	**1,180**	**21.1**
1998	41.97	41.13	2.0	8.28	9.32	-11.1	0.06	4.32	-98.7	0.20	0.18	8.0	**1,461**	**1,207**	**21.1**
1999	43.20	41.97	2.9	8.21	9.23	-11.1	0.13	4.99	-97.5	0.20	0.19	8.0	**1,496**	**1,237**	**20.9**
2000	44.49	42.95	3.6	8.13	9.14	-11.0	0.13	5.59	-97.6	0.20	0.19	8.0	**1,530**	**1,269**	**20.6**
2001	45.72	43.82	4.3	8.06	9.06	-11.1	0.15	5.78	-97.4	0.20	0.18	8.0	**1,563**	**1,289**	**21.2**
2002	46.83	44.59	5.0	8.00	8.99	-11.1	0.08	5.87	-98.7	0.20	0.18	8.0	**1,590**	**1,305**	**21.8**
2003	47.70	45.28	5.3	7.88	8.87	-11.2	0.08	6.05	-98.7	0.20	0.18	8.0	**1,611**	**1,321**	**21.9**
2004	48.48	45.94	5.5	7.76	8.74	-11.3	0.17	6.30	-97.3	0.20	0.19	8.0	**1,632**	**1,338**	**22.0**
2005	49.28	46.62	5.7	7.63	8.61	-11.4	0.22	6.53	-96.6	0.20	0.18	8.0	**1,653**	**1,354**	**22.0**
2006	50.10	47.33	5.8	7.51	8.49	-11.5	0.30	7.04	-95.7	0.20	0.18	8.0	**1,673**	**1,376**	**21.6**
2007	50.90	48.14	5.7	7.39	8.36	-11.6	0.34	7.50	-95.5	0.19	0.18	8.0	**1,692**	**1,399**	**21.0**
2008	51.65	48.94	5.5	7.27	8.23	-11.7	0.32	7.91	-96.0	0.19	0.18	8.0	**1,709**	**1,421**	**20.3**
2009	52.36	49.71	5.3	7.24	8.19	-11.7	0.55	8.80	-93.8	0.19	0.18	8.0	**1,735**	**1,456**	**19.2**
2010	53.01	50.37	5.2	7.18	8.13	-11.7	0.58	9.46	-93.8	0.19	0.18	8.0	**1,753**	**1,442**	**21.5**
2011	54.28	50.68	7.1	7.13	8.08	-11.7	0.72	10.45	-93.1	0.19	0.18	8.0	**1,791**	**1,480**	**21.0**
2012	55.12	51.93	6.1	7.07	8.00	-11.7	0.76	10.66	-92.8	0.19	0.18	8.0	**1,814**	**1,492**	**21.6**
2013	55.81	52.29	6.7	7.03	7.96	-11.7	0.69	10.51	-93.4	0.19	0.18	8.0	**1,831**	**1,497**	**22.4**
2014	56.40	52.59	7.2	7.03	7.95	-11.7	0.77	10.60	-92.7	0.20	0.18	8.0	**1,851**	**1,506**	**22.9**
2015	56.83	52.80	7.6	7.04	7.97	-11.7	0.67	10.91	-93.9	0.19	0.18	5.5	**1,860**	**1,518**	**22.5**
2016	57.18	53.00	7.9	7.05	7.98	-11.7	0.66	10.47	-93.7	0.20	0.19	4.5	**1,871**	**1,515**	**23.6**
2017	57.47	53.17	8.1	7.04	7.97	-11.7	0.72	10.42	-93.1	0.20	0.19	4.4	**1,882**	**1,518**	**24.0**

7.1.6 *Planned improvements related to the category, including improvements identified during the inspection*

Planned improvements for categories are described in the relevant sections.

7.1.7 Completeness assessment

The greenhouse gas emission inventory includes emissions from five source categories: 4.A Solid Waste Disposal, 4.B Biological Treatment of Solid Waste, 4.C Waste Incineration and Open Burning, 4.D.1 Domestic Wastewater Treatment and Discharge, and 4.D.2 Industrial Wastewater Treatment and Discharge.

Table 7-6. Completeness assessment of GHG emissions from the Waste sector

Category code and name	CO_2	CH_4	N_2O
4.A Solid waste disposal		X	
4.B Biological treatment of solid waste	X	X	
4.C Waste incineration and open burning	X	NE	NE
4.D.1 Domestic wastewater treatment and discharge		X	X
4.D.2 Industrial wastewater treatment and discharge		X	

X – Source category is included. NE - Not estimated

7.2 Solid waste disposal (4.A)

7.2.1 Source Category Description

There are 57 municipal landfills in Georgia. Until 2013, most landfills operated in an unorganized manner, failing to comply with environmental protection standards. Since 2013, LLC "Solid Waste Management Company of Georgia" has managed 54 municipal landfills, excluding those in Tbilisi and the Autonomous Republic of Adjara. The company has improved 31 municipal landfills and closed 23 in accordance with relevant standards. Most of the landfills are managed, 2 landfills are unmanaged, and 2 are uncategorized[1].

Currently, municipal landfills are the mainstay of the waste disposal system in Georgia, although this trend will change in the future. New regional landfills will replace existing municipal ones. Some of them will be closed, while others will be equipped with transfer stations.

Table 7-7 shows methane emissions from landfills in Georgia in 1990-2022 years.

Table 7-7. Methane emissions from landfills of Georgia (in Gg) in 1990-2022 years

	Tbilisi				Kutaisi	Rustavi closed	Rustavi	Batumi	Kobuleti	Gori	Poti	Zugdidi closed	Zugdidi	Sareki	Opeti	Kokhra	Dedoplis-tskaro	Telavi	Meria	Tagveti	Akhtala	Kizilajlo	Chacharaki	Hypothe-tic	Total, Gg	
	Didi Lilo	Gldani	Iaghluji	Lilo																					**CH_4**	**CO_2eq**
1990		11.39	2.01	0.20	3.88	1.21		2.77		0.37	0.72			0.34	0.78	0.49	0.22	0.47	0.55	0.45	0.40	0.35	0.13	1.36	**28.12**	**787**
1991		11.76	2.38	0.38	3.97	1.26		2.83		0.43	0.73			0.40	0.90	0.57	0.26	0.55	0.63	0.53	0.47	0.41	0.15	1.57	**30.19**	**845**
1992		12.12	2.75	0.56	4.06	1.31		2.89		0.49	0.74			0.45	1.00	0.64	0.30	0.63	0.70	0.61	0.53	0.46	0.17	1.77	**32.18**	**901**
1993		12.45	3.12	0.73	4.16	1.36		2.97		0.54	0.75			0.49	1.09	0.71	0.33	0.70	0.77	0.68	0.59	0.52	0.19	1.95	**34.09**	**955**
1994		12.76	3.48	0.88	4.25	1.41		3.05		0.58	0.76			0.54	1.17	0.77	0.37	0.77	0.82	0.74	0.65	0.57	0.20	2.12	**35.88**	**1,005**
1995		13.02	3.82	1.07	4.34	1.46		3.14		0.62	0.77			0.58	1.24	0.82	0.40	0.83	0.88	0.81	0.71	0.62	0.22	2.28	**37.62**	**1,053**
1996		13.25	4.12	1.25	4.43	1.51		3.21		0.67	0.78			0.61	1.31	0.88	0.43	0.90	0.92	0.87	0.76	0.67	0.23	2.42	**39.21**	**1,098**
1997		13.45	4.40	1.42	4.51	1.56		3.27		0.70	0.79			0.65	1.36	0.92	0.46	0.96	0.96	0.93	0.81	0.71	0.24	2.55	**40.65**	**1,138**
1998		13.61	4.66	1.58	4.58	1.61		3.32		0.74	0.80			0.68	1.42	0.97	0.48	1.01	1.00	0.98	0.86	0.75	0.25	2.68	**41.97**	**1,175**
1999		13.76	4.90	1.73	4.64	1.65		3.36		0.77	0.81	0.00		0.71	1.46	1.01	0.51	1.07	1.03	1.03	0.91	0.79	0.26	2.79	**43.20**	**1,210**
2000		13.90	5.13	1.87	4.69	1.70		3.40		0.79	0.82	0.15		0.73	1.51	1.05	0.53	1.12	1.06	1.08	0.95	0.83	0.27	2.89	**44.49**	**1,246**
2001		14.02	5.36	2.00	4.73	1.75		3.45		0.81	0.82	0.31		0.76	1.55	1.08	0.56	1.17	1.09	1.13	0.99	0.87	0.28	2.99	**45.72**	**1,280**
2002		14.13	5.56	2.13	4.76	1.80		3.49		0.83	0.82	0.45		0.78	1.58	1.12	0.58	1.21	1.11	1.18	1.03	0.90	0.29	3.08	**46.83**	**1,311**
2003		14.23	5.76	2.24	4.77	1.70		3.51		0.84	0.83	0.57		0.80	1.61	1.15	0.60	1.26	1.14	1.22	1.07	0.93	0.30	3.16	**47.70**	**1,335**
2004		14.32	5.95	2.35	4.78	1.61		3.52		0.85	0.84	0.68		0.82	1.64	1.17	0.62	1.30	1.15	1.26	1.10	0.96	0.30	3.24	**48.48**	**1,357**
2005		14.71	6.13	2.24	4.76	1.52		3.53	0.00	0.86	0.84	0.78		0.84	1.66	1.20	0.64	1.34	1.17	1.30	1.14	0.99	0.31	3.31	**49.28**	**1,380**
2006		15.07	6.31	2.13	4.74	1.44		3.54	0.08	0.87	0.85	0.86		0.85	1.68	1.22	0.66	1.38	1.19	1.33	1.17	1.02	0.32	3.37	**50.10**	**1,403**
2007		15.41	6.50	2.02	4.73	1.36		3.54	0.14	0.89	0.85	0.95		0.87	1.70	1.24	0.68	1.42	1.20	1.37	1.20	1.05	0.32	3.43	**50.90**	**1,425**
2008		15.75	6.69	1.93	4.70	1.29		3.54	0.20	0.90	0.86	1.03		0.88	1.72	1.26	0.69	1.45	1.21	1.40	1.23	1.07	0.35	3.49	**51.65**	**1,446**
2009		16.07	6.89	1.83	4.66	1.22		3.54	0.24	0.92	0.86	1.10		0.90	1.74	1.28	0.71	1.48	1.23	1.43	1.26	1.10	0.36	3.54	**52.36**	**1,466**
2010		16.38	7.09	1.74	4.62	1.16		3.53	0.28	0.93	0.87	1.16		0.91	1.75	1.30	0.72	1.51	1.24	1.46	1.28	1.12	0.36	3.59	**53.01**	**1,484**
2011		16.69	7.28	1.66	4.57	1.10		3.52	0.31	0.95	0.87	1.04	0.82	0.92	1.77	1.32	0.74	1.54	1.25	1.49	1.31	1.14	0.36	3.63	**54.28**	**1,520**
2012	1.25	15.88	6.93	1.58	4.51	1.04	0.13	3.52	0.33	0.97	0.87	0.94	1.50	0.93	1.78	1.33	0.75	1.57	1.25	1.52	1.33	1.17	0.36	3.67	**55.12**	**1,543**
2013	2.44	15.10	6.59	1.50	4.46	0.98	0.26	3.51	0.36	0.98	0.88	0.84	2.06	0.94	1.79	1.34	0.76	1.60	1.26	1.55	1.36	1.18	0.36	3.71	**55.81**	**1,563**
2014	3.55	14.37	6.27	1.43	4.39	0.93	0.38	3.51	0.37	1.03	0.90	0.75	2.50	0.95	1.80	1.36	0.78	1.62	1.27	1.57	1.38	1.20	0.36	3.75	**56.40**	**1,579**
2015	4.57	13.67	5.96	1.36	4.31	0.88	0.51	3.49	0.37	1.07	0.93	0.68	2.83	0.96	1.81	1.37	0.79	1.65	1.27	1.59	1.40	1.22	0.36	3.78	**56.83**	**1,591**
2016	5.55	13.00	5.67	1.29	4.24	0.83	0.64	3.48	0.38	1.11	0.95	0.61	3.07	0.96	1.81	1.38	0.80	1.67	1.28	1.62	1.42	1.24	0.37	3.81	**57.18**	**1,601**
2017	6.49	12.37	5.39	1.23	4.18	0.79	0.76	3.48	0.39	1.15	0.97	0.55	3.23	0.97	1.82	1.39	0.81	1.69	1.28	1.64	1.44	1.26	0.37	3.83	**57.47**	**1,609**
2018	7.47	11.76	5.13	1.17	4.13	0.75	0.92	3.51	0.35	1.21	1.00	0.49	3.34	0.99	1.84	1.41	0.83	1.61	1.30	1.67	1.37	1.20	0.37	3.75	**57.57**	**1,612**
2019	8.43	11.19	4.88	1.11	4.13	0.71	1.04	3.58	0.32	1.37	1.01	0.44	3.39	0.99	1.85	1.42	0.84	1.64	1.30	1.69	1.39	1.22	0.37	3.78	**58.09**	**1,627**
2020	9.37	10.64	4.64	1.06	4.14	0.67	1.17	3.65	0.28	1.50	1.03	0.39	3.41	1.00	1.85	1.43	0.85	1.66	1.30	1.71	1.41	1.23	0.37	3.81	**58.55**	**1,639**
2021	10.29	10.12	4.42	1.01	4.15	0.63	1.29	3.74	0.25	1.60	1.04	0.35	3.40	1.00	1.84	1.43	0.85	1.68	1.30	1.73	1.43	1.25	0.37	3.82	**58.98**	**1,651**
2022	11.19	9.63	4.20	0.96	4.18	0.60	1.41	3.85	0.23	1.67	1.04	0.32	3.35	1.00	1.83	1.43	0.86	1.70	1.29	1.74	1.44	1.26	0.37	3.83	**59.37**	**1,662**

In 2022, the total methane emissions from 6 big landfills amounted to more than 60% of total methane emissions from landfills in Georgia (Table 7-8).

Table 7-8. Share of Methane emissions from 6 large landfills in methane emissions from all landfills by 2022

Landfill	Didi Lilo	Gldani	Iaghluji	Kutaisi	Batumi	Zugdidi	🏟
Share, %	18.8	16.2	7.1	7.0	6.5	5.6	61.2

7.2.2 Managed waste disposal sites (4.A.1)

7.2.2.1 Source Category Description

A waste disposal site/landfill is managed if the waste is managed under anaerobic conditions and the waste disposal is controlled (waste is placed in specially prepared areas, there is control of scavenging and also fire control) and includes at least one of the following: (i) the waste is covered with a covering material; (ii) it is mechanically compacted; or (iii) the waste is leveled.

Most of Georgia's landfills are managed: they are fenced, periodically compacted, and operated in accordance with a compliance plan approved by the Ministry of Environmental Protection and Agriculture.

Table 7-9 presents methane emissions from managed landfills. According to the table, emissions from managed landfills accounted for 69.8% of total methane emissions from all landfills in Georgia in 2022. The table includes emissions from 19 landfills, while the remaining, smaller managed landfills are grouped as a single hypothetic landfill. The parameters for this hypothetical landfill were based on those of the other managed landfills (e.g., daily waste deposited, year of operation). In 2022, methane emissions from this hypothetic landfill represented only about 6% of total emissions from all landfills.

Table 7-9. Methane emissions (in Gg) from managed landfills in Georgia

	Tbilisi		Kutaisi	Rustavi Closed	Rustavi	Gori	Poti	Zugdidi Closed	Zugdidi	Sareki	Opeti	Kokhra	Dedoplistskaro	Telavi	Meria	Tagveti	Akhtala	Kizilajlo	Chacharaki	Hypothetic	**Total**	
	Didi Lilo	Lilo																			**Gg CH_4**	**Gg CO_2eq**
1990		0.20	3.88	1.21		0.37	0.72			0.34	0.78	0.49	0.22	0.47	0.55	0.45	0.40	0.35	0.13	1.36	**11.94**	**334**
1991		0.38	3.97	1.26		0.43	0.73			0.40	0.90	0.57	0.26	0.55	0.63	0.53	0.47	0.41	0.15	1.57	**13.22**	**370**
1992		0.56	4.06	1.31		0.49	0.74			0.45	1.00	0.64	0.30	0.63	0.70	0.61	0.53	0.46	0.17	1.77	**14.42**	**404**
1993		0.73	4.16	1.36		0.54	0.75			0.49	1.09	0.71	0.33	0.70	0.77	0.68	0.59	0.52	0.19	1.95	**15.55**	**435**
1994		0.88	4.25	1.41		0.58	0.76			0.54	1.17	0.77	0.37	0.77	0.82	0.74	0.65	0.57	0.20	2.12	**16.60**	**465**
1995		1.07	4.34	1.46		0.62	0.77			0.58	1.24	0.82	0.40	0.83	0.88	0.81	0.71	0.62	0.22	2.28	**17.65**	**494**
1996		1.25	4.43	1.51		0.67	0.78			0.61	1.31	0.88	0.43	0.90	0.92	0.87	0.76	0.67	0.23	2.42	**18.62**	**521**
1997		1.42	4.51	1.56		0.70	0.79			0.65	1.36	0.92	0.46	0.96	0.96	0.93	0.81	0.71	0.24	2.55	**19.53**	**547**
1998		1.58	4.58	1.61		0.74	0.80			0.68	1.42	0.97	0.48	1.01	1.00	0.98	0.86	0.75	0.25	2.68	**20.38**	**571**
1999		1.73	4.64	1.65		0.77	0.81	0.00		0.71	1.46	1.01	0.51	1.07	1.03	1.03	0.91	0.79	0.26	2.79	**21.18**	**593**
2000		1.87	4.69	1.70		0.79	0.82	0.15		0.73	1.51	1.05	0.53	1.12	1.06	1.08	0.95	0.83	0.27	2.89	**22.06**	**618**
2001		2.00	4.73	1.75		0.81	0.82	0.31		0.76	1.55	1.08	0.56	1.17	1.09	1.13	0.99	0.87	0.28	2.99	**22.89**	**641**
2002		2.13	4.76	1.80		0.83	0.82	0.45		0.78	1.58	1.12	0.58	1.21	1.11	1.18	1.03	0.90	0.29	3.08	**23.65**	**662**
2003		2.24	4.77	1.70		0.84	0.83	0.57		0.80	1.61	1.15	0.60	1.26	1.14	1.22	1.07	0.93	0.30	3.16	**24.19**	**677**
2004		2.35	4.78	1.61		0.85	0.84	0.68		0.82	1.64	1.17	0.62	1.30	1.15	1.26	1.10	0.96	0.30	3.24	**24.68**	**691**
2005		2.24	4.76	1.52		0.86	0.84	0.78		0.84	1.66	1.20	0.64	1.34	1.17	1.30	1.14	0.99	0.31	3.31	**24.91**	**697**
2006		2.13	4.74	1.44		0.87	0.85	0.86		0.85	1.68	1.22	0.66	1.38	1.19	1.33	1.17	1.02	0.32	3.37	**25.10**	**703**
2007		2.02	4.73	1.36		0.89	0.85	0.95		0.87	1.70	1.24	0.68	1.42	1.20	1.37	1.20	1.05	0.32	3.43	**25.29**	**708**
2008		1.93	4.70	1.29		0.90	0.86	1.03		0.88	1.72	1.26	0.69	1.45	1.21	1.40	1.23	1.07	0.35	3.49	**25.48**	**714**
2009		1.83	4.66	1.22		0.92	0.86	1.10		0.90	1.74	1.28	0.71	1.48	1.23	1.43	1.26	1.10	0.36	3.54	**25.62**	**717**
2010		1.74	4.62	1.16		0.93	0.87	1.16		0.91	1.75	1.30	0.72	1.51	1.24	1.46	1.28	1.12	0.36	3.59	**25.73**	**720**
2011		1.66	4.57	1.10		0.95	0.87	1.04	0.82	0.92	1.77	1.32	0.74	1.54	1.25	1.49	1.31	1.14	0.36	3.63	**26.47**	**741**
2012	1.25	1.58	4.51	1.04	0.13	0.97	0.87	0.94	1.50	0.93	1.78	1.33	0.75	1.57	1.25	1.52	1.33	1.17	0.36	3.67	**28.46**	**797**
2013	2.44	1.50	4.46	0.98	0.26	0.98	0.88	0.84	2.06	0.94	1.79	1.34	0.76	1.60	1.26	1.55	1.36	1.18	0.36	3.71	**30.25**	**847**
2014	3.55	1.43	4.39	0.93	0.38	1.03	0.90	0.75	2.50	0.95	1.80	1.36	0.78	1.62	1.27	1.57	1.38	1.20	0.36	3.75	**31.89**	**893**
2015	4.57	1.36	4.31	0.88	0.51	1.07	0.93	0.68	2.83	0.96	1.81	1.37	0.79	1.65	1.27	1.59	1.40	1.22	0.36	3.78	**33.34**	**933**
2016	5.55	1.29	4.24	0.83	0.64	1.11	0.95	0.61	3.07	0.96	1.81	1.38	0.80	1.67	1.28	1.62	1.42	1.24	0.37	3.81	**34.65**	**970**
2017	6.49	1.23	4.18	0.79	0.76	1.15	0.97	0.55	3.23	0.97	1.82	1.39	0.81	1.69	1.28	1.64	1.44	1.26	0.37	3.83	**35.84**	**1,004**
2018	7.47	1.17	4.13	0.75	0.92	1.21	1.00	0.49	3.34	0.99	1.84	1.41	0.83	1.61	1.30	1.67	1.37	1.20	0.37	3.75	**36.81**	**1,031**
2019	8.43	1.11	4.13	0.71	1.04	1.37	1.01	0.44	3.39	0.99	1.85	1.42	0.84	1.64	1.30	1.69	1.39	1.22	0.37	3.78	**38.12**	**1,067**
2020	9.37	1.06	4.14	0.67	1.17	1.50	1.03	0.39	3.41	1.00	1.85	1.43	0.85	1.66	1.30	1.71	1.41	1.23	0.37	3.81	**39.34**	**1,101**
2021	10.29	1.01	4.15	0.63	1.29	1.60	1.04	0.35	3.40	1.00	1.84	1.43	0.85	1.68	1.30	1.73	1.43	1.25	0.37	3.82	**40.45**	**1,132**
2022	11.19	0.96	4.18	0.60	1.41	1.67	1.04	0.32	3.35	1.00	1.83	1.43	0.86	1.70	1.29	1.74	1.44	1.26	0.37	3.83	**41.46**	**1,161**

7.2.2.2 Methodological issues

IPCC "First-Order Decay Method"

The methane emissions from the landfills of Georgia are estimated based on the First order decay (FOD) method. The FOD method assumes that the degradable organic component/degradable organic carbon (DOC) in waste decays slowly throughout a few decades, during which CH_4 and CO_2 are formed.

Methane emissions

CH_4 is produced by the decomposition/decay of organic material under anaerobic conditions. Part of the CH_4 produced is oxidized in the landfill top layer or can be recovered for energy or flaring. In this case, the actual amount of CH_4 emitted from the landfill will be less than the amount produced. The equation used to calculate CH_4 emissions from a landfill in a given year is:

$$CH_4 \text{ emissions} = \left[\sum_x CH_4generated_{x,T} - R_T\right] \cdot (1 - OX_T)$$

Where:

CH_4 emissions — CH_4 emitted in year T, Gg

$CH_4\ generated_{x,T}$ — Amount of CH_4 generated in year T from decomposable material type x

T — Inventory year

x — Waste category or type/material

R_T — recovered CH_4 in year T, Gg

OX_T — Oxidation factor in year T, (fraction)

The recovered methane must be subtracted from the generated methane. Only the remaining methane in the top layer of the landfill is oxidized.

The basis for estimating methane emissions is one of the key parameters of the IPCC FOD model - the amount of decomposable organic carbon ($DDOC_m$). DDOCm represents the fraction of organic carbon that will decompose under anaerobic conditions in a landfill.

The amount of DDOCm (where the index m indicates mass) is calculated by the equation[1]:

$$DDOC_m = W \cdot DOC \cdot DOC_f \cdot MCF$$

Where:

$DDOC_m$ — mass of decomposable DOC, Gg

W — mass of waste deposited, Gg

DOC — degradable organic carbon in the year of deposition, fraction, Gg C/Gg waste

DOC_f — fraction of DOC that can decompose (fraction)

MCF — CH_4 correction factor for aerobic decomposition in the year of deposition (fraction)

Although the CH4 formation potential Lo is not explicitly used in the manual, it is the product of DDOCm, the CH_4 concentration in the gas (F), and the molecular weight ratio of CH4 and C (16/12).

Using $DDOC_m$, the methane generation potential (Lo) can be calculated using the equation[1]:

$L_o = DDOC_m \bullet F \bullet 12/16$

Where:

L_o — CH_4 generation potential, Gg CH_4

$DDOC_m$ — mass of decomposable DOC, Gg

F — fraction of CH_4 in generated landfill gas (volume fraction)

16/12 — molecular weight ratio CH4/C (ratio)

$DDOCma_T = DDOCmd_T + (DDOCma_{T-1} \cdot e^{-k})$[78]

$DDOCm\ decomp_T = DDOCma_{T-1} + (1 - e^{-k})$[79]

Where:

T Inventory year

$DDOCma_T$ DDOCm accumulated at the landfill at the end of year T, Gg

$DDOCma_{T-1}$ DDOCm accumulated at the landfill at the end of the year (T-1), Gg

$DDOCmd_T$ DDOCm deposited into the landfill in year T, Gg

$DDOCm\ decomp_T$ DDOCm decomposed at a landfill in year T, Gg

k Reaction Constant, $k = \ln(2)/(t_{1/2})$, (1/ Year)

$t_{1/2}$ Half-life time, Year

Generated CH_4 from decomposing DDOCm

The amount of CH_4 produced from the decomposing material is calculated by multiplying the CH_4 fraction in the generated landfill gas by the CH_4/C molecular weight ratio[3].

$CH_4\ generated_T = DDOCm\ decomp_T \cdot F \cdot 16/12$

where:

$CH_4\ generated_T$ Amount of CH_4 generated from decomposable material

$DDOCm\ decomp_T$ DDOCm decomposed in year T, Gg

F fraction of CH4, by volume, in generated landfill gas (fraction)

16/12 Molecular weight ratio CH_4/C (ratio)

Delay time: Waste is deposited in landfills continuously throughout the year, usually daily. However, there is evidence that the production of CH_4 does not begin immediately after the deposition of the waste.

Methane Correction Factor (MCF): This factor takes into account the fact that unmanaged landfills produce less methane than managed ones. In the upper layers of unmanaged landfills, the majority of waste decomposes under aerobic (oxygenated) conditions. In managed landfills, the methane correction factor MCF = 1.

Waste Composition: There is limited information on the composition of solid waste disposed of in Georgian landfills. Since 2014, waste composition has been determined at several landfills. The results of studies conducted on the composition of waste in these landfills were used, including the 2020–2021 seasonal survey at the Tbilisi landfill and the Rustavi landfill survey in Kvemo Kartli. The data in Table 7–10 are provided by the Solid Waste Management Company of Georgia. For other managed landfills, default values for the Eastern European region from the 2006 IPCC were used.

Table 7-10. Composition of solid waste disposed at managed landfills

Component	Landfill		
	Tbilisi	Rustavi	All others (default for Eastern European region)
Food waste	28.0	49.2	30.1
Mixed paper	14.2	6.5	10
Cardboard	2.0	1.0	11.8
Textile	6.6	9.8	4.7
Wood			7.5
Polyethylene/plastic	21.6	18.0	6.2
Other	17.6	15.5	19.7

[78] *2006 IPCC, Volume 5, Chapter 3, p. 3.9, Equation 3.4*

[79] *2006 IPCC, Volume 5, Chapter 3, p 3.9, Equation 3.5*

Degradable Organic Carbon (DOC): Degradable organic carbon represents the fraction of carbon in solid waste that is susceptible to biochemical decomposition[3]. The DOC value was calculated based on the results of a laboratory experiment conducted by Dr. Barlaz. This experiment provides data on the amount of CH_4 generated by each type of organic material when decomposed by bacteria under anaerobic conditions, similar to those found in landfills. The DOC of the k component of the waste ($DOC^k_{100\%}$) is provided in Table 7-11.

Table 7-11. Details of DOC estimation for other landfills

k - Component	$DOC^k_{100\%}$	DOC_F	P - Waste composition, %	DOC_i
	gram C/gram wet waste			gram C/gram wet waste
Food waste	0.137	0.70	30.1	0.041
Cardboard	0.416	0.40	11.8	0.049
Paper	0.311	0.42	10.0	0.031
Wood	0.393	0.36	7.5	0.029
Textile	0.495	0.55	4.700	0.023
Leather	0.480	0.55	0.700	0.003
				0.1775

The data in this table were used to calculate the DOC of the k-component (DOC^k_p) and the total DOC of landfill waste. The results are presented in Table 7-12.

$$DOC^k_p = DOC^k_{100\%} \cdot \frac{p}{100}\,; \qquad DOC = \sum_k DOC^k_p$$

Table 7-12. DOC of waste placed in landfills

Landfill	Tbilisi	Rustavi	Other
DOC	0.1364	0.1462	0.1775

Fraction of Degradable Organic Carbon Dissimilated (DOC_F): DOC_F represents the fraction of carbon that has decomposed. It is generally good practice to use a default value of DOC_F = 0.5–0.6. According to the GPG, national DOC_F values can be used based on well-documented research. For municipal solid waste, DOC_F is calculated based[5] on the Van Soest log-linear ratio and the Barlaz experiment, following the formula below:

$$DOC_F = \sum_k \frac{DOC_k \cdot GOC_{F,k}}{GOC}$$

The calculation results are presented in Table 7-13.

Table 7-13. Calculated DOCF for solid waste disposed of at various landfills

Landfill	Tbilisi	Rustavi	Other
DOC_F	0.5537	0.6024	0.4890

Fraction of CH_4 in generated landfill gas (F): The extended Buswell equation is used to calculate the fraction of methane in landfill gas[80]. The calculation results are presented in Table 7-14.

Table 7-14. Estimated methane fraction in landfill gas for managed landfills

Landfill	Tbilisi	Rustavi	Other
F, The fraction of methane in landfill gas	0.5651	0.5639	0.5396

Half-life $t_{1/2}$: The half-life $t_{1/2}$ is the time taken for the DOCm in waste to decay to half its initial mass., $k = \ln(2)/t_{1/2}$. The Tbilisi and Rustavi landfills are located in the eastern Georgian valley, where the climate is moderately dry. Using Table 3.4 from the 2006 IPCC (2006 IPCC, Volume 5, Chapter 3, page 3.18) and taking into account the composition of the waste, k=0.05 ($t_{1/2}$=13.8 years) was obtained for the Tbilisi landfill, and k=0.055 ($t_{1/2}$=12.7

[80] *Buswell A.M., Hatfield W.D. (ed.) (1937): Anaerobic Fermentations. State of Illinois, Department of Registration and Education, Bulletin No. 32.*

years) for the Rustavi landfill. The other landfills are almost equally distributed between western and eastern Georgia. For them, k was chosen based on location.

Delay time: According to the 2006 IPCC, it is good practice to choose a delay time between zero and 6 months. The calculations were performed assuming a delay time of 6 months.

Activity data: The source of information on daily waste disposed of at landfills in 2022 is the Solid Waste Company of Georgia. For 2018-2021, interpolation was made using data from 2017 and 2022.

7.2.2.3 Description of the flexibility used

Flexibility was not used.

7.2.2.4 Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

7.2.2.5 Category-specific quality control/quality assurance and verification

Standard quality control and quality assurance procedures were carried out for this category, and forms and checklists were filled in. The activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. A mechanical error identified in Table 7-9 during quality control has been corrected. In addition, in response to a quality assurance observation, the category codes were aligned with the 2006 Reporting Guidelines.

7.2.2.6 Category-specific recalculation, including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts

Recalculation of methane emissions from managed landfills for 1990-2017 was performed due to the use of different half-life values in the calculations, as well as by changes in the global warming potential/GWP for methane (GWP=21 in the Fourth National Communication, and GWP=28 in the Fifth National Communication).

Table 7-15. Values of the coefficient k used in the calculations

Landfill	Didi Lilo	Kutaisi	Rustavi	Gori	Poti	Zugdidi	Kobuleti	Sareki	Opeti	Kokhra
k	0.05	0.089	0.055	0.089	0.108	0.108	0.108	0.079	0.108	0.079
$t_{1/2}$, year	13.9	7.8	12.6	7.8	6.4	6.4	6.4	8.8	6.4	8.8

Table 7-15: Continuation

Landfill	Dedoplistskaro	Telavi	Meria	Tagveti	Akhtala	Kizgalo	Chacharaki	Hypothetic
K	0.05	0.05	0.108	0.05	0.05	0.05	0.079	0.079
$t_{1/2}$, Year	13.9	13.9	6.4	13.9	13.9	13.9	8.8	8.8

In the previous inventory cycle, k=0.09 ($t_{1/2}$=7.7 years) was used for landfills located in Western Georgia, and k=0.06 ($t_{1/2}$=11.5 years) was used for landfills located in Eastern Georgia.

Table 7-16. Recalculated methane emissions from managed landfills in 1990-2017 years

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC5	11.94	13.22	14.42	15.55	16.60	17.65	18.62	19.53	20.38	21.18	22.06	22.89	23.65	24.19

NC4	11.94	12.69	13.31	13.83	14.35	14.87	15.35	15.79	16.21	16.63	17.2	17.7	18.14	18.53
Difference, %	0.0	4.2	8.4	12.5	15.7	18.7	21.3	23.7	25.7	27.4	28.2	29.3	30.4	30.5
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NC5	24.68	24.91	25.10	25.29	25.48	25.62	25.73	26.47	28.46	30.25	31.89	33.34	34.65	35.84
NC4	18.74	18.82	18.96	19.2	19.46	19.69	19.82	20.29	23.05	24.84	26.47	27.95	29.33	30.62
Difference %	31.7	32.3	32.4	31.7	31.0	30.1	29.8	30.5	23.5	21.8	20.5	19.3	18.1	17.0

7.2.2.7 Planned improvements related to the category, including improvements identified during the inspection

Improvements will be made by recalculating methane emissions if new data on waste composition becomes available.

7.2.3 Unmanaged waste disposal sites (4.A.2)

7.2.3.1 Source Category Description

A solid waste disposal site (landfill) is considered unmanaged if it does not meet the requirements for a managed landfill and in which the depth of the waste layer is equal to or greater than 5 meters. According to the 2006 IPCC, the methane correction factor for this type of landfill MCF=0.8.

According to the Solid Waste Management Company, as of 2023, there are 2 unmanaged landfills in Georgia, the Batumi landfill and the Kobuleti landfill.

Table 7-17. Characteristic of unmanaged landfills

Landfill	Year of activation	Thickness of layer, meter	Methane Correction Factor (MCF)
Batumi	1965	15	0.8
Kobuleti	2005	6	0.8

7.2.3.2 Methodological issues

The same methodology is used as in the case of managed landfills.

Composition of solid waste. The Batumi landfill study was used. The source of the data presented in Table 7-18 is the Solid Waste Management Company of Georgia.

Table 7-18. Composition of solid waste disposed at Batumi landfill

Component	Composition, %
Food waste	40.0
Mixed paper	15.4
Cardboard	2.0
Textile	3.3
Polyethylene/plastic	20.1
Other	19.2

Degradable organic carbon – DOC.

DOC of waste disposed in Batumi landfill = 0.1414.

Fraction of degradable organic carbon dissimilated (DOC_F). DOC_F =0.5687.

$$DOC_F = \sum_k \frac{DOC_k \cdot GOC_{F,k}}{GOC} = \frac{0.0804}{0.1414} = 0.5687$$

Table 7-19. Details of DOC and DOCF calculation for solid waste disposed at unmanaged landfills

Component	DOC	DOC_F	Waste composition, %	DOC_i	DOCi * DOCF
	Grams C/grams wet waste.	Grams C/grams wet waste.		Grams C/grams wet waste.	
Food waste	0.137	0.70	40	0.055	0.038
Cardboard	0.416	0.40	2	0.008	0.003
Paper	0.311	0.42	15.4	0.062	0.030

Textile	0.495	0.55	3.3	0.016	0.009
				0.1414	0.0804

Methane fraction in landfill gas (F): The extended Buswell equation is used to calculate the fraction of methane in landfill gas. The methane fraction in Batumi landfill gas F =0.5618.

Half-life ($t_{1/2}$): Batumi landfill is located in western Georgia on the Black Sea coast, in a temperate humid climate, for it k=0.108 ($t_{1/2}$=6.4 years).

Activity data: The source of information on daily waste disposed at landfills in 2022 is the Solid Waste Management Company of Georgia.

Calculated emissions: Calculated methane emissions from unmanaged landfills are presented in Table 7-20.

Table 7-20. Calculated methane emissions from unmanaged landfills in 1990-2022 years

Landfill	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Batumi	2.77	2.83	2.89	2.97	3.05	3.14	3.21	3.27	3.32	3.36	3.40	3.45	3.49	3.51	3.52	3.53	3.54
Kobuleti																	0.08
Total Gg CH_4	2.77	2.83	2.89	2.97	3.05	3.14	3.21	3.27	3.32	3.36	3.40	3.45	3.49	3.51	3.52	3.53	3.61
Total Gg CO_2-eq	77.6	79.2	81.1	83.1	85.4	87.8	90.0	91.6	92.9	94.1	95.3	96.6	97.6	98.3	98.7	98.9	101.2
Landfill	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
Batumi	3.54	3.54	3.54	3.53	3.52	3.52	3.51	3.51	3.49	3.48	3.48	3.51	3.58	3.65	3.74	3.85	
Kobuleti	0.14	0.20	0.24	0.28	0.31	0.33	0.36	0.37	0.37	0.38	0.39	0.35	0.32	0.28	0.25	0.23	
Total Gg CH_4	3.68	3.74	3.78	3.81	3.84	3.85	3.87	3.87	3.87	3.86	3.87	3.86	3.90	3.93	3.99	4.08	
Total Gg CO_2-eq	103.1	104.7	105.9	106.7	107.4	107.8	108.2	108.5	108.2	108.2	108.3	108.2	109.2	110.1	111.8	114.2	

7.2.3.3 Description of any flexibility used

Flexibility is not used.

7.2.3.4 Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

7.2.3.5 Category-specific quality control/quality assurance and verification

For the category "Methane emissions from unmanaged landfills", standard quality control and quality assurance procedures were carried out, and forms and checklists were completed. Activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

7.2.3.6 Category-specific recalculation, including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts

Methane emissions from unmanaged landfills for 1990-2017 were recalculated due to the use of different half-life values in the calculations. In the previous inventory cycle, k=0.09 ($t_{1/2}$=7.7 years) was used for the Batumi landfill, while in the current cycle, k=0.108 ($_{1/2}$=6.4 years). In the current cycle, solid waste decomposition occurs more rapidly. The Kobuleti landfill was not separately considered in the Fourth National Communication. In the Fifth National Communication, emissions are lower by approximately 20-23%. In the Fifth National Communication, a delay period (6 months) was used.

Table 7-21. Recalculated methane emissions from Batumi landfill in 1990-2017 years

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC5	2.77	2.83	2.89	2.97	3.05	3.14	3.21	3.27	3.32	3.36	3.40	3.45	3.49	3.51
NC4	3.46	3.54	3.63	3.73	3.84	3.95	4.04	4.12	4.18	4.24	4.31	4.36	4.41	4.45
Difference	-19.9	-20.1	-20.3	-20.6	-20.7	-20.6	-20.5	-20.5	-20.6	-20.8	-20.9	-21.0	-21.0	-21.1
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NC5	3.52	3.53	3.54	3.54	3.54	3.54	3.53	3.52	3.52	3.51	3.51	3.49	3.48	3.48
NC4	4.47	4.49	4.50	4.52	4.52	4.53	4.53	4.53	4.52	4.52	4.52	4.51	4.51	4.50
Difference	-21.2	-21.3	-21.5	-21.6	-21.7	-21.9	-22	-22.1	-22.2	-22.3	-22.4	-22.6	-22.7	-22.8

7.2.3.7 Planned improvements related to the category, including improvements identified during the inspection

No improvements are planned.

7.2.4 Uncategorized landfills (waste disposal sites) (5.A.3)

7.2.4.1 Source Category Description

In cases where countries are unable to categorize landfills into managed or unmanaged landfills, landfill is considered uncategorized. The MCF for "uncategorized landfill" is used. The solid waste management company considers the landfills in Tbilisi (Gldani and Iagluji), which have been closed since 2011, as uncategorized.

7.2.4.2 Methodological issues

The same methodology is used as in the case of managed landfills.

Solid waste composition. Same as in the previous inventory cycle.

Degradable organic carbon (DOC). Same as in the previous inventory cycle. DOC=0.1884

Fraction of degradable organic carbon dissimilated (DOCF). Same as in the previous inventory cycle. DOCF =0.5208

Fraction of methane in landfill gas (F): Same as in the previous inventory cycle. F= 0.5308

Half-life ($t_{1/2}$): k=0.05 ($t_{1/2}$=13.86 years). In the previous inventory cycle k=0.06 (t1/2=11.55 years).

Activity data: The same data as in the previous inventory cycle were used.

Calculated emissions: The calculated methane emissions from uncategorized landfills are presented in Table 7-22. Methane emissions from uncategorized landfills accounted for 23.3% of total methane emissions from landfills in 2022.

Table 7-22. Methane emissions from uncategorized landfills in 1990-2022 years

Landfill	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Gldani	11.39	11.76	12.12	12.45	12.76	13.02	13.25	13.45	13.61	13.76	13.90	14.02	14.13	14.23	14.32	14.71	15.07
Iaghluji	2.01	2.38	2.75	3.12	3.48	3.82	4.12	4.40	4.66	4.90	5.13	5.36	5.56	5.76	5.95	6.13	6.31
Total Gg CH_4	13.40	14.14	14.87	15.57	16.23	16.84	17.37	17.85	18.27	18.66	19.03	19.38	19.70	20.00	20.27	20.84	21.38
Total Gg CO_2-eq	375.3	396.0	416.3	436.1	454.5	471.4	486.5	499.8	511.6	522.4	532.8	542.6	551.5	559.9	567.6	583.5	598.6
Landfill	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
Gldani	15.41	15.75	16.07	16.38	16.69	15.88	15.10	14.37	13.67	13.00	12.37	11.76	11.19	10.64	10.12	9.63	
Iaghluji	6.50	6.69	6.89	7.09	7.28	6.93	6.59	6.27	5.96	5.67	5.39	5.13	4.88	4.64	4.42	4.20	
Total Gg CH_4	21.92	22.43	22.96	23.47	23.97	22.80	21.69	20.63	19.63	18.67	17.76	16.89	16.07	15.29	14.54	13.83	
Total Gg CO_2-eq	613.8	628.1	643.0	657.2	671.3	638.5	607.4	577.8	549.6	522.8	497.3	473.0	450.0	428.0	407.1	387.3	

7.2.4.3 Description of any flexibility used

Flexibility is not used

7.2.4.4 Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

7.2.4.5 Category-specific quality control quality assurance and verification

Standard quality control and quality assurance procedures were performed, and forms and checklists were completed. Activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

7.2.4.6 Category-specific explained and justified recalculation, description of changes related to the verification process, and impact on emission trends.

Methane emissions were recalculated for 1990-2017 years due to the use of different half-life values in the calculations.

Table 7-23. Recalculated methane emissions from uncategorized landfills in 1990-2017 years

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC5	13.40	14.14	14.87	15.57	16.23	16.84	17.37	17.85	18.27	18.66	19.03	19.38	19.70	20.00
NC4	15.76	16.56	17.33	18.07	18.75	19.36	19.88	20.34	20.74	21.10	21.44	21.76	22.04	22.31
Difference, %	-14.9	-14.6	-14.2	-13.8	-13.4	-13.0	-12.6	-12.3	-11.9	-11.6	-11.3	-10.9	-10.6	-10.3
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NC5	20.27	20.84	21.38	21.92	22.43	22.96	23.47	23.97	22.80	21.69	20.63	19.63	18.67	17.76
NC4	22.73	23.31	23.87	24.43	24.95	25.50	26.02	25.86	24.36	22.94	21.60	20.34	19.16	18.04
Difference, %	-10.8	-10.6	-10.4	-10.3	-10.1	-10.0	-9.8	-7.3	-6.4	-5.4	-4.5	-3.5	-2.5	-1.6

7.2.4.7 Planned improvements related to the category, including improvements identified during the inspection

No improvements are planned.

7.3 Biological treatment of solid waste (4.B)

7.3.1 Composting (4.B.1)

7.3.1.1 Source-category description

Composting is a biological process that occurs as a result of the interaction of organic waste, microorganisms, moisture, and oxygen, through which solid organic waste is transformed into a humus-like product - compost. Compost is a black, loose organic mass with the smell of soil. Composting reduces the volume of waste, stabilizes the waste, and destroys pathogens in the waste.

Composting is a predominantly aerobic process, in which much of the degradable organic carbon (DOC) in the waste material is converted to carbon dioxide (CO_2). CO_2 emissions are of biogenic origin and should only be reported as an information point in the energy sector. CH_4 is produced in the anaerobic areas of the compost, but it is largely oxidized in the aerobic areas of the compost. The amount of CH_4 released into the atmosphere ranges from less than 1 percent to several percent of the initial carbon content of the material.

Composting may also result in emissions of N_2O. Emissions range from less than 0.5 percent to 5 percent of the initial nitrogen content of the material. Poor composting is likely to produce more CH_4 and N_2O.

Table 7-24: shows methane and nitrous oxide emissions from composting.

Table 7-24. Methane and nitrous oxide emissions from waste composting

Gas			Year										
			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Emmission	CH_4	Gg CH_4	0.002	0.012	0.023	0.037	0.047	0.055	0.062	0.064	0.064	0.064	0.066
		Gg CO_2-eq	0.05	0.34	0.65	1.03	1.33	1.55	1.72	1.78	1.79	1.79	1.84
	N_2O	Gg N_2O	0.000	0.001	0.002	0.003	0.004	0.004	0.005	0.005	0.005	0.005	0.005
		Gg CO_2-eq	0.04	0.24	0.46	0.73	0.94	1.10	1.22	1.26	1.27	1.27	1.31
	Total	Gg CO_2-eq	0.1	0.6	1.1	1.8	2.3	2.7	2.9	3.0	3.1	3.1	3.1

7.3.1.2 Methodological Issues

CH_4 and N_2O emissions from composting were estimated using the 2006 IPCC default method[6]:

$$CH_4 Emissions = \sum (M_i \cdot EF_i) \cdot 10^{-3} - R$$

Where:

CH_4 Emissions Total methane emissions in the inventory year, Gg CH_4

Mi Mass of organic waste treated by biological treatment type i, Gg

EF emission factor for treatmenti , gram CH_4/kg treated waste

i Composting or anaerobic digestion

R Total amount of CH_4 recovered in the inventory year, Gg CH_4

$$N_2O\ Emissions = \sum (M_i \cdot EF_i) \cdot 10^{-3}$$ [81]

Where:

N_2O Emissions Total N_2O emissions in the inventory year, Gg N_2O

Mi Mass of organic waste treated by biological treatment type I, Gg

EF Emission factor for Treatment i, gr N_2O/kg treated waste

i composting or anaerobic digestion

Activity data: Composting is not widely used in Georgia. Only in recent years have several enterprises been established, about which there is more or less reliable information. Accordingly, only recent years are considered. The largest among them is the composting plant located in Gardabani municipality in Kvemo Kartli, which is operated by the poultry production company "Chirina". The investment is fully implemented by the owner of the facility. The plant uses chicken manure, which is processed by an aerobic process. The plant's design capacity is 5,000 tons of compost per year.

Table 7-25. Mass of composted organic waste in 2015-2022 years

Year	2015	2016	2017	2018	2019	2020	2021	2022
Mass of organic waste, g	9.2	11.8	13.8	15.4	15.9	16.0	16.0	16.4

Emission factors: In Georgia, waste is mainly used for composting in raw/wet form, therefore default emission factors corresponding to wet waste have been used (2006 IPCC, Vol. 5, Chapter 4, p. 4.6, Table 4.1).

Table 7-26. Default emission factors for CH4 and N2O from waste composting

Gas	Emission factor

[81] *2006 IPCC, volume 5, chapter 4, pg. 4.5, equation 4.2*

CH_4	4 grams CH_4/kg of waste processed (on a wet weight basis)
N_2O	1.3 grams N_2O/kg of waste processed (on a wet weight basis)

7.3.1.3 Description of any flexibility used

Flexibility was not used

7.3.1.4 Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations included in the 2006 IPCC Guidelines.

7.3.1.5 Category-specific quality control quality assurance and verification

Standard quality control and quality assurance procedures were performed, and forms and checklists were completed. Activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

7.3.1.6 Category-specific recalculations, including explanatory information and justification for recalculations, changes made in response to the review/verification process, and impacts

Methane emissions from waste composting have been calculated for the first time.

7.3.1.7 Planned improvements related to the category, including improvements identified during the inspection

Calculations will be made as new data becomes available on composting plants and the amount of compost produced.

7.3.2 Anaerobic digestion in biogas plants (5.B.2)

NE - Not estimated - There are practically no biogas plants in Georgia. Donors have funded biogas plants for several dozen families, but due to poor maintenance, most of the plants have broken down.

7.4 Waste incineration and open burning (4.C)

7.4.1 Waste incineration (4.C.1)

7.4.1.1 Source Category Description

Waste incineration is defined as the combustion of solid and liquid waste in controlled incineration facilities. In Georgia, medical waste is mainly incinerated. According to the Ministry of Environment Protection and Agriculture, out of 26 clinical waste processing enterprises, 25 are incinerators, and one enterprise processes waste by autoclaving.

Table 7-27: shows the CO_2 emissions calculated based on information provided by companies on the amount of clinical waste incinerated.

Table 7-27. CO2 emissions from clinical waste incineration in 2017-2022 years

	2017	2018	2019	2020	2021	2022
CO_2 emission, Gg	0.73	0.85	1.01	1.51	2.14	2.02

In addition to clinical waste incinerators, environmental permits have been issued for 8 enterprises that incinerate animal waste (chicken, pig, and cattle farm waste). Information from these enterprises is not officially available.

7.4.1.2 Methodological issues

Since CO_2 emissions from waste incineration and open burning are not a key source category, a Tier 1 approach was used (2006 IPCC, Vol. 5, Chapter 5, p. 5.7).

CO_2 emissions from waste incineration and open burning are calculated using the following equation[82]:

$$CO_2\ Emissions = \sum_i (SW_i \cdot dm_i \cdot CF_i \cdot FCF_i \cdot OF_i) \cdot \frac{44}{12}$$

Where:

$CO_2\ Emissions$ CO_2 Emissions in the inventory year, Gg/year

SW_i Amount of waste type i (wet weight) incinerated or open burned, Gg/year

dm_i dry matter content in the waste (wet weight) incinerated or open-burned, (fraction)

CF_i fraction of carbon in the dry matter (total carbon content), (fraction)

FCF_i fraction of fossil carbon in the total carbon, (fraction)

OF_i Oxidation factor, (fraction)

44/12 From C to CO_2 conversion factor

i Incinerated/open burned waste type

Emission factors. Default values of emission factors are used (2006 IPCC, Vol. 5, Chapter 5, p. 5.18, Table 5.2): dry matter content in the residue (wet weight) dmi = 0.9, fraction of carbon in the dry matter (total carbon content) CFi = 0.6; fossil carbon fraction in the total carbon FCF = 0.4, oxidation factor OF = 1.

Activity data. Clinical waste is incinerated in 19 incinerators located in the regions of Georgia, data are available for 2017-2022 years.

Table 7-28. Amount of clinical waste incinerated in 2017-2022 years

Open	2017	2018	2019	2020	2021	2022
Amount of incinerated waste, thousand tons	920	1,070	1,274	1,902	2,701	2,549

Methane and nitrous oxide emissions from clinical waste incineration have not been estimated.

7.4.1.3 Description of any flexibility used

Flexibility was not used.

7.4.1.4 Assessment of uncertainty and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the 2017-2022 time period, in accordance with the recommendations included in the 2006 IPCC Guidelines.

7.4.1.5 Category-specific quality control quality assurance and verification

Standard quality control and quality assurance procedures were performed, and forms and checklists were completed. Activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

[82] *2006 IPCC, volume 5, chapter 5, pg. 5.7, equation 5.1*

7.4.1.6 Category-specific recalculations, including explanatory information and justification for recalculations, changes made in response to the review/review process, and impacts

Carbon dioxide emissions from waste incineration have been calculated for the first time.

7.4.1.7 Planned improvements related to the category, including improvements identified during the inspection

No improvements are planned.

7.4.2 Open burning of waste (4.C.2)

NE Not estimated.

7.5 Wastewater treatment and disposal (4.D)

7.5.1 Domestic wastewater treatment and discharge (4.D.1)

7.5.1.1 Source-category description

Water used in households and industries contains a large amount of toxins, which significantly harms the environment. In general, wastewater is transported from its source to the point of discharge. Before discharge, wastewater is chemically and biologically "passivated" by treatment systems. In the first stage of wastewater treatment (primary treatment), large solids are removed from the wastewater. Then the remaining particles are sedimented. The next stage of treatment involves a combination of biological processes that promote biodegradation by microorganisms.

When wastewater is treated anaerobically, methane is produced. Methane emissions from aerobic systems are insignificant. Both types of wastewater treatment systems (aerobic and anaerobic) produce nitrous oxide by nitrification and denitrification of nitrogen present in the wastewater.

7.5.1.2 Methodological issues

Methane emissions are directly dependent on the content of biodegradable organic matter (DC) in wastewater. The amount of DC in wastewater is characterized by the biochemical oxygen demand (BOD) or the chemical oxygen demand (COD). BOD is an aerobic parameter since its concentration only indicates the amount of carbon that can be aerobically degraded. COD is a measurement of the total amount of material that can be oxidized (both biodegradable and non-biodegradable).

Methane generation also depends on the type of treatment plant and the temperature. Systems that provide anaerobic conditions produce mainly methane, while systems with aerobic conditions produce either no methane or only small amounts. The rate of methane production increases with increasing temperature. Methane production usually requires temperatures above 15°C.

To calculate total emissions from wastewater, the selected emission factors are multiplied by the corresponding organic wastewater amount and summed.

The equation[83] is used to calculate methane emissions from wastewater treatment:

$$CH_4 \,„„Emission = \left[\sum_{i.j} \left(U_i \cdot T_{i,j} \cdot EF_j\right)\right] \; (TOW - S) - R$$

Where:

CH_4 Emissions CH4 emission from wastewater in the inventory year, kg CH_4/year

TOW Total organic matter in wastewater in the inventory year, kg BOD/year

[83] 2006 IPCC, volume 5, chapter 6, pg. 6.11, equation 6.1

S Organic component removed as sludge in the inventory year, kg BOD/year

Ui fraction of population in income group i in inventory year

Ti,j degree of utilization of treatment/discharge pathway or system, j, for each income group

fraction i in inventory year

R amount of CH4 recovered in inventory year, kgCH4/year

i income group: rural, urban high income and urban low income

j each treatment/discharge pathway or system

EFj Emission factor, kg CH_4/kgBOD

The emission factor of a wastewater treatment system is a function of the maximum CH4-producing potential (Bo) and the methane correction factor (MCF) for the wastewater treatment and discharge system[84]:

$$EF_j = B_o \cdot MCF_j$$

Where:

EF_j Emission factor, kg CH_4/kg BOD

j Each treatment/discharge pathway or system

Bo Maximum methane producing capacity, kg CH_4/kg BOD

MCF_j Methane correction factor (fraction)

(TOW) is a function of the human population and BOD generation per person. It is expressed in terms of biochemical oxygen demand (kg BOD/year) and is calculated by the formula[10]:

$$TOW = P \cdot BOD \cdot 0.001 \cdot I \cdot 365$$

Where:

TOW Total organic matter in wastewater in the inventory year, kg BOD/year

P Country Population in the inventory year, (persons)

BOD country-specific per capita BOD in inventory year, g/person/day.

0.001 conversion from grams BOD to kg BOD

I correction factor for additional industrial BOD discharged into sewers

According to the 2006 IPCC, it is good practice to consider three categories of population: rural population, urban high-income population, and urban low-income population. There is no information on the income distribution of the urban population of Georgia. This means that the index summation is used only for urban (total) and rural populations. It is also good practice to use a default value of Bo of 0.25 kg CH_4/kg COD or 0.6 kg CH_4/kg BOD (2006 IPCC, Vol. 5, Chapter 6, p. 6.12).

Emission factors: If country-specific data are not available, the 2006 IPCC recommends that the default value of a neighboring comparable country be used as the BOD value. The default value for Greece BOD=0.057 kg BOD/person/day (20,805 kg BOD/1000 persons/year) was used.

About 80% of the urban population is connected to sewage systems. Wastewater treatment is carried out in poorly managed aerobic treatment plants. Methane correction factor MCF=30% (2006 IPCC, Vol. 5, Chapter 6, p. 6.12 Table 6.3). The wastewater of the remaining population (20%) is discharged mainly into rivers, MCF=10% (2006 IPCC, Vol. 5, Chapter 6, p. 6.12 Table 6.3). In rural Georgia, latrines are usually used (groundwater levels are assumed to be low), MCF=10% (2006 IPCC, Vol. 5, Chapter 6, p. 6.12 Table 6.3).

Activity data: The source of information on urban and rural populations is the National Statistical Office of Georgia.

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[84] *2006 IPCC, volume 5, chapter 6, pg. 6.12, equation 6.2*

Table 7-29. Urban and rural population in 1990-2022 years

Year	Population in thousands		
	Urban	Rural	Total
1990	2,999	2,426	5,424
1991	3,005	2,449	5,453
1992	2,983	2,484	5,467
1993	2,914	2,432	5,346
1994	2,653	2,277	4,930
1995	2,568	2,226	4,794
1996	2,483	2,191	4,675
1997	2,413	2,146	4,558
1998	2,366	2,139	4,505
1999	2,338	2,132	4,470
2000	2,308	2,127	4,435
2001	2,293	2,102	4,395
2002	2,278	2,078	4,356
2003	2,265	2,006	4,271
2004	2,252	1,935	4,186
2005	2,238	1,863	4,102
2006	2,225	1,792	4,017

Year	Population in thousands		
	Urban	Rural	Total
2007	2,212	1,720	3,932
2008	2,199	1,649	3,848
2009	2,188	1,641	3,829
2010	2,172	1,628	3,800
2011	2,157	1,617	3,774
2012	2,137	1,602	3,739
2013	2,125	1,593	3,718
2014	2,124	1,593	3,717
2015	2,127	1,595	3,722
2016	2,131	1,598	3,729
2017	2,130	1,597	3,726
2018	2,175	1,555	3,730
2019	2,184	1,539	3,724
2020	2,195	1,522	3,717
2021	2,216	1,513	3,729
2022	2,201	1,488	3,689

Table 7-30. CH4 emissions from Domestic wastewater treatment and discharge

Year	CH_4 From the population		Emission	
	Urban	Rural	Gg CH_4	Gg CO_2-eq
1990	7.11	3.03	10.14	284.0
1991	7.13	3.06	10.18	285.2
1992	7.07	3.10	10.18	284.9
1993	6.91	3.04	9.95	278.5
1994	6.29	2.84	9.13	255.8
1995	6.09	2.78	8.87	248.3
1996	5.89	2.74	8.62	241.5
1997	5.72	2.68	8.40	235.3
1998	5.61	2.67	8.28	231.9
1999	5.55	2.66	8.21	229.8
2000	5.47	2.66	8.13	227.6
2001	5.44	2.62	8.06	225.8
2002	5.40	2.59	8.00	223.9
2003	5.37	2.50	7.88	220.5
2004	5.34	2.42	7.76	217.2
2005	5.31	2.33	7.63	213.8
2006	5.28	2.24	7.51	210.4

Year	CH_4 From the population		Emission	
	Urban	Rural	Gg CH_4	Gg CO_2-eq
2007	5.25	2.15	7.39	207.0
2008	5.22	2.06	7.27	203.7
2009	5.19	2.05	7.24	202.7
2010	5.15	2.03	7.18	201.1
2011	5.12	2.02	7.13	199.7
2012	5.07	2.00	7.07	197.9
2013	5.04	1.99	7.03	196.8
2014	5.04	1.99	7.03	196.7
2015	5.05	1.99	7.04	197.0
2016	5.05	1.99	7.05	197.4
2017	5.05	1.99	7.04	197.2
2018	5.54	1.94	7.48	209.4
2019	5.94	1.92	7.86	220.2
2020	6.36	1.90	8.26	231.2
2021	6.80	1.89	8.69	243.4
2022	7.14	1.86	9.00	252.0

7.5.1.3 Description of any flexibility used

Flexibility was not used.

7.5.1.4 Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines. Details are provided in the subsections.

7.5.1.5 Category-specific quality control and quality assurance and verification

Standard quality control and quality assurance procedures were performed, and forms and checklists were filled in. Activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

7.5.1.6 Category-specific recalculations, explanatory information and justification for recalculations, changes made in response to the review/ verification process, and impacts

The recalculation was carried out because the methane correction factor MCF=30% was used in the calculations for urban wastewater (instead of the value MCF=50% used in the Fourth National Communication) and it was taken into account that 55% of the population's wastewater is discharged into water facilities without treatment, corresponding to MCF=10%.

Table 7-31. Recalculated methane emissions from domestic wastewater in 1990-2017 years

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC5	10.14	10.18	10.18	9.95	9.13	8.87	8.62	8.40	8.28	8.21	8.13	8.06	8.00	7.88
NC4	11.45	11.50	11.48	11.22	10.29	9.99	9.71	9.46	9.32	9.23	9.14	9.06	8.99	8.87
Difference %	-11.4	-11.4	-11.4	-11.3	-11.3	-11.2	-11.2	-11.1	-11.1	-11.1	-11.0	-11.1	-11.1	-11.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NC5	7.76	7.63	7.51	7.39	7.27	7.24	7.18	7.13	7.07	7.03	7.03	7.04	7.05	7.04
NC4	8.74	8.61	8.49	8.36	8.23	8.19	8.13	8.08	8.00	7.96	7.95	7.97	7.98	7.97
Difference %	-11.3	-11.4	-11.5	-11.6	-11.7	-11.7	-11.7	-11.7	-11.7	-11.7	-11.7	-11.7	-11.7	-11.7

7.5.1.7 Planned improvements related to the category, including improvements identified during the inspection

Improvements will be made with new data on the share of the population whose wastewater is discharged into water facilities without treatment.

7.5.2 Nitrous oxide emissions from wastewater

7.5.2.1 Source-category description

Polluted waters are formed as a result of human consumption of food. The main source of nitrogen in polluted water is protein. Protein is a complex, high-molecular-weight organic compound consisting of amino acids linked by peptide bonds.

Table 7-32. N2O emissions from Domestic wastewater in 1990-2022 years

Year	Population, thsd persons	Protein consumption, g/person/day	Gg N_2O	Gg CO_2-eq
1990	5,424	56	0.19	50.8
1991	5,453	56	0.19	51.1
1992	5,467	56	0.19	51.2
1993	5,346	60	0.20	53.6
1994	4,930	65	0.20	53.6
1995	4,794	69	0.21	55.3
1996	4,675	69	0.20	53.9
1997	4,558	69	0.20	52.6
1998	4,505	70	0.20	52.7
1999	4,470	71	0.20	53.1
2000	4,435	72	0.20	53.4
2001	4,395	72	0.20	52.9
2002	4,356	72	0.20	52.4
2003	4,271	74	0.20	52.8
2004	4,186	76	0.20	53.2
2005	4,102	77	0.20	52.8
2006	4,017	77	0.20	51.7

Year	Population, thsd persons	Protein consumption, g/person/day	Gg N_2O	Gg CO_2-eq
2007	3,932	77	0.19	50.6
2008	3,848	78	0.19	50.2
2009	3,829	79	0.19	50.6
2010	3,800	80	0.19	50.8
2011	3,774	81	0.19	51.1
2012	3,739	82	0.19	51.3
2013	3,718	83	0.19	51.6
2014	3,717	84	0.20	52.2
2015	3,722	83	0.19	51.6
2016	3,729	83	0.20	51.9
2017	3,726	84	0.20	52.4
2018	3,730	85	0.20	52.7
2019	3,723	86	0.20	53.2
2020	3,717	86	0.20	53.6
2021	3,729	87	0.21	54.4
2022	3,689	85	0.20	52.2

7.5.2.2 Methodological issues

Discharge of wastewater into natural waters results in significant emissions of nitrous oxide. Nitrous oxide emissions from the source category domestic wastewater were calculated using the 2006 IPCC Tier 1 approach, using the following equation[85]:

$$N_2O\ Emissions = N_{EFFLUENT} \bullet EF_{EFFLUENT} \bullet 44/28$$

Where:

N_2O Emissions — N_2O emission in the inventory year, kg N_2O/year;

$N_{EFFLUENT}$ — nitrogen in the effluent discharged to the aquatic environments, kgN/year

$EF_{EFFLUENT}$ — Emission factor for N_2O emissions from discharged to wastewater, kg N_2O-N/kg N;

Default value is 0.005 kg N_2O-N/kg N (2006 IPCC, Vol. 5, Chapter 6, p. 6.27, Table 6.11);

44/28 — conversion of kg N_2O-Nto kg N_2O

Nitrogen in the effluent is estimated as follows:

$$N_{EFFLUENT} = (P \bullet Protein \bullet F_{NPR} \bullet F_{NON-CON} \bullet F_{IND-COM}) - N_{SLUDGE}$$ [86]

Where:

$N_{EFFLUENT}$ — annual amount of nitrogen in the wastewater effluent, kg N/year

P — human population

Protein — Annual per capita protein consumption, kg/person/year

F_{NPR} — fraction of nitrogen in protein,

$F_{NON-CON}$ — factor for non-consumed protein added to wastewater

$F_{IND-COM}$ — factor for industrial and commercial protein co-discharged into the sewer system

N_{SLUDGE} — Nitrogen removed with sludge (default = 0), kg N/year

Activity data: The National Statistical Office's Statistical Publications provide per capita protein consumption from food products for 2015-2022 years. The data for previous years are the same as in the Fourth National Communication of Georgia to the UNFCCC. In particular, the FAO Statistical Office data on per capita protein consumption in Georgia: 56 grams/person/day in 1990-1992, 69 grams/person/day in 2000-2002, and 72 grams/person/day in 2005-2007. Protein consumption in 2008-2014 was calculated assuming that per capita protein consumption would increase by 1 gram until 2015.

Table 7-33. Protein consumption from food by the population, grams/person/day

Food	Year							
	2015	2016	2017	2018	2019	2020	2021	2022
Meat	15.0	15.1	15.4	15.2	16.4	15.6	15.6	16.3
Milk	15.0	15.1	15.1	16.1	16.5	16.5	17.3	17.3
Egg	2.6	2.6	2.7	2.8	3.0	3.1	3.0	3
Wheat	38.2	37.5	38.8	38.7	38.5	38.7	38.0	35.2
Maize	7.6	8.0	7.4	7.3	6.7	7.8	8.6	8.4
Potato	2.2	2.3	2.2	2.0	2.0	2.1	2.3	2.3
Vegetable	2.4	2.6	2.5	2.4	2.4	2.5	2.4	2.2
Total	**83.0**	**83.2**	**84.1**	**84.5**	**85.5**	**86.3**	**87.2**	**84.7**

Emission factors: Default values of $EF_{EFFLUENT}$ are 0.005 kg N_2O-N/kg N, F_{NPR} = 0.16 kg N/kg protein, $F_{NON-CON}$ =1.1, $F_{IND-COM}$ =1.25 (2006 IPCC, Vol. 5, Chapter 6, p. 6.27, Table 6.11)

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[85] 2006 IPCC, volume 5, chapter 6, pg. 6.25, equation 6.7

[86] 2006 IPCC, volume 5, chapter 6, pg. 6.25, equation 6.8

7.5.2.3 Description of any flexibility used

Flexibility was not used.

7.5.2.4 Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines. Details are provided in the subsections.

7.5.2.5 Category-specific quality control and quality assurance and verification

Standard quality control and quality assurance procedures were performed, and forms and checklists were completed. Operational data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

7.5.2.6 Category-specific recalculation, explanatory information and justification for recalculations, changes made in response to the review/ verification process, and impacts

The change is due to a change in the calculation algorithm (methodology).

Table 7-34. Recalculated nitrous oxide emissions from domestic wastewater in 1990-2017 years

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC5	0.19	0.19	0.19	0.20	0.20	0.21	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
NC4	0.18	0.18	0.18	0.19	0.19	0.19	0.19	0.18	0.18	0.19	0.19	0.18	0.18	0.18
Difference, %	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NC5	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.20	0.19	0.20	0.20
NC4	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.19	0.19
Difference, %	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	5.5	4.5	4.4

7.5.2.7 Planned improvements related to the category, including improvements identified during the inspection

Improvements will be made as new data becomes available on the amount of protein consumed by the population.

7.5.3 Industrial wastewater treatment and discharge (5.D.2)

7.5.3.1Source Category description

The assessment of the methane generation potential from industrial wastewater is based on the concentration of biodegradable organic matter in the wastewater, the volume of wastewater, and the industry's propensity to treat its wastewater.

7.5.3.2 Methodological issues

The method for calculating emissions from industrial wastewater is similar to that used for domestic wastewater. The preparation of emission factors and activity data is more difficult because there are many types of wastewater and many different industries.

For industrial wastewater, the acceptable indicator of DC is COD. The 2006 IPCC provides typical COD values for different industries by region. The IPCC also provides default values for wastewater generated per unit of output (m^3/tonne of product) by industry. The formula[87] used to calculate methane emissions from industrial wastewater is:

[87] *2006 IPCC, volume 5, chapter 6, pg. 6.20, equation 6.4*

$$CH_4 Emissions = \sum_i [(TOW_i - S_i) \times EF_i - R_i]$$

Where:

TOW_i total organically degradable material in wastewater from industry i in inventory year, kg COD/yr

i Industry sector

S_i organic component removed as sludge in inventory year, kg COD/yr

EF_i emission factor for industry *i*, kg CH4/kg COD for treatment/discharge pathway or system(s) used in inventory year

R_i Methane recovered from wastewater type i, kg CH_4/year

Emission factor: The emission factor depends on the maximum methane-producing capacity for each industry and the methane correction factor[13].

$$EF_j = B_0 \cdot MCF_j$$

Where:

EF_j Emission factor of the cleaning/discharge system, kg CH_4/kg COD

j each treatment/discharge pathway or system

Bo maximum CH_4 producing capacity, kg CH_4/kg COD

MCF_j Methane correction factor (fraction)

If country-specific data are not available, it is good practice to use the IPCC COD default value (Bo=0.25 kg CH_4/kg COD). MCF=0.3. The organic component is not removed and methane is not recovered, i.e. S=0 and R=0. The amount of organically degradable material in wastewater discharged (TOW_I) from a specific industry is calculated using the formula[88]:

$$TOW = P_i \cdot W_i \cdot COD_i$$

Where:

TOW_i total organically degradable material in wastewater for industry *i*, kg COD/yr

i Industry sector

P_i total industrial product for industrial sector *i*, t/yr

W_i Wastewater generated (m^3/ton of product)

COD_i chemical oxygen demand (industrial degradable organic component in wastewater), kg COD/m^3

Activity data: The source of data on production from industries is the National Statistical Office of Georgia.

CH_4 emissions from industrial wastewater treatment are presented in Table 7-35.

Table 7-35. CH4 emissions from industrial wastewater treatment in 1990-2022 years

Year	Alcohol Refining	Beer & malt	Dairy Product	Meat and poultry	Organic chemicals	Paper and pulp	Vegetables, Fruits & Juices	Wine and vinegar	Soft drinks	Canneries	**Total**
1990	0.163	0.065	0.177	0.296	0.007	1.454	0.004	0.042	0.041	0.004	**2.25**
1991	0.153	0.041	0.108	0.029	0.005	0.025	0.002	0.033	0.023	0.002	**0.42**
1992	0.128	0.016	0.017	0.009	0.004	0.006	0.000	0.046	0.008	0.001	**0.24**
1993	0.235	0.008	0.013	0.001	0.003	0.000	0.000	0.027	0.002	0.000	**0.29**
1994	0.045	0.004	0.013	0.000	0.002	0.000	0.000	0.016	0.001	0.000	**0.08**
1995	0.020	0.004	0.003	0.000	0.002	0.002	0.000	0.009	0.002	0.000	**0.04**
1996	0.026	0.003	0.003	0.001	0.003	0.002	0.000	0.006	0.005	0.000	**0.05**
1997	0.050	0.005	0.004	0.002	0.004	0.003	0.000	0.008	0.012	0.000	**0.09**
1998	0.022	0.007	0.005	0.002	0.004	0.002	0.000	0.006	0.008	0.000	**0.06**

[88] *2006 IPCC, volume 5, chapter 6, pg. 6.22, equation 6.6*

Year	Alcohol Refining	Beer & malt	Dairy Product	Meat and poultry	Organic chemicals	Paper and pulp	Vegetables, Fruits & Juices	Wine and vinegar	Soft drinks	Canneries	**Total**
1999	0.092	0.009	0.003	0.003	0.005	0.003	0.000	0.005	0.006	0.000	**0.13**
2000	0.087	0.016	0.003	0.004	0.005	0.004	0.000	0.004	0.008	0.000	**0.13**
2001	0.105	0.018	0.003	0.001	0.006	0.001	0.000	0.005	0.010	0.000	**0.15**
2002	0.027	0.019	0.007	0.001	0.006	0.000	0.000	0.005	0.011	0.000	**0.08**
2003	0.023	0.019	0.004	0.002	0.006	0.000	0.000	0.006	0.019	0.000	**0.08**
2004	0.087	0.033	0.005	0.005	0.006	0.000	0.000	0.007	0.026	0.000	**0.17**
2005	0.114	0.040	0.005	0.005	0.006	0.003	0.000	0.010	0.036	0.000	**0.22**
2006	0.154	0.050	0.007	0.008	0.007	0.000	0.021	0.005	0.047	0.004	**0.30**
2007	0.132	0.049	0.009	0.012	0.007	0.000	0.067	0.004	0.052	0.007	**0.34**
2008	0.164	0.043	0.010	0.016	0.008	0.000	0.021	0.005	0.042	0.010	**0.32**
2009	0.121	0.047	0.282	0.012	0.008	0.000	0.033	0.004	0.036	0.006	**0.55**
2010	0.112	0.057	0.300	0.020	0.008	0.000	0.026	0.007	0.044	0.010	**0.58**
2011	0.131	0.054	0.360	0.031	0.009	0.001	0.067	0.008	0.039	0.025	**0.72**
2012	0.132	0.068	0.371	0.041	0.009	0.001	0.059	0.012	0.055	0.016	**0.76**
2013	0.082	0.069	0.340	0.053	0.009	0.001	0.050	0.017	0.054	0.018	**0.69**
2014	0.080	0.068	0.350	0.056	0.009	0.001	0.094	0.029	0.063	0.025	**0.77**
2015	0.045	0.059	0.337	0.057	0.010	0.000	0.044	0.020	0.062	0.033	**0.67**
2016	0.021	0.070	0.320	0.067	0.009	0.000	0.058	0.024	0.058	0.033	**0.66**
2017	0.032	0.061	0.353	0.071	0.009	0.001	0.075	0.023	0.065	0.032	**0.72**
2018	0.038	0.061	0.393	0.087	0.008	0.001	0.058	0.030	0.077	0.026	**0.78**
2019	0.037	0.070	0.398	0.081	0.010	0.001	0.054	0.037	0.081	0.025	**0.79**
2020	0.039	0.074	0.403	0.074	0.003	0.001	0.050	0.025	0.085	0.021	**0.78**
2021	0.045	0.076	0.417	0.087	0.002	0.001	0.045	0.032	0.105	0.026	**0.84**
2022	0.047	0.084	0.400	0.105	0.003	0.001	0.041	0.033	0.121	0.026	**0.86**

7.5.3.3 Description of any flexibility used

Flexibility was not used.

7.5.3.4 Uncertainty assessment and time series consistency

Uncertainty assessment

See information in Annex II.

Time series consistency

To ensure time series consistency of the results obtained, the same approach was used for the entire period considered, in accordance with the recommendations of the 2006 IPCC Guidelines.

7.5.3.5 Category-specific quality control and quality assurance and verification

Standard quality control and quality assurance procedures were performed, and forms and checklists were filled in. Activity data and methods used to estimate greenhouse gas emissions were documented and archived in both hard copy and electronic form. No errors were identified during quality control and quality assurance.

7.5.3.6 Category-specific recalculations, explanatory information and justification for recalculations, changes made in response to the review/ verification process, and impacts

The recalculated CH_4 emissions from industrial wastewater treatment are significantly lower than those reported in the Fourth National Communication. This is mainly due to the revision of organic chemical production data.

Table 7-36. Recalculated CH4 emissions from industrial wastewater treatment in 1990-2017 years

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NC5	2.25	0.42	0.24	0.29	0.08	0.04	0.05	0.09	0.06	0.13	0.13	0.15	0.08	0.08
NC4	8.84	5.83	4.47	3.34	1.96	2.52	3.12	3.76	4.32	4.99	5.59	5.78	5.87	6.05
Difference, %	-74.5	-92.8	-94.7	-91.4	-95.8	-98.2	-98.4	-97.7	-98.7	-97.5	-97.6	-97.4	-98.7	-98.7
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NC5	0.17	0.22	0.30	0.34	0.32	0.55	0.58	0.72	0.76	0.69	0.77	0.67	0.66	0.72
NC4	6.30	6.53	7.04	7.50	7.91	8.80	9.46	10.45	10.66	10.51	10.60	10.91	10.47	10.42
Difference, %	-97.3	-96.6	-95.7	-95.5	-96.0	-93.8	-93.8	-93.1	-92.8	-93.4	-92.7	-93.9	-93.7	-93.1

7.5.3.7 Planned improvements related to the category, including improvements identified during the inspection

Improvements will be made if more accurate data on wastewater from industrial facilities is available.

Chapter 8. Other (CRT sector 6)

Not Applicable

Chapter 9. Indirect carbon dioxide and nitrous oxide emissions

The indirect nitrous oxide (N_2O) emissions are estimated from agriculture, specifically from manure management and managed soils.

Indirect N_2O emissions result primarily from nitrogen volatilization in the form of ammonia (NH_3) and nitrogen oxides (NO_x). These nitrogen losses begin in animal housing and areas where manure is spread. The detailed information can be seen in Chapter 5.

Chapter 10. Recalculations and improvements

In Georgia's national GHG inventory, the application of higher-tier methodologies (Tier 2 and Tier 3) and the use of country-specific data have been significantly expanded compared to the previous inventory report. These methodological improvements enhance the accuracy and reliability of emissions estimates across multiple sectors, ensuring better alignment with the Enhanced Transparency Framework (ETF) requirements. The information on the recalculations are presented in the sectoral chapters.

In the energy sector, Tier 2 methods are implemented for CO_2, CH_4, and N_2O emissions from fuel combustion in the energy industry, improving the precision of emission estimates by incorporating more detailed and sector-specific parameters. Additionally, in the category of fugitive emissions from oil and natural gas, Tier 2 methodologies are specifically applied to estimate CH_4 emissions from natural gas systems, ensuring a more accurate representation of methane losses within the sector.

Within the IPPU sector, higher-tier methods are utilized to refine emission estimates across various industrial activities:

Mineral Industry: Both Tier 2 and Tier 3 methods are used to assess CO_2 emissions, enhancing the specificity and accuracy of emission factors.

Chemical Industry: Tier 3 methodologies are applied to improve the estimation of process emissions, incorporating detailed process-specific parameters and measurements.

Metal Production: Tier 2 methods are used for CO_2 emissions, ensuring more precise calculations through industry-specific data.

Other Industrial Processes: In select cases, Tier 2 methodologies are employed to estimate N_2O emissions from specific production activities, reflecting improvements in data accuracy and process characterization.

Country-specific emission factors have been introduced, particularly in the mineral and chemical industries, to enhance the accuracy of CO_2 emission estimates by replacing default IPCC factors with data tailored to Georgia's industrial operations.

In the agriculture sector, Tier 2 methodologies are applied to improve the precision of emission estimates:

Enteric Fermentation: A Tier 2 approach is used for CH_4 emissions, incorporating country-specific livestock data to enhance accuracy.

Manure Management: Tier 2 methods are applied for both CH_4 and N_2O emissions, integrating national-level data on manure storage and treatment practices to refine estimations.

Country-specific emission factors are also utilized in this sector, particularly for CH_4 emissions from enteric fermentation and manure management, as well as for N_2O emissions from manure management, ensuring that estimates reflect Georgia's agricultural conditions more accurately.

In the LULUCF sector, Tier 2 methodologies are applied for CO_2 emissions from forest lands, allowing for more precise assessments of carbon stock changes and emissions associated with land use dynamics. Additionally, plant-specific emission factors are introduced alongside IPCC default values in various land-use categories, including forest lands, croplands, and grasslands, to improve the accuracy of emission and sequestration estimates.

In the waste sector, Tier 2 methods are employed for CH_4 emissions from solid waste disposal sites, refining estimations by incorporating country-specific parameters on waste composition, degradation rates, and site management practices. Furthermore, country-specific data is integrated into CH_4 emission estimates, enhancing the representation of waste sector emissions in the national inventory.

Annexes to the national inventory document

Annex I. **Key Category Analysis**

This annex describes the analysis of the key source categories by emission and removal of greenhouse gases, the first approach to estimating the level and trend for the initial year 1990 and the final year 2022. The key categories are analysed under two assumptions: (1) taking into account land use, land use change, and the forest sector, and (2) without taking it into account.

Description of the approach used for identifying key categories

The key category analysis, as described in the 2006 IPCC Guidelines, is a systematic procedure for prioritising categories in greenhouse gas inventories based on their importance to overall emissions and removals. The goal of this analysis is threefold:

1. Efficient Resource Allocation: By identifying key categories, limited resources can be directed toward improving data collection and methods for the most impactful categories.
2. Methodological Choice: To improve inventory accuracy, more thorough, higher-tier procedures (Tier 2 and Tier 3) should be used in these areas.
3. Quality Assurance: Quality assurance and control techniques should be used to conduct further scrutiny on key categories.

The identification of key categories in greenhouse gas inventories involves several approaches. The first approach, known as Approach 1, includes two main analyses: a level assessment and a trend assessment, which was applied in this inventory. The level assessment identifies categories that contribute significantly to the absolute level of emissions and removals, while the trend assessment focuses on categories whose trends have a substantial impact on the overall inventory trend. This approach employs a cumulative threshold, usually 95% of total emissions, to determine the key categories.

The level assessment is performed according to equation 4.1, Ch.4, Vol1, IPCC 2006 GL (p 4.14), and the trend assessment is performed according to equation 4.2, Ch.4, Vol1, IPCC 2006 GL (p.4.15).

Information on the level of disaggregation

The IPCC 2006 Guidelines suggest specific aggregation levels for analysis under Approach 1, as outlined in Table 4.1 (Ch. 4, Vol. 1, IPCC 2006 GL, pp. 4.8–4.12). While the key category analysis generally adheres to these suggested levels of disaggregation, the following adjustments were made to enhance the accuracy and relevance of the analysis:

1. **Category 1A3b (Road Transportation) and 1A3c (Railways, Waterborne Navigation, and Other Transportation):** These categories were further disaggregated by main fuel types due to the significant variation in fuel consumption and associated greenhouse gas (GHG) emissions. For instance, in 2022, GHG emissions from liquid fuel consumption by road transport exceeded 3,000 Gg CO_2, while emissions from gaseous fuels were approximately ten times lower. This disaggregation provides a more precise understanding of the dominant fuel types contributing to emissions and enables targeted mitigation measures.
2. **Category 4A (CRT 5A – Solid Waste Disposal):** This category was disaggregated into subcategories based on landfill types due to the significant differences in CH_4 emissions from various types of landfills. For example, managed landfills generate substantially higher CH_4 emissions compared to unmanaged or Uncategorised landfills. This level of detail ensures that the

analysis captures the disproportionately high contribution of managed landfills to overall GHG emissions, facilitating more effective waste management and emission reduction strategies.

These refinements to the disaggregation levels align to improve the accuracy and utility of the key category analysis by accounting for significant circumstances within broad categories.

Key categories

The main categories of greenhouse gas emissions and removals estimated for the year 1990 are presented by level in Table I.1 and Table I.2.

Table 10-1 Greenhouse gas emissions and removals level by Key categories in 1990, including the LULUCF sector

IPCC Category Code	IPCC Category	Greenhouse Gas	Beginning Year Estimate Ex,t Gg CO2 eq.	Beginning Year Estimate Absolute Value |Ex,t|	Level Assessment Lx,t	Cumulative Total Value
1A1	Fuel Combustion - Energy Industries - Liquid fuels	CO2	8,172.17	8,172.17	0.147	0.147
1A2	Fuel Combustion - Manufacturing Industries and Construction - Gaseous fuels	CO2	7,281.16	7,281.16	0.131	0.278
1B2b	Fugitive Emissions from Natural Gas	CH4	6,915.46	6,915.46	0.124	0.402
4A	Forest Land Remanning Forest Land	CO2	-6,904.30	6,904.30	0.124	0.526
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	CO2	4,604.23	4,604.23	0.083	0.609
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	CO2	4,185.94	4,185.94	0.075	0.684
1A4b	Fuel Combustion - Residential - Gaseous fuels	CO2	2,786.65	2,786.65	0.050	0.734
3A1	Enteric Fermentation - Cattle	CH4	2,657.20	2,657.20	0.048	0.782
4B	Cropland Remaining Cropland	CO2	-1,730.01	1,730.01	0.031	0.813
1A1	Fuel Combustion - Manufacture of Solid Fuel and Other Energy Industries - Solid Fuels	CO2	955.76	955.76	0.017	0.830
1B1	Fugitive Emissions from Solid Fuels	CH4	954.73	954.73	0.017	0.847
1A4b	Fuel Combustion - Residential - Liquid fuels	CO2	762.13	762.13	0.014	0.861
1A4a	Fuel Combustion - Commercial/Institutional- Liquid fuels	CO2	626.90	626.90	0.011	0.872
3D1	Direct N2O Emissions from Managed Soils	N2O	604.20	604.20	0.011	0.883
2B1	Chemical Industry - Ammonia Production	CO2	C	C	C	C
2A1	Mineral Industry - Cement Production	CO2	C	C	C	C
4C	Grasslands Remaining Grasslands	CO2	438.90	438.90	0.008	0.909

IPCC Category Code	IPCC Category	Greenhouse Gas	Beginning Year Estimate Ex,t Gg CO2 eq.	Beginning Year Estimate Absolute Value |Ex,t|	Level Assessment Lx,t	Cumulative Total Value
1A4c	Fuel Combustion - Agriculture/Forestry/Fishing/Fish Farms - Liquid fuels	CO2	390.99	390.99	0.007	0.916
5A3	Solid Waste Disposal -Uncategorised	CH4	375.20	375.20	0.007	0.923
5A1	Solid Waste Disposal - Managed	CH4	334.32	334.32	0.006	0.929
3A4	Enteric Fermentation - Other Cattle	CH4	323.12	323.12	0.006	0.935
5D1	Domestic Wastewater Treatment	CH4	283.92	283.92	0.005	0.940
1A4b	Fuel Combustion - Residential - Solid Fuels	CO2	273.83	273.83	0.005	0.945
3B1	Manure Management - Cattle	CH4	247.24	247.24	0.004	0.949
1A4a	Fuel Combustion - Commercial/Institutional- Gaseous fuels	CO2	228.21	228.21	0.004	0.953

According to Table I.1, in 1990 the number of key categories was 25. Of these, 13 are from the energy sector (1A1, 1A2, 1A4b, 1A4c, 1B1, 1B2b...), 4 - from the agriculture sector (3A1, 3A4, 3B1, 3D1), 2 - from the industry sector (2A1, 2B1), 3 - from the LULUCF sector (4A, 4B, 4C), and 3 - from the waste sector (5A1, 5A3, 5D1).

For the same year, the analysis of the key categories excluding land use, land use change and forestry is presented in 24 categories, of which 14 are from the energy sector (1A1, 1A2, 1A4a, 1A4b, 1A4c, 1B1, 1B2, 1B3b...), 4 from the agriculture sector (3A1, 3A4, 3B1, 3D1), 3 from the industry sector (2A1, 2B1, 2C1), and 3 from the waste sector (5A1, 5A3, 5D1) (Table I.2).

Table 10-2 Greenhouse gas emissions and removals level by Key categories in 1990, excluding the LULUCF sector

IPCC Category Code	IPCC Category	Greenhouse Gas	Beginning Year Estimate Ex,t Gg CO2 eq.	Beginning Year Estimate Absolute Value |Ex,t|	Level Assessment Lx,t	Cumulative Total Value
1A1	Fuel Combustion - Energy Industries - Liquid fuels	CO2	8,172.17	8,172.17	0.175	0.175
1A2	Fuel Combustion - Manufacturing Industries and Construction - Gaseous fuels	CO2	7,281.16	7,281.16	0.156	0.332
1B2b	Fugitive Emissions from Natural Gas	CH4	6,915.46	6,915.46	0.148	0.480
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	CO2	4,604.23	4,604.23	0.099	0.579
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	CO2	4,185.94	4,185.94	0.090	0.669

IPCC Code Category	IPCC Category	Greenhouse Gas	Beginning Year Estimate Ex,t Gg CO2 eq.	Beginning Year Estimate Absolute Value |Ex,t|	Level Assessment Lx,t	Cumulative Total Value
1A4b	Fuel Combustion - Residential - Gaseous fuels	CO_2	2,786.65	2,786.65	0.060	0.729
3A1	Enteric Fermentation - Cattle	CH_4	2,657.20	2,657.20	0.057	0.786
1A1	Fuel Combustion - Manufacture of Solid Fuel and Other Energy Industries - Solid Fuels	CO_2	955.76	955.76	0.021	0.806
1B1	Fugitive Emissions from Solid Fuels	CH_4	954.73	954.73	0.020	0.827
1A4b	Fuel Combustion - Residential - Liquid fuels	CO_2	762.13	762.13	0.016	0.843
1A4a	Fuel Combustion - Commercial/Institutional-Liquid fuels	CO_2	626.90	626.90	0.013	0.857
3D1	Direct N_2O Emissions from Managed Soils	N_2O	604.20	604.20	0.013	0.870
2B1	Chemical Industry - Ammonia Production	CO_2	C	C	C	C
2A1	Mineral Industry - Cement Production	CO_2	C	C	C	C
1A4c	Fuel Combustion - Agriculture/Forestry/Fishing/Fish Farms - Liquid fuels	CO_2	390.99	390.99	0.008	0.900
5A3	Solid Waste Disposal -Uncategorised	CH_4	375.20	375.20	0.008	0.908
5A1	Solid Waste Disposal - Managed	CH_4	334.32	334.32	0.007	0.916
3A4	Enteric Fermentation - Other Cattle	CH_4	323.12	323.12	0.007	0.922
5D1	Domestic Wastewater Treatment	CH_4	283.92	283.92	0.006	0.929
1A4b	Fuel Combustion - Residential - Solid Fuels	CO_2	273.83	273.83	0.006	0.934
3B1	Manure Management - Cattle	CH_4	247.24	247.24	0.005	0.940
1A4a	Fuel Combustion - Commercial/Institutional-Gaseous fuels	CO_2	228.21	228.21	0.005	0.945
2C1	Metal Production - Iron and Steel Production	CO_2	203.89	203.89	0.004	0.949
1A2	Fuel Combustion - Manufacturing Industries and Construction - Liquid fuels	CO_2	197.03	197.03	0.004	0.953

The key categories assessed for greenhouse gas emissions and removals by level for the last year of the greenhouse gas inventory, 2022, are presented in Table I.3 and Table I.4, and in Table I.5 and Table I.6, according to trend.

Table 10-3 Greenhouse gas emissions and removals level by Key categories in 2022, including the LULUCF sector

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year Estimate Ex,t Gg CO2 eq.	Latest Year Estimate Absolute Value |Ex,t|	Level Assessment Lx,t	Cumulative Total Value
4A	Forest Land Remanning Forest Land	CO2	-6,693.62	6,693.62	0.242	0.242
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	CO2	3,351.94	3,351.94	0.121	0.363
1A4b	Fuel Combustion - Residential - Gaseous fuels	CO2	2,646.01	2,646.01	0.096	0.458
1B2b	Fugitive Emissions from Natural Gas	CH4	1,643.33	1,643.33	0.059	0.518
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	CO2	1,521.66	1,521.66	0.055	0.573
3A1	Enteric Fermentation - Cattle	CH4	1,466.92	1,466.92	0.053	0.626
5A1	Solid Waste Disposal - Managed	CH4	1,160.88	1,160.88	0.042	0.668
1A2	Fuel Combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	892.25	892.25	0.032	0.700
2A1	Mineral Industry - Cement Production	CO2	C	C	C	C
4C	Grasslands Remaining Grasslands	CO2	765.23	765.23	0.028	0.755
1A3e	Fuel Combustion - Transport – Other Transport - Gaseous fuels	CO2	649.36	649.36	0.023	0.779
2B1	Chemical Industry - Ammonia Production	CO2	541.85	541.85	0.020	0.798
1A2	Fuel Combustion - Manufacturing Industries and Construction - Gaseous fuels	CO2	528.07	528.07	0.019	0.817
1A4a	Fuel Combustion - Commercial/Institutional- Gaseous fuels	CO2	518.19	518.19	0.019	0.836
2F1	Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	HFCs	479.12	479.12	0.017	0.853
2C2	Metal Production -Ferroalloys Production	CO2	475.56	475.56	0.017	0.871
5A3	Solid Waste Disposal -Uncategorised	CH4	387.24	387.24	0.014	0.885
1A3b	Fuel Combustion - Transport - Road Transport - Gaseous fuels	CO2	383.40	383.40	0.014	0.898
1A2	Fuel Combustion - Manufacturing Industries and Construction - Liquid fuels	CO2	365.56	365.56	0.013	0.912
3D1	Direct N2O Emissions from Managed Soils	N2O	353.88	353.88	0.013	0.924

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year Estimate Ex,t Gg CO2 eq.	Latest Year Estimate Absolute Value |Ex,t|	Level Assessment Lx,t	Cumulative Total Value
1B2c	Fugitive Emissions from Natural Gas	CH4	283.55	283.55	0.010	0.935
5D1	Domestic Wastewater Treatment	CH4	252.00	252.00	0.009	0.944
2B2	Chemical Industry - Nitric Acid Production	N2O	C	C	C	C

According to Table I.3, the number of key categories in 2022 is 23. Of these, 11 are from the energy sector (1A1, 1A2, 1A3b, 1A4a, 1A4b, 1B2b...), 2 are from the agriculture sector (3A1, 3D1), 5 are from the industry sector (2A1, 2B1, 2B2, 2C2, 2F), 2 are from the land use sector (4A, 4C), and 3 are from the waste sector (5A1, 5A3, 5D1).

For the same year, the analysis of the main categories excluding land use, land use change and forestry is presented by 23 categories, of which 11 are from the energy sector (1A1, 1A2, 1A3b, 1A3e, 1A4a, 1A4b, 1B2b...), 3 from the agriculture sector (3A1, 3A4, 3D1), 5 from the industry sector (2A1, 2B1, 2B2, 2C2, 2F1), and 4 from the waste sector (5A1, 5A2, 5A3, 5D1) (Table I.4).

Table 10-4 Greenhouse gas emissions and removals level by Key categories in 2022, excluding the LULUCF sector

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year Estimate Ex,t Gg CO2 eq.	Latest Year Estimate Absolute Value |Ex,t|	Level Assessment Lx,t	Cumulative Total Value
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	CO2	3,351.94	3,351.94	0.167	0.167
1A4b	Fuel Combustion - Residential - Gaseous fuels	CO2	2,646.01	2,646.01	0.132	0.298
1B2b	Fugitive Emissions from Natural Gas	CH4	1,643.33	1,643.33	0.082	0.380
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	CO2	1,521.66	1,521.66	0.076	0.456
3A1	Enteric Fermentation - Cattle	CH4	1,466.92	1,466.92	0.073	0.529
5A1	Solid Waste Disposal - Managed	CH4	1,160.88	1,160.88	0.058	0.587
1A2	Fuel Combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	892.25	892.25	0.044	0.631
2A1	Mineral Industry - Cement Production	CO2	C	C	C	C
1A3e	Fuel Combustion - Transport - Other Transport - Gaseous fuels	CO2	649.36	649.36	0.032	0.702

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year Estimate Ex,t Gg CO2 eq.	Latest Year Estimate Absolute Value |Ex,t|	Level Assessment Lx,t	Cumulative Total Value
2B1	Chemical Industry - Ammonia Production	CO2	C	C	C	C
1A2	Fuel Combustion - Manufacturing Industries and Construction - Gaseous fuels	CO2	528.07	528.07	0.026	0.755
1A4a	Fuel Combustion - Commercial/Institutional-Gaseous fuels	CO2	518.19	518.19	0.026	0.781
2F1	Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	HFCs	479.12	479.12	0.024	0.805
2C2	Metal Production -Ferroalloys Production	CO2	475.56	475.56	0.024	0.828
5A3	Solid Waste Disposal -Uncategorised	CH4	387.24	387.24	0.019	0.848
1A3b	Fuel Combustion - Transport - Road Transport - Gaseous fuels	CO2	383.40	383.40	0.019	0.867
1A2	Fuel Combustion - Manufacturing Industries and Construction - Liquid fuels	CO2	365.56	365.56	0.018	0.885
3D1	Direct N2O Emissions from Managed Soils	N2O	353.88	353.88	0.018	0.903
1B2c	Fugitive Emissions from Natural Gas	CH4	283.55	283.55	0.014	0.917
5D1	Domestic Wastewater Treatment	CH4	252.00	252.00	0.013	0.929
2B2	Chemical Industry - Nitric Acid Production	N2O	C	C	C	C
3A4	Enteric Fermentation - Other Cattle	CH4	182.56	182.56	0.009	0.949
5A2	Solid Waste Disposal - Unmanaged	CH4	114.24	114.24	0.006	0.955

According to the trend assessment of key categories (Table I.5), 25 categories are presented, including land use, land use change and forest sector, 15 of which are from the energy sector (1A1, 1A2, 1A3b, 1A3e, 1A4a, 1A4b, 1A4c, 1B2b...), 5 from the industry sector (2A1, 2B1, 2B2, 2C2, 2F1), 3 from the land use sector (4A, 4B, 4C), and 2 from the waste sector (5A1, 5A3).

According to the trend assessment of key categories (Table I.6), 25 categories are presented for land use, land use change and excluding the forest sector, 16 of which are from the energy sector (1A1, 1A2, 1A3b, 1A3e, 1A4a, 1A4b, 1A4c, 1B2b...), 5 from the industry sector (2A1, 2B1, 2B2, 2C2, 2F1), 1 from the agriculture sector (3A1), and 3 from the waste sector (5A1, 5A3, 5D1).

Table 10-5 Greenhouse gas emission-removal trends in 2022 by key categories, including the LULUCF sector

IPCC Category Code	IPCC Category	Greenhouse Gas	Beginning Year Estimate Ex,t Gg CO2 eq.	Beginning Year Estimate Absolute Value |Ex,t|	Latest Year Estimate Ex,t Gg CO2 eq.	Latest Year Estimate Absolute Value |Ex,t|	|Ex,o|/Σ|Ey,o|	Ex,t-Ex,o	I/|Ex,o|	(ΣEy,t-ΣEy,o)/|ΣEy,o|	J-K	Trend Assessment Tx,t	Contribution %	Cumulative Total Contribution
1A1	Fuel Combustion - Energy Industries - Liquid fuels	**CO2**	8,172	8,172	-	-	0.15	-8,172	-1.00	-0.50	0.50	0.07	0.15	0.15
4A	Forest Land Remaining Forest Land	**CO2**	-6,904	6,904	-6,694	6,694	0.12	211	0.03	-0.50	0.53	0.07	0.13	0.28
1A2	Fuel Combustion - Manufacturing Industries and Construction - Gaseous fuels	**CO2**	7,281	7,281	528	528	0.13	-6,753	-0.93	-0.50	0.42	0.06	0.11	0.40
4B	Cropland Remaining Cropland	**CO2**	-1,730	1,730	102	102	0.03	1,832	1.06	-0.50	1.56	0.05	0.10	0.49
1B2b	Fugitive Emissions from Natural Gas	**CH4**	6,915	6,915	1,643	1,643	0.12	-5,272	-0.76	-0.50	0.26	0.03	0.07	0.56
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	**CO2**	4,186	4,186	3,352	3,352	0.08	-834	-0.20	-0.50	0.30	0.02	0.05	0.61
1A4b	Fuel Combustion - Residential - Gaseous fuels	**CO2**	2,787	2,787	2,646	2,646	0.05	-141	-0.05	-0.50	0.45	0.02	0.05	0.65
5A1	Solid Waste Disposal - Managed	**CH4**	334	334	1,161	1,161	0.01	827	2.47	-0.50	2.97	0.02	0.04	0.69
1A2	Fuel Combustion - Manufacturing Industries and Construction - Solid Fuels	**CO2**	57	57	892	892	0.00	835	14.72	-0.50	15.22	0.02	0.03	0.72
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	**CO2**	4,604	4,604	1,522	1,522	0.08	-3,083	-0.67	-0.50	0.17	0.01	0.03	0.75
1A3e	Fuel Combustion - Transport - Other Transport - Gaseous fuels	**CO2**	58	58	649	649	0.00	592	10.26	-0.50	10.77	0.01	0.02	0.77
4C	Grasslands Remaining Grasslands	**CO2**	439	439	765	765	0.01	326	0.74	-0.50	1.25	0.01	0.02	0.79
2A1	Mineral Industry - Cement Production	**CO2**	C	C	C	C	C	C	C	C	C	C	C	C
2F1	Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	**HFCs**	0	0	479	479	0.00	479	1,994	-0.50	1,995	0.01	0.02	0.83
1A1	Fuel Combustion - Manufacture of Solid Fuel and Other Energy Industries - Solid Fuels	**CO2**	956	956	1	1	0.02	-955	-1.00	-0.50	0.50	0.01	0.02	0.85
1A4a	Fuel Combustion - Commercial/Institutional- Gaseous fuels	**CO2**	228	228	518	518	0.00	290	1.27	-0.50	1.77	0.01	0.01	0.86
2C2	Metal Production -Ferroalloys Production	**CO2**	143	143	476	476	0.00	333	2.33	-0.50	2.84	0.01	0.01	0.88
1B1	Fugitive Emissions from Solid Fuels	**CH4**	955	955	93	93	0.02	-861	-0.90	-0.50	0.40	0.01	0.01	0.89
1A4b	Fuel Combustion - Residential - Liquid fuels	**CO2**	762	762	15	15	0.01	-747	-0.98	-0.50	0.48	0.01	0.01	0.90
1A4a	Fuel Combustion - Commercial/Institutional- Liquid fuels	**CO2**	627	627	0	0	0.01	-627	-1.00	-0.50	0.50	0.01	0.01	0.91
2B1	Chemical Industry - Ammonia Production	**CO2**	C	C	C	C	C	C	C	C	C	C	C	C
1A2	Fuel Combustion - Manufacturing Industries and Construction - Liquid fuels	**CO2**	197	197	366	366	0.00	169	0.86	-0.50	1.36	0.00	0.01	0.93
5A3	Solid Waste Disposal -Uncategorised	**CH4**	375	375	387	387	0.01	12	0.03	-0.50	0.53	0.00	0.01	0.94

IPCC Category Code	IPCC Category	Greenhouse Gas	Beginning Year Estimate Ex,t Gg CO2 eq.	Beginning Year Estimate Absolute Value |Ex,t|	Latest Year Estimate Ex,t Gg CO2 eq.	Latest Year Estimate Absolute Value |Ex,t|	|Ex,o|/Σ|Ey,o|	Ex,t-Ex,o	I/|Ex,o|	(ΣEy,t-Σey,o)/|ΣEy,o|	J-K	Trend Assessment Tx,t	Contribution %	Cumulative Total Contribution
1A4c	Fuel Combustion - Agriculture/Forestry/Fishing/Fish Farms - Liquid fuels	**CO2**	391	391	29	29	0.01	-362	-0.93	-0.50	0.42	0.00	0.01	0.95
2B2	Chemical Industry - Nitric Acid Production	**N2O**	C	C	C	C	C	C	C	C	C	C	C	C

Table 10-6 Key categories by greenhouse gas emission-removal trend in 2022, excluding the LULUCF sector

IPCC Category Code	IPCC Category	Greenhouse Gas	Beginning Year Estimate Ex,t Gg CO2 eq.	Beginning Year Estimate Absolute Value |Ex,t|	Latest Year Estimate Ex,t Gg CO2 eq.	Latest Year Estimate Absolute Value |Ex,t|	|Ex,o|/Σ|Ey,o|	Ex,t-Ex,o	I/|Ex,o|	(ΣEy,t-Σey,o)/|ΣEy,o|	J-K	Trend Assessment Tx,t	Contribution %	Cumulative Total Contribution
1A1	Fuel Combustion - Energy Industries - Liquid fuels	**CO2**	8,172	8,172	-	-	0.18	-8,172	-1.00	-0.57	0.43	0.076	0.184	0.184
1A2	Fuel Combustion - Manufacturing Industries and Construction - Gaseous fuels	**CO2**	7,281	7,281	528	528	0.16	-6,753	-0.93	-0.57	0.36	0.056	0.136	0.320
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	**CO2**	4,186	4,186	3,352	3,352	0.09	-834	-0.20	-0.57	0.37	0.033	0.081	0.401
1A4b	Fuel Combustion - Residential - Gaseous fuels	**CO2**	2,787	2,787	2,646	2,646	0.06	-141	-0.05	-0.57	0.52	0.031	0.075	0.476
1B2b	Fugitive Emissions from Natural Gas	**CH4**	6,915	6,915	1,643	1,643	0.15	-5,272	-0.76	-0.57	0.19	0.029	0.070	0.546
5A1	Solid Waste Disposal - Managed	**CH4**	334	334	1,161	1,161	0.01	827	2.47	-0.57	3.04	0.022	0.053	0.599

IPCC Category Code	IPCC Category	Greenhouse Gas	Beginning Year Estimate Ex,t Gg CO2 eq.	Beginning Year Estimate Absolute Value |Ex,t|	Latest Year Estimate Ex,t Gg CO2 eq.	Latest Year Estimate Absolute Value |Ex,t|	|Ex,o|/Σ|Ey,o|	Ex,t-Ex,o	I/|Ex,o|	(ΣEy,t-ΣEy,o)/|ΣEy,o|	J-K	Trend Assessment Tx,t	Contribution %	Cumulative Total Contribution
1A2	Fuel Combustion - Manufacturing Industries and Construction - Solid Fuels	**CO2**	57	57	892	892	0.00	835	14.72	-0.57	15.29	0.019	0.045	0.644
1A3e	Fuel Combustion - Transport - Other Transport - Gaseous fuels	**CO2**	58	58	649	649	0.00	592	10.26	-0.57	10.83	0.013	0.033	0.677
2A1	Mineral Industry - Cement Production	**CO2**	C	C	C	C	C	C	C	C	C	C	C	C
2F1	Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	**HFCs**	0	0	479	479	0.00	479	1,994	-0.57	1,995	0.010	0.025	0.730
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	**CO2**	4,604	4,604	1,522	1,522	0.10	-3,083	-0.67	-0.57	0.10	0.010	0.024	0.755
1A4a	Fuel Combustion - Commercial/Institutional- Gaseous fuels	**CO2**	228	228	518	518	0.00	290	1.27	-0.57	1.84	0.009	0.022	0.777
2C2	Metal Production -Ferroalloys Production	**CO2**	143	143	476	476	0.00	333	2.33	-0.57	2.90	0.009	0.022	0.798
1A1	Fuel Combustion - Manufacture of Solid Fuel and Other Energy Industries - Solid Fuels	**CO2**	956	956	1	1	0.02	-955	-1.00	-0.57	0.43	0.009	0.021	0.820
3A1	Enteric Fermentation - Cattle	**CH4**	2,657	2,657	1,467	1,467	0.06	-1,190	-0.45	-0.57	0.12	0.007	0.017	0.836
1B1	Fugitive Emissions from Solid Fuels	**CH4**	955	955	93	93	0.02	-861	-0.90	-0.57	0.33	0.007	0.017	0.853
2B1	Chemical Industry - Ammonia Production	**CO2**	C	C	C	C	C	C	C	C	C	C	C	C
1A4b	Fuel Combustion - Residential - Liquid fuels	**CO2**	762	762	15	15	0.02	-747	-0.98	-0.57	0.41	0.007	0.016	0.886
1A2	Fuel Combustion - Manufacturing Industries and Construction - Liquid fuels	**CO2**	197	197	366	366	0.00	169	0.86	-0.57	1.42	0.006	0.015	0.900
1A4a	Fuel Combustion - Commercial/Institutional- Liquid fuels	**CO2**	627	627	0	0	0.01	-627	-1.00	-0.57	0.43	0.006	0.014	0.914
5A3	Solid Waste Disposal -Uncategorised	**CH4**	375	375	387	387	0.01	12	0.03	-0.57	0.60	0.005	0.012	0.926
2B2	Chemical Industry - Nitric Acid Production	**N2O**	C	C	C	C	C	C	C	C	C	C	C	C
1A4c	Fuel Combustion - Agriculture/Forestry/Fishing/Fish	**CO2**	391	391	29	29	0.01	-362	-0.93	-0.57	0.36		0.007	

IPCC Category Code	IPCC Category	Greenhouse Gas	Beginning Year Estimate Ex,t Gg CO2 eq.	Beginning Year Estimate Absolute Value |Ex,t|	Latest Year Estimate Ex,t Gg CO2 eq.	Latest Year Estimate Absolute Value |Ex,t|	|Ex,o|/Σ|Ey,o|	Ex,t-Ex,o	I/|Ex,o|	(ΣEy,t-Σey,o)/|ΣEy,o|	J-K	Trend Assessment Tx,t	Contribution %	Cumulative Total Contribution
	Farms - Liquid fuels											0.003		0.942
5D1	Domestic Wastewater Treatment	**CH4**	284	284	252	252	0.01	-32	-0.11	-0.57	0.46	0.003	0.007	0.949
1A4b	Fuel Combustion - Residential - Solid Fuels	**CO2**	274	274	0	0	0.01	-273	-1.00	-0.57	0.43	0.003	0.006	0.955

Annex II. Uncertainty Assessment

The uncertainty assessment of Georgia's greenhouse gas (GHG) inventory has been fully conducted and covers all categories. Using the first approach (error propagation), the uncertainty was estimated for the base year, the current reporting year, and the overall trend.

The percentage uncertainty of the total greenhouse gas inventory is 8.85%, reflecting the overall estimation uncertainty across all source categories. In addition, the trend uncertainty was determined to be 4.57%, indicating the reliability of the estimation of emission trends over time. These results are consistent with the 2006 IPCC Guidelines and provide a solid basis for analysing Georgia’s emissions data.

Description of the methodology used to determine uncertainty

The uncertainty in Georgia's greenhouse gas inventory has been fully estimated for all categories. The uncertainty is estimated for the base year, the current reporting year, and the corresponding trend. In Georgia, the uncertainty calculations for the first BTR are performed using the first approach (error propagation).

The results of the current uncertainty analysis are presented in, consistent with Table 3.4 of the 2006 IPCC Guidelines.[89]

Table 10-7. Uncertainty estimation by category (Approach 1, error propagation consistent with Table 3.4 of the 2006 IPCC Guidelines

	A	B	C	D	E	F	G	H	I	J	K	L	M
	IPCC Categories	Gases	Emissions/Removals in 1990	Emissions/Removals in 2022	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty	Contribution to variance by source/sink category in the year 2022	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor/estimation	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
			მონაცემები	მონაცემები	მონაცემები	მონაცემები	$\sqrt{E^2+F^2}$	$\frac{(G \times D)^2}{(\sum D)^2}$		$\left\lvert\frac{D}{\sum C}\right\rvert$	I * F	√2 E *	K^2+L^2
			Gg CO2-eq.	**Gg CO2-eq**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
1A1	Fuel Burning - Electricity And Heat Production - Liquid Fuel	**CO_2**	8172.2	0.0	2	5	5.39	0.00	-0.08	0.00	0.00	-0.16	0.03
1A1	Fuel Burning - Electricity and Heat Production - Gas Fuel	**CO_2**	4604.2	1521.7	2	3	3.61	0.15	-0.01	0.04	0.17	-0.01	0.03
1A1	Fuel Burning - heat Production And Other Energy industry - solid Fuel	**CO_2**	955.5	1.2	1	5	5.10	0.00	-0.01	0.00	0.00	-0.01	0.00
1A1	Fuel Burning - Electricity And Heat Production - Liquid Fuel	**CH_4**	8.9	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Fuel Burning - Electricity And Heat Production - Gas Fuel	**CH_4**	2.3	0.8	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Fuel Burning - heat Production And Other Energy industry - solid Fuel	**CH_4**	0.3	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00

[89] IPCC 2006, Vol 1, Chapter 3, table 3.4

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A1	Fuel Burning - Electricity And Heat Production - Liquid Fuel	N_2O	16.8	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Fuel Burning - Electricity And Heat Production - Gas Fuel	N_2O	2.2	0.7	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Fuel Burning - heat Production And Other Energy industry - solid Fuel	N_2O	4.0	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Fuel Burning - recycling Industry And Construction - Solid Fuel	CO_2	56.8	892.3	2	7	7.28	0.21	0.02	0.02	0.23	0.05	0.05
1A2	Fuel Burning - recycling Industry And Construction - Biomass	CO_2	0.0	2.4	5	20	20.62	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Fuel Burning - recycling Industry And Construction - Liquid Fuel	CO_2	197.0	365.6	3	5	5.83	0.02	0.01	0.01	0.07	0.02	0.01
1A2	Fuel Burning - recycling Industry And Construction - Air Fuel	CO_2	7281.2	528.1	3	2.5	3.91	0.02	-0.06	0.01	0.05	-0.17	0.03
1A2	Fuel Burning - recycling Industry And Construction - Solid Fuel	CH_4	0.2	2.5	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Fuel Burning - recycling Industry And Construction - Biomass	CH_4	0.0	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Fuel Burning - recycling Industry And Construction - Liquid Fuel	CH_4	0.2	0.4	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Fuel Burning - recycling Industry And Construction - Air Fuel	CH_4	12.2	0.3	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Fuel Burning - recycling Industry And Construction - Solid Fuel	N_2O	0.2	3.5	5	100	100.12	0.00	0.00	0.00	0.01	0.00	0.00
1A2	Fuel Burning - recycling Industry And Construction - Biomass	N_2O	0.0	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Fuel Burning - recycling Industry And Construction - Liquid Fuel	N_2O	0.4	0.8	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Fuel Burning - recycling Industry And Construction - Air Fuel	N_2O	17.8	0.3	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A3a	Fuel combustion - Transport - Civil aviation	CO_2	0.0	1.5	5	4	6.40	0.00	0.00	0.00	0.00	0.00	0.00
1A3b	Fuel Burning - Transport - Road Transport - Liquid Fuel	CO_2	4185.9	3351.9	2	3	3.61	0.71	0.05	0.09	0.37	0.09	0.15
1A3b	Fuel Burning - Transport - Road Transport - Air Fuel	CO_2	0.0	383.4	2	4	4.47	0.01	0.01	0.01	0.06	0.02	0.00
1A3b	Fuel Burning - Transport - Road Transport	CH_4	36.4	47.4	5	50	50.25	0.03	0.00	0.00	0.09	0.00	0.01
1A3b	Fuel Burning - Transport - Road Transport	N_2O	53.9	47.6	5	100	100.12	0.11	0.00	0.00	0.18	0.00	0.03
1A3c	Fuel Combustion - Transport - Railway - Liquid Fuel	CO_2	84.3	4.0	5	3	5.83	0.00	0.00	0.00	0.00	0.00	0.00
1A3c	Fuel Combustion - Transport - Railways - Solid Fuel	CO_2	43.2	0.0	5	3	5.83	0.00	0.00	0.00	0.00	0.00	0.00
1A3c	Fuel Combustion - Transport - Railway - Liquid Fuel	CH_4	0.2	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A3c	Fuel Combustion - Transport - Railways - Solid Fuel	CH_4	0.0	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A3 c	Fuel Combustion - Transport - Railway - Liquid Fuel	N_2O	0.2	0.4	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A3 c	Fuel Combustion - Transport - Railways - Solid Fuel	N_2O	0.2	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A3 d	Fuel Combustion - Transport - Domestic Watercraft Navigation	CO_2	0.0	4.2	5	3	5.83	0.00	0.00	0.00	0.00	0.00	0.00
1A3 d	Fuel Combustion - Transport - Domestic Watercraft Navigation	CH_4	0.0	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A3 d	Fuel Combustion - Transport - Domestic Watercraft Navigation	N_2O	0.0	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A3 e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	CO_2	38.4	9.4	5	3	5.83	0.00	0.00	0.00	0.00	0.00	0.00
1A3 e	Fuel Combustion - Transport - Other Transport - Air Fuel	CO_2	57.6	649.4	5	3	5.83	0.07	0.02	0.02	0.07	0.08	0.01
1A3 e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	CH_4	0.1	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A3 e	Fuel Combustion - Transport - Other Transport - Air Fuel	CH_4	0.0	0.3	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A3 e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	N_2O	3.9	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A3 e	Fuel Combustion - Transport - Other Transport - Air Fuel	N_2O	0.0	0.3	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Solid Fuel	CO_2	85.9	0.0	5	5	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	CO_2	626.9	0.2	3	3	4.24	0.00	-0.01	0.00	0.00	-0.02	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Gas Fuel	CO_2	228.2	518.2	2	1.5	2.50	0.01	0.01	0.01	0.03	0.02	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Biomass	CO_2	0.0	0.0	20	15	25.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Solid Fuel	CH_4	0.2	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	CH_4	2.8	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Gas Fuel	CH_4	0.6	1.3	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Biomass	CH_4	129.6	7.3	5	50	50.25	0.00	0.00	0.00	0.01	-0.01	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Solid Fuel	N_2O	0.3	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	N_2O	1.6	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Gas Fuel	N_2O	0.1	0.2	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4 a	Fuel Combustion - Commercial / Institutional - Biomass	N_2O	16.4	9.2	5	100	100.12	0.00	0.00	0.00	0.03	0.00	0.00

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4b	Fuel Burning - Household - Solid Fuel	CO_2	273.8	0.4	5	7	8.60	0.00	0.00	0.00	0.00	-0.01	0.00
1A4b	Fuel Burning - Household - Liquid Fuel	CO_2	762.1	14.8	5	5	7.07	0.00	-0.01	0.00	0.00	-0.04	0.00
1A4b	Fuel Combustion - Domestic - Gas Fuel	CO_2	2786.7	2646.0	3	3	4.24	0.62	0.04	0.07	0.29	0.13	0.10
1A4b	Fuel Burning - Household - Solid Fuel	CH_4	6.1	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Fuel Burning - Household - Liquid Fuel	CH_4	1.0	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Fuel Combustion - Domestic - Gas Fuel	CH_4	6.6	6.6	5	50	50.25	0.00	0.00	0.00	0.01	0.00	0.00
1A4b	Fuel Combustion - Household - Biomass	CH_4	0.4	0.4	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Fuel Burning - Household - Solid Fuel	N_2O	0.3	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Fuel Burning - Household - Liquid Fuel	N_2O	0.4	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Fuel Combustion - Domestic - Gas Fuel	N_2O	1.2	1.2	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4b	Fuel Combustion - Household - Biomass	N_2O	1.2	0.1	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Fuel Burning - Stationary - Solid Fuel	CO_2	56.8	4.5	3	7	7.62	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Fuel Combustion - Stationary - Liquid Fuel	CO_2	391.0	29.1	5	5	7.07	0.00	0.00	0.00	0.01	-0.02	0.00
1A4c	Fuel Combustion - stationary - gas Fuel	CO_2	70.5	20.6	3	3	4.24	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Fuel Combustion - Stationary - Biomass	CO_2	0.0	0.0	20	50	53.85	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Fuel Burning - Stationary - Solid Fuel	CH_4	5.0	0.4	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Fuel Combustion - Stationary - Liquid Fuel	CH_4	1.5	65.3	5	50	50.25	0.05	0.00	0.00	0.12	0.01	0.01
1A4c	Fuel Combustion - stationary - gas Fuel	CH_4	0.2	0.1	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Fuel Combustion - Stationary - Biomass	CH_4	0.0	0.0	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Fuel Burning - Stationary - Solid Fuel	N_2O	0.2	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Fuel Combustion - Stationary - Liquid Fuel	N_2O	0.8	2.4	5	100	100.12	0.00	0.00	0.00	0.01	0.00	0.00
1A4c	Fuel Combustion - stationary - gas Fuel	N_2O	0.0	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4c	Fuel Combustion - Stationary - Biomass	N_2O	0.0	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A5	Fuel Burning - Undefined - Biomass	CO_2	0.0	0.0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A5	Fuel Burning - Undefined - Biomass	CH_4	31.6	0.0	20	50	53.85	0.00	0.00	0.00	0.00	-0.01	0.00
1A5	Fuel Burning - Undefined - Biomass	N_2O	4.0	0.0	20	100	101.98	0.00	0.00	0.00	0.00	0.00	0.00
1B1	Fugitive Emissions Solid Fuel Extraction - from transformation	CO2	54.9	4.8	10	25	26.93	0.00	0.00	0.00	0.00	0.00	0.00
1B1	Fugitive Emissions Solid Fuel Extraction - from transformation	CH4	954.7	93.4	5	50	50.25	0.11	-0.01	0.00	0.17	-0.03	0.03
1B2 a	Fugitive Emissions from Oils	CO2	11.4	0.1	10	25	26.93	0.00	0.00	0.00	0.00	0.00	0.00
1B2 a	Fugitive Emissions from Oils	CH4	196.9	42.8	2	50	50.04	0.02	0.00	0.00	0.08	0.00	0.01
1B2 a	Fugitive Emissions from Oils	N2O	0.1	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1B2 b	Fugitive Emissions Natural From the air	CO2	0.3	0.2	10	25	26.93	0.00	0.00	0.00	0.00	0.00	0.00
1B2 b	Fugitive Emissions Natural From the air	CH4	6915.5	1643.3	2	50	50.04	33.06	-0.02	0.04	3.03	-0.05	9.16
1B2 b	Fugitive Emissions Natural From the air	N2O	0.0	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1B2 c	Fugitive Emissions From ventilation And Torchlight From burning	CO2	0.0	2.3	10	25	26.93	0.00	0.00	0.00	0.00	0.00	0.00
1B2 c	Fugitive Emissions From ventilation And Torchlight From burning	CH4	0.0	283.6	2	50	50.04	0.98	0.01	0.01	0.52	0.01	0.27
1B2 c	Fugitive Emissions From ventilation And Torchlight From burning	N2O	0.0	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
2A1	Mineral Industry - Cement Production	CO_2	C	C	C	C	C	C	C	C	C	C	C
2A2	Mineral Industry - Lime Production	CO_2	38.0	37.8	2	2	2.83	0.00	0.00	0.00	0.00	0.00	0.00
2A3	Mineral Industry - Glass Production	CO_2	C	C	C	C	C	C	C	C	C	C	C
2B1	Chemical Industry - Ammonia Production	CO_2	C	C	C	C	C	C	C	C	C	C	C
2B2	Chemical Industry - Nitric Acid Production	N_2O	C	C	C	C	C	C	C	C	C	C	C
2C1	Metals Production - cast iron And Steel Production	CO_2	203.9	18.0	10	10	14.14	0.05	0.00	0.01	0.08	0.04	0.01
2C1	Metals Production - cast iron And Steel Production	CH_4	0.9	0.0	10	10	14.14	0.00	0.00	0.00	0.01	0.00	0.00
2C2	Metals Production - colored Metals Production	CO_2	142.6	475.6	5	25	25.50	0.72	0.01	0.01	0.44	0.06	0.19
2C2	Metals Production - colored Metals Production	CH_4	0.3	0.1	5	25	25.50	0.00	0.00	0.00	0.00	0.00	0.00
2D1	Non-energy products from fuel and solvent consumption	CO_2	C	C	C	C	C	C	C	C	C	C	C

	A	B	C	D	E	F	G	H	I	J	K	L	M
2F1	Use of substitute products for ozone-depleting substances - refrigerators and air conditioning	HFC	0.2	479.1	5	25	25.50	0.73	0.01	0.01	0.44	0.06	0.20
2F4	Use of substitute products for ozone-depleting substances - aerosols	HFCs		0.5	20	20	28.28	0.00	0.00	0.00	0.00	0.00	0.00
2G	Other Product Manufacture and Use	SF6		1.1	2	3	3.61	0.00	0.00	0.00	0.00	0.00	0.00
3A1	Intestinal Fermentation - Corn Cattle	CH_4	2657.2	1466.9	7	25	25.96	7.09	0.01	0.04	1.35	0.09	1.83
3A2	Intestinal Fermentation - Sheep	CH_4	0.0	0.0	7	25	25.96	0.00	0.00	0.00	0.00	0.00	0.00
3A3	Intestinal Fermentation - Pigs	CH_4	0.0	0.0	7	25	25.96	0.00	0.00	0.00	0.00	0.00	0.00
3A4	Intestinal Fermentation - Other Cattle	CH_4	323.1	182.6	7	25	25.96	0.11	0.00	0.00	0.17	0.01	0.03
3B1	Manure Management - Horned Cattle	CH_4	247.2	92.1	7	30	30.81	0.04	0.00	0.00	0.10	0.00	0.01
3B1	Manure Management - Horned Cattle	N_2O	63.1	32.7	7	30	30.81	0.00	0.00	0.00	0.04	0.00	0.00
3B2	Manure Management - Sheep	CH_4	0.0	0.0	7	30	30.81	0.00	0.00	0.00	0.00	0.00	0.00
3B3	Manure Management - Pigs	CH_4	0.0	0.0	7	30	30.81	0.00	0.00	0.00	0.00	0.00	0.00
3B4	Manure Management - Other Cattle	CH_4	96.0	26.0	7	30	30.81	0.00	0.00	0.00	0.03	0.00	0.00
3B4	Manure Management - Other Cattle	N_2O	47.4	15.6	7	30	30.81	0.00	0.00	0.00	0.02	0.00	0.00
3B5	Manure Management - Indirect N2O Emissions	N_2O	70.2	37.1	7	30	30.81	0.01	0.00	0.00	0.04	0.00	0.00
3D1	Soil Direct Emissions - to be determined Which one Sub There are categories. Important	N_2O	604.2	353.9	10	30	31.62	0.61	0.00	0.01	0.39	0.03	0.15
3D2	Soil Indirect Emissions - to be determined Which one Sub There are categories. Important	N_2O	172.3	96.4	50	50	70.71	0.23	0.00	0.00	0.18	0.04	0.03
3F	Savannah Established Burning	CH_4	2.2	2.2	10	50	50.99	0.00	0.00	0.00	0.00	0.00	0.00
3F	Savannah Established Burning	N_2O	0.5	0.5	10	50	50.99	0.00	0.00	0.00	0.00	0.00	0.00
3H	Urea Consumption	CO_2	0.0	4.0	3	20	20.22	0.00	0.00	0.00	0.00	0.00	0.00
4A	Preserved Forest Lands - important Supplies To be determined	CO_2	-6904.3	-6693.6	1.5	10	10.11	22.40	-0.11	-0.17	-2.47	-0.16	6.10
4A	Preserved Forest Lands - important Supplies To be determined	CH_4	0.1	0.1	1.5	10	10.11	0.00	0.00	0.00	0.00	0.00	0.00
4A	Preserved Forest Lands - important Supplies To be determined	N_2O	0.0	5.3	10	50	50.99	0.00	0.00	0.00	0.01	0.00	0.00
4A	Land Changed Forest Land - important Supplies To be determined	CO_2	0.0	0.0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4B	Preserved Arable - sowing Lands - important Supplies To be determined	CO_2	-1730.0	101.7	10	50	50.99	0.13	0.02	0.00	0.19	0.19	0.07
4B	Lands Changed Arable - for sowing Land - important Supplies To be determined	CO_2	0.0	0.0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	A	B	C	D	E	F	G	H	I	J	K	L	M
4C	Preserved Pastures - important Supplies To be determined	CO_2	438.9	765.2	7	25	25.96	1.93	0.02	0.02	0.70	0.11	0.51
4C	Lands Changed Pastures - important Supplies To be determined	CO_2	0.0	0.0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4D	Preserved Wetland Lands	CH_4	15.8	26.1	10	50	50.99	0.01	0.00	0.00	0.05	0.01	0.00
5A1	Solid Waste Landfills - managed	CH_4	334.3	1160.9	20	25	32.02	6.75	0.03	0.03	1.07	0.54	1.43
5A2	Solid Waste Landfills - unmanaged	CH_4	77.6	114.2	30	30	42.43	0.11	0.00	0.00	0.13	0.07	0.02
5A3	Solid Waste Landfills - natural	CH_4	375.2	387.2	5	30	30.41	0.68	0.01	0.01	0.43	0.03	0.18
5B1	Composting	CH_4	0.0	1.8	5	50	50.25	0.00	0.00	0.00	0.00	0.00	0.00
5B1	Composting	N_2O	0.0	1.3	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
5C1	Waste Incineration	CO_2	0.0	2.0	5	30	30.41	0.00	0.00	0.00	0.00	0.00	0.00
5D1	Household Wastewater Waters Processing	CH_4	283.9	252.0	5	30	30.41	0.29	0.00	0.01	0.28	0.02	0.08
5D1	Household Wastewater Waters Processing	N_2O	50.4	53.0	5	30	30.41	0.01	0.00	0.00	0.06	0.00	0.00
5D2	Industrial Wastewater Waters Processing	CH_4	63.0	24.1	30	30	42.43	0.01	0.00	0.00	0.03	0.00	0.00
	Total:		**38394.4**	**14302.1**				**78.33**					**20.87**
						Percentage uncertainty in total inventory		**8.85**				**Trend uncertainty:**	**4.57**

Table 3.3 of Volume 1 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Table II-2 (Table 3.3) presents a general table of inventory uncertainty assessment reporting, regardless of which approach is used. In the case of Georgia, the first approach was used, and the results are presented in the table below.

Table 10-8. General reporting table for uncertainty

	A	B	C	D	E		F		G		H	I	J		K
	IPCC Categories	Gas	Base year emissions/removals	Year 2022 emissions/removals	Activity data uncertainty		Emission Factor/estimation parameter uncertainty (combined if more		Combined uncertainty		Contribution to variance in Year 2022	Inventory trend in national emissions for the year 2022 increase concerning the base year	Uncertainty introduced into the trend in total national emissions		Approach and Comments
			Gg CO_2 eq.	Gg CO_2 eq.	(-) %	(+) %	(-)%	(+) %	(-) %	(+) %	Fraction	(% of Base Year)	(-) %	(+) %	
1A1	Fuel Burning - Electricity And Heat Production - Liquid Fuel	CO2	8172.2	0.0	2	2	5	5	5	5	0.00	-100	0.03	0.03	Approach 1
1A1	Fuel Burning - Electricity And Heat Production - Gas Fuel	CO2	4604.2	1521.7	2	2	3	3	4	4	0.00	-67	0.03	0.03	Approach 1
1A1	Fuel Burning - heat Production And Other Energy industry - solid Fuel	CO2	955.5	1.2	1	1	5	5	5	5	0.00	-100	0.00	0.00	Approach 1
1A1	Fuel Burning - Electricity And Heat Production - Liquid Fuel	CH4	8.9	0.0	5	5	50	50	50	50	0.00	-100	0.00	0.00	Approach 1
1A1	Fuel Burning - Electricity And Heat Production - Gas Fuel	CH4	2.3	0.8	5	5	50	50	50	50	0.00	-67	0.00	0.00	Approach 1
1A1	Fuel Burning - heat Production And Other Energy industry - solid Fuel	CH4	0.3	0.0	5	5	50	50	50	50	0.00	-100	0.00	0.00	Approach 1
1A1	Fuel Burning - Electricity and Heat Production - Liquid Fuel	N2O	16.8	0.0	5	5	100	100	100	100	0.00	-100	0.00	0.00	Approach 1
1A1	Fuel Burning - Electricity and Heat Production - Gas Fuel	N2O	2.2	0.7	5	5	100	100	100	100	0.00	-67	0.00	0.00	Approach 1
1A1	Fuel Burning - heat Production And Other Energy industry - solid Fuel	N2O	4.0	0.0	5	5	100	100	100	100	0.00	-100	0.00	0.00	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Solid Fuel	CO2	56.8	892.3	2	2	7	7	7	7	0.00	1472	0.05	0.05	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Biomass	CO2	0.0	2.4	5	5	20	20	21	21	0.00		0.00	0.00	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Liquid Fuel	CO2	197.0	365.6	3	3	5	5	6	6	0.00	86	0.01	0.01	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Air Fuel	CO2	7281.2	528.1	3	3	3	3	4	4	0.00	-93	0.03	0.03	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Solid Fuel	CH4	0.2	2.5	5	5	50	50	50	50	0.00	1378	0.00	0.00	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Biomass	CH4	0.0	0.0	5	5	50	50	50	50	0.00		0.00	0.00	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Liquid Fuel	CH4	0.2	0.4	5	5	50	50	50	50	0.00	92	0.00	0.00	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Air Fuel	CH4	12.2	0.3	5	5	50	50	50	50	0.00	-98	0.00	0.00	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Solid Fuel	N2O	0.2	3.5	5	5	100	100	100	100	0.00	1378	0.00	0.00	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Biomass	N2O	0.0	0.0	5	5	100	100	100	100	0.00		0.00	0.00	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Liquid Fuel	N2O	0.4	0.8	5	5	100	100	100	100	0.00	92	0.00	0.00	Approach 1

	A	B	C	D	E		F		G		H	I	J		K
1A2	Fuel Burning - recycling Industry And Construction - Air Fuel	N2O	17.8	0.3	5	5	100	100	100	100	0.00	-99	0.00	0.00	Approach 1
1A3 a	Fuel combustion - Transport - Civil aviation	CO2	0.0	1.5	5	5	4	4	6	6	0.00		0.00	0.00	Approach 1
1A3 b	Fuel Burning - Transport - Road Transport - Liquid Fuel	CO2	4185.9	3351.9	2	2	3	3	4	4	0.01	-20	0.15	0.15	Approach 1
1A3 b	Fuel Burning - Transport - Road Transport - Air Fuel	CO2	0.0	383.4	2	2	4	4	4	4	0.00		0.00	0.00	Approach 1
1A3 b	Fuel Burning - Transport - Road Transport	CH4	36.4	47.4	5	5	50	50	50	50	0.00	30	0.01	0.01	Approach 1
1A3 b	Fuel Burning - Transport - Road Transport	N2O	53.9	47.6	5	5	100	100	100	100	0.00	-12	0.03	0.03	Approach 1
1A3 c	Fuel Combustion - Transport - Railway - Liquid Fuel	CO2	84.3	4.0	5	5	3	3	6	6	0.00	-95	0.00	0.00	Approach 1
1A3 c	Fuel Combustion - Transport - Railways - Solid Fuel	CO2	43.2	0.0	5	5	3	3	6	6	0.00	-100	0.00	0.00	Approach 1
1A3 c	Fuel Combustion - Transport - Railway - Liquid Fuel	CH4	0.2	0.0	5	5	50	50	50	50	0.00	-96	0.00	0.00	Approach 1
1A3 c	Fuel Combustion - Transport - Railways - Solid Fuel	CH4	0.0	0.0	5	5	50	50	50	50	0.00	-100	0.00	0.00	Approach 1
1A3 c	Fuel Combustion - Transport - Railway - Liquid Fuel	N2O	0.2	0.4	5	5	100	100	100	100	0.00	135	0.00	0.00	Approach 1
1A3 c	Fuel Combustion - Transport - Railways - Solid Fuel	N2O	0.2	0.0	5	5	100	100	100	100	0.00	-100	0.00	0.00	Approach 1
1A3 d	Fuel Combustion - Transport - Domestic Watercraft Navigation	CO2	0.0	4.2	5	5	3	3	6	6	0.00		0.00	0.00	Approach 1
1A3 d	Fuel Combustion - Transport - Domestic Watercraft Navigation	CH4	0.0	0.0	5	5	50	50	50	50	0.00		0.00	0.00	Approach 1
1A3 d	Fuel Combustion - Transport - Domestic Watercraft Navigation	N2O	0.0	0.0	5	5	100	100	100	100	0.00		0.00	0.00	Approach 1
1A3 e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	CO2	38.4	9.4	5	5	3	3	6	6	0.00	-76	0.00	0.00	Approach 1
1A3 e	Fuel Combustion - Transport - Other Transport - Air Fuel	CO2	57.6	649.4	5	5	3	3	6	6	0.00	1026	0.01	0.01	Approach 1
1A3 e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	CH4	0.1	0.0	5	5	50	50	50	50	0.00	-82	0.00	0.00	Approach 1
1A3 e	Fuel Combustion - Transport - Other Transport - Air Fuel	CH4	0.0	0.3	5	5	50	50	50	50	0.00	723	0.00	0.00	Approach 1
1A3 e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	N2O	3.9	0.0	5	5	100	100	100	100	0.00	-99	0.00	0.00	Approach 1
1A3 e	Fuel Combustion - Transport - Other Transport - Air Fuel	N2O	0.0	0.3	5	5	100	100	100	100	0.00	723	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Solid Fuel	CO2	85.9	0.0	5	5	5	5	7	7	0.00	-100	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	CO2	626.9	0.2	3	3	3	3	4	4	0.00	-100	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Gas Fuel	CO2	228.2	518.2	2	2	2	2	3	3	0.00	127	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Biomass	CO2	0.0	0.0	20	20	15	15	25	25	0.00		0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Solid Fuel	CH4	0.2	0.0	5	5	50	50	50	50	0.00	-100	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	CH4	2.8	0.0	5	5	50	50	50	50	0.00	-100	0.00	0.00	Approach 1

	A	B	C	D	E		F		G		H	I	J		K
1A4 a	Fuel Combustion - Commercial / Institutional - Gas Fuel	CH4	0.6	1.3	5	5	50	50	50	50	0.00	127	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Biomass	CH4	129.6	7.3	5	5	50	50	50	50	0.00	-94	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Solid Fuel	N2O	0.3	0.0	5	5	100	100	100	100	0.00	-100	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	N2O	1.6	0.0	5	5	100	100	100	100	0.00	-100	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Gas Fuel	N2O	0.1	0.2	5	5	100	100	100	100	0.00	121	0.00	0.00	Approach 1
1A4 a	Fuel Combustion - Commercial / Institutional - Biomass	N2O	16.4	9.2	5	5	100	100	100	100	0.00	-44	0.00	0.00	Approach 1
1A4 b	Fuel Burning - Household - Solid Fuel	CO2	273.8	0.4	5	5	7	7	9	9	0.00	-100	0.00	0.00	Approach 1
1A4 b	Fuel Burning - Household - Liquid Fuel	CO2	762.1	14.8	5	5	5	5	7	7	0.00	-98	0.00	0.00	Approach 1
1A4 b	Fuel Combustion - Domestic - Gas Fuel	CO2	2786.7	2646.0	3	3	3	3	4	4	0.01	-5	0.10	0.10	Approach 1
1A4 b	Fuel Burning - Household - Solid Fuel	CH4	6.1	0.0	5	5	50	50	50	50	0.00	-100	0.00	0.00	Approach 1
1A4 b	Fuel Burning - Household - Liquid Fuel	CH4	1.0	0.0	5	5	50	50	50	50	0.00	-97	0.00	0.00	Approach 1
1A4 b	Fuel Combustion - Domestic - Gas Fuel	CH4	6.6	6.6	5	5	50	50	50	50	0.00	1	0.00	0.00	Approach 1
1A4 b	Fuel Combustion - Household - Biomass	CH4	0.4	0.4	5	5	50	50	50	50	0.00	22	0.00	0.00	Approach 1
1A4 b	Fuel Burning - Household - Solid Fuel	N2O	0.3	0.0	5	5	100	100	100	100	0.00	-100	0.00	0.00	Approach 1
1A4 b	Fuel Burning - Household - Liquid Fuel	N2O	0.4	0.0	5	5	100	100	100	100	0.00	-99	0.00	0.00	Approach 1
1A4 b	Fuel Combustion - Domestic - Gas Fuel	N2O	1.2	1.2	5	5	100	100	100	100	0.00	0	0.00	0.00	Approach 1
1A4 b	Fuel Combustion - Household - Biomass	N2O	1.2	0.1	5	5	100	100	100	100	0.00	-95	0.00	0.00	Approach 1
1A4 c	Fuel Burning - Stationary - Solid Fuel	CO2	56.8	4.5	3	3	7	7	8	8	0.00	-92	0.00	0.00	Approach 1
1A4 c	Fuel Combustion - Stationary - Liquid Fuel	CO2	391.0	29.1	5	5	5	5	7	7	0.00	-93	0.00	0.00	Approach 1
1A4 c	Fuel Combustion - stationary - gas Fuel	CO2	70.5	20.6	3	3	3	3	4	4	0.00	-71	0.00	0.00	Approach 1
1A4 c	Fuel Combustion - Stationary - Biomass	CO2	0.0	0.0	20	20	50	50	54	54	0.00		0.00	0.00	Approach 1
1A4 c	Fuel Burning - Stationary - Solid Fuel	CH4	5.0	0.4	5	5	50	50	50	50	0.00	-93	0.00	0.00	Approach 1
1A4 c	Fuel Combustion - Stationary - Liquid Fuel	CH4	1.5	65.3	5	5	50	50	50	50	0.00	4285	0.01	0.01	Approach 1
1A4 c	Fuel Combustion - stationary - gas Fuel	CH4	0.2	0.1	5	5	50	50	50	50	0.00	-71	0.00	0.00	Approach 1
1A4 c	Fuel Combustion - Stationary - Biomass	CH4	0.0	0.0	5	5	50	50	50	50	0.00		0.00	0.00	Approach 1
1A4 c	Fuel Burning - Stationary - Solid Fuel	N2O	0.2	0.0	5	5	100	100	100	100	0.00	-93	0.00	0.00	Approach 1
1A4 c	Fuel Combustion - Stationary - Liquid Fuel	N2O	0.8	2.4	5	5	100	100	100	100	0.00	186	0.00	0.00	Approach 1

	A	B	C	D	E		F		G		H	I	J		K
1A4 c	Fuel Combustion - stationary - gas Fuel	N2O	0.0	0.0	5	5	10 0	100	100	100	0.00	-71	0.0 0	0.0 0	Approach 1
1A4 c	Fuel Combustion - Stationary - Biomass	N2O	0.0	0.0	5	5	10 0	100	100	100	0.00		0.0 0	0.0 0	Approach 1
1A5	Fuel Burning - Undefined - Biomass	CO2	0.0	0.0	0	0	0	0	0	0	0.00		0.0 0	0.0 0	Approach 1
1A5	Fuel Burning - Undefined - Biomass	CH4	31.6	0.0	20	20	50	50	54	54	0.00	-100	0.0 0	0.0 0	Approach 1
1A5	Fuel Burning - Undefined - Biomass	N2O	4.0	0.0	20	20	10 0	100	102	102	0.00	-100	0.0 0	0.0 0	Approach 1
1B1	Fugitive Emissions Solid Fuel Extraction - from transformation	CO2	54.9	4.8	10	10	25	25	27	27	0.00	-91	0.0 0	0.0 0	Approach 1
1B1	Fugitive Emissions Solid Fuel Extraction - from transformation	CH4	954.7	93.4	5	5	50	50	50	50	0.00	-90	0.0 3	0.0 3	Approach 1
1B2 a	Fugitive Emissions from Oils	CO2	11.4	0.1	10	10	25	25	27	27	0.00	-99	0.0 0	0.0 0	Approach 1
1B2 a	Fugitive Emissions from Oils	CH4	196.9	42.8	2	2	50	50	50	50	0.00	-78	0.0 1	0.0 1	Approach 1
1B2 a	Fugitive Emissions from Oils	N2O	0.1	0.0	5	5	10 0	100	100	100	0.00	-100	0.0 0	0.0 0	Approach 1
1B2 b	Fugitive Emissions Natural From the air	CO2	0.3	0.2	10	10	25	25	27	27	0.00	-33	0.0 0	0.0 0	Approach 1
1B2 b	Fugitive Emissions Natural From the air	CH4	6915.5	1643.3	2	2	50	50	50	50	0.42	-76	9.1 6	9.1 6	Approach 1
1B2 b	Fugitive Emissions Natural From the air	N2O	0.0	0.0	5	5	10 0	100	100	100	0.00	-100	0.0 0	0.0 0	Approach 1
1B2 c	Fugitive Emissions From ventilation And Torchlight From burning	CO2	0.0	2.3	10	10	25	25	27	27	0.00		0.0 0	0.0 0	Approach 1
1B2 c	Fugitive Emissions From ventilation And Torchlight From burning	CH4	0.0	283.6	2	2	50	50	50	50	0.01		0.2 7	0.2 7	Approach 1
1B2 c	Fugitive Emissions From ventilation And Torchlight From burning	N2O	0.0	0.0	5	5	10 0	100	100	100	0.00		0.0 0	0.0 0	Approach 1
2A1	Mineral Industry - Cement Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	Approach 1
2A2	Mineral Industry - Lime Production	CO2	38.0	37.8	2	2	2	2	3	3	0.00	-1	0.0 0	0.0 0	Approach 1
2A3	Mineral Industry - Glass Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	Approach 1
2B1	Chemical Industry - Ammonia Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	Approach 1
2B2	Chemical Industry - Nitric Acid Production	N2O	C	C	C	C	C	C	C	C	C	C	C	C	Approach 1
2C1	Metals Production - cast iron And Steel Production	CO2	203.9	18.0	10	10	10	10	14	14	0.00	-91	0.0 1	0.0 1	Approach 1
2C1	Metals Production - cast iron And Steel Production	CH4	0.9	0.0	10	10	10	10	14	14	0.00	-100	0.0 0	0.0 0	Approach 1
2C2	Metals Production - colored Metals Production	CO2	142.6	475.6	5	5	25	25	25	25	0.01	233	0.1 9	0.1 9	Approach 1
2C2	Metals Production - colored Metals Production	CH4	0.3	0.1	5	5	25	25	25	25	0.00	-70	0.0 0	0.0 0	Approach 1
2D1	Non-energy products from fuel and solvent consumption	CO2	C	C	C	C	C	C	C	C	C	C	C	C	Approach 1
2F1	Use of substitute products for ozone-depleting substances - refrigerators and air conditioning	HFC	0.2	479.1	5	5	25	25	25	25	0.01	199412	0.2 0	0.2 0	Approach 1

	A	B	C	D	E		F		G		H	I	J		K
2F4	Use of substitute products for ozone-depleting substances - aerosols	HFCs	0.0	0.5	20	20	20	20	28	28	0.00		0.00	0.00	Approach 1
2G	Other Product Manufacture and Use	SF6	0.0	1.1	2	2	3	3	4	4	0.00		0.00	0.00	Approach 1
3A1	Intestinal Fermentation - Corn Cattle	CH4	2657.2	1466.9	7	7	25	25	26	26	0.09	-45	1.83	1.83	Approach 1
3A2	Intestinal Fermentation - Sheep	CH4	0.0	0.0	7	7	25	25	26	26	0.00		0.00	0.00	Approach 1
3A3	Intestinal Fermentation - Pigs	CH4	0.0	0.0	7	7	25	25	26	26	0.00		0.00	0.00	Approach 1
3A4	Intestinal Fermentation - Other Cattle	CH4	323.1	182.6	7	7	25	25	26	26	0.00	-44	0.03	0.03	Approach 1
3B1	Manure Management - Horned Cattle	CH4	247.2	92.1	7	7	30	30	31	31	0.00	-63	0.01	0.01	Approach 1
3B1	Manure Management - Horned Cattle	N2O	63.1	32.7	7	7	30	30	31	31	0.00	-48	0.00	0.00	Approach 1
3B2	Manure Management - Sheep	CH4	0.0	0.0	7	7	30	30	31	31	0.00		0.00	0.00	Approach 1
3B3	Manure Management - Pigs	CH4	0.0	0.0	7	7	30	30	31	31	0.00		0.00	0.00	Approach 1
3B4	Manure Management - Other Cattle	CH4	96.0	26.0	7	7	30	30	31	31	0.00	-73	0.00	0.00	Approach 1
3B4	Manure Management - Other Cattle	N2O	47.4	15.6	7	7	30	30	31	31	0.00	-67	0.00	0.00	Approach 1
3B5	Manure Management - Indirect N2O Emissions	N2O	70.2	37.1	7	7	30	30	31	31	0.00	-47	0.00	0.00	Approach 1
3D1	Soil Direct Emissions - to be determined Which one Sub There are categories. Important	N2O	604.2	353.9	10	10	30	30	32	32	0.01	-41	0.15	0.15	Approach 1
3D2	Soil Indirect Emissions - to be determined Which one Sub There are categories. Important	N2O	172.3	96.4	50	50	50	50	71	71	0.00	-44	0.03	0.03	Approach 1
3F	Savannah Established Burning	CH4	2.2	2.2	10	10	50	50	51	51	0.00	0	0.00	0.00	Approach 1
3F	Savannah Established Burning	N2O	0.5	0.5	10	10	50	50	51	51	0.00	0	0.00	0.00	Approach 1
3H	Urea Consumption	CO2	0.0	4.0	3	3	20	20	20	20	0.00		0.00	0.00	Approach 1
4A	Preserved Forest Lands - important Supplies To be determined	CO2	-6904.3	-6693.6	2	2	10	10	10	10	0.29	-3	6.10	6.10	Approach 1
4A	Preserved Forest Lands - important Supplies To be determined	CH4	0.1	0.1	2	2	10	10	10	10	0.00	-10	0.00	0.00	Approach 1
4A	Preserved Forest Lands - important Supplies To be determined	N2O	0.0	5.3	10	10	50	50	51	51	0.00	99900	0.00	0.00	Approach 1
4A	Land Changed Forest Land - important Supplies To be determined	CO2	0.0	0.0	0	0	0	0	0	0	0.00		0.00	0.00	Approach 1
4B	Preserved Arable - sowing Lands - important Supplies To be determined	CO2	-1730.0	101.7	10	10	50	50	51	51	0.00	-106	0.07	0.07	Approach 1
4B	Lands Changed Arable - for sowing Land - important Supplies To be determined.	CO2	0.0	0.0	0	0	0	0	0	0	0.00		0.00	0.00	Approach 1
4C	Preserved Pastures - important Supplies To be determined	CO2	438.9	765.2	7	7	25	25	26	26	0.02	74	0.51	0.51	Approach 1
4C	Lands Changed Pastures - important Supplies To be determined	CO2	0.0	0.0	0	0	0	0	0	0	0.00		0.00	0.00	Approach 1
4D	Preserved Wetland Lands	CH4	15.8	26.1	10	10	50	50	51	51	0.00	65	0.00	0.00	Approach 1

	A	B	C	D	E		F		G		H	I	J		K
5A1	Solid Waste Landfills - managed	CH4	334.3	1160.9	20	20	25	25	32	32	0.09	247	1.4 3	1.4 3	Approach 1
5A2	Solid Waste Landfills - unmanaged	CH4	77.6	114.2	30	30	30	30	42	42	0.00	47	0.0 2	0.0 2	Approach 1
5A3	Solid Waste Landfills - natural	CH4	375.2	387.2	5	5	30	30	30	30	0.01	3	0.1 8	0.1 8	Approach 1
5B1	Composting	CH4	0.0	1.8	5	5	50	50	50	50	0.00		0.0 0	0.0 0	Approach 1
5B1	Composting	N2O	0.0	1.3	5	5	10 0	100	100	100	0.00		0.0 0	0.0 0	Approach 1
5C1	Waste Incineration	CO2	0.0	2.0	5	5	30	30	30	30	0.00		0.0 0	0.0 0	Approach 1
5D1	Household Wastewater Waters Processing	CH4	283.9	252.0	5	5	30	30	30	30	0.00	-11	0.0 8	0.0 8	Approach 1
5D1	Household Wastewater Waters Processing	N2O	50.4	53.0	5	5	30	30	30	30	0.00	5	0.0 0	0.0 0	Approach 1
5D2	Industrial Wastewater Waters Processing	CH4	63.0	24.1	30	30	30	30	42	42	0.00	-62	0.0 0	0.0 0	Approach 1
	Total:		38394.44	14302.16							1.00		4.5 7	4.5 7	

Annex III. A detailed description of the reference approach (including inputs to the reference approach such as the national energy balance) and the results of the comparison of national estimates of emissions with those obtained using the reference approach (related to a non-mandatory provision as per para. 36 of the MPGs)

This annex presents the energy balance used in the greenhouse gas inventory, which was developed by the National Statistics Office of Georgia.

Annex IV. QA/QC plan

This annex presents information on the quality control and quality assurance plan used in the implementation of the Greenhouse Gas (GHG) Inventory of Georgia. The Quality Control and Quality Assurance Plan developed within the framework of the CBIT project, was used for the first time in the process of the GHG Inventory. Information on the implementation of the plan is provided in the tabular format below.

Table 10-9. QA/QC Plan

Activity	**Duration (when the activity is performed)**	**Result (describe the result of the activity)**	**Possible improvement (How can activities be changed so that we get better results)**
Preparation of documents for quality control and assurance activities by the coordinator (Appendix 2 – 6)			
Presentation of the Quality Control and Assurance Plan by the Coordinator at the first meeting of the GHG Inventory (Annex 2)			
Transfer of documents intended for quality control and assurance activities by the coordinator to the team leader of the inventory group (Appendix 1 – 6)			
Distribution of documents intended for quality control by the team leader of the inventory group to sectoral experts (Appendix 3)			
Preparation and transfer of quality control reports by sectoral experts to the team leader of the inventory group (Appendix 3)			
Consolidation of quality control reports by the team leader of the inventory group and transfer to the coordinator (Appendix 3)			
Preparation of the overall control report by the coordinator (Annex 4)			
Sending the general control report of the level by the coordinator to the team leader of the inventory group (Appendix 4)			
Sharing of the inventory control report with the sectoral experts by the team			

Activity	Duration (when the activity is performed)	Result (describe the result of the activity)	Possible improvement (How can activities be changed so that we get better results)
leader of the inventory group (Annex 4)			
Improvement of the inventory report according to the general control report of the sectoral experts.			
Preparation of the results of the general control report by general experts and sharing with the team leader of the inventory group (Annex 4 Table 3)			
The team leader of the inventory group reflects the results of the general control report of the level in the inventory report. (Appendix 4)			
Transfer of the inventory working document and materials by the coordinator to the quality assurance expert.			
Preparation of the quality assurance report by the external auditor and transfer to the coordinator (Appendix 5)			
Transfer of the quality assurance report by the coordinator to the team leader of the inventory group (Appendix 5)			
Distribution of quality assurance report by the head of the inventory team to sectoral experts (Annex 5)			
Improvement of inventory report according to quality assurance report by sectoral experts			
Sharing the results of the quality assurance report by the sectoral experts to the team leader of the inventory team (Annex 5 Table 5)			
The team leader of the inventory group reflects the results of the quality assurance report in the inventory report.			
Delivery of the improved inventory report by the team leader of the inventory group to the coordinator			
Improved handover of			

Activity	Duration (when the activity is performed)	Result (describe the result of the activity)	Possible improvement (How can activities be changed so that we get better results)
inventory by the coordinator to the QA expert			
Quality assurance expert checks if the comments specified in the quality assurance report are reflected in the inventory report			
A quality assurance expert requests to reflect/reject the comments specified in the quality assurance report in the inventory report from the team leader of the inventory group (Appendix 5 Table 5)			
Delivery of the improved inventory report by the head of the inventory team to the coordinator			
Transfer of the inventory working document and materials by the coordinator to the verifier			
Preparation of verification report by the verifier and transfer to the coordinator (Annex 6)			
Delivery of the verification report by the coordinator to the head of the inventory team			
Distribution of the validation report by the team leader of the inventory group to the sectoral experts			
Correction of the inventory report according to the verification report by the sectoral experts and preparation of the justification			
Sharing the results of the verification report by the sectoral experts to the team leader of the inventory group (Annex 6 Table 7)			
Reflecting the results of the verification report by the head of the inventory group in the inventory report			

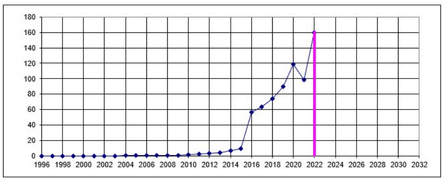
Estimation of HFCs

Tier 1 Refrigeration
Georgia - HFC-32

HFC-32

Current Year	2022
	Data Used Here
Use in current year - 2022 (tonnes)	
Production of HFC-32	0
Imports in current Year	26
Exports in current year	0
Total new agent to domestic market	*26*
Year of Introduction of HFC-32	2001
Growth Rate in New Equipment Sales	25.0%
Tier 1 Defaults	
Assumed Equipment Lifetime (years)	10
Emission Factor from installed base	15%
% of HFC-32 destroyed at End-of-Life	25%

Summary
Country: Georgia
Agent: HFC-32
Year: 2022
Emission: 159.8 tonnes
In Bank: 487.6 tonnes



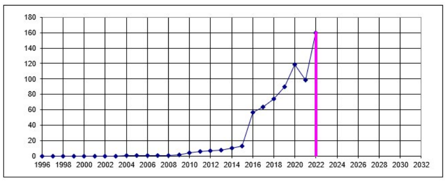
Estimated data for earlier years	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	**2022**
Production	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Agent in Exports	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Agent in Imports	0	0	0	0	0	0	0	1	1	1	0	0	1	1	6	11	6	6	22	21	86	98	109	121	133	145	**26**
Total New Agent in Domestic Equipment	0	0	0	0	0	0	0	1	1	1	0	0	1	1	6	11	6	6	22	21	86	98	109	121	133	145	**26**
Agent in Retired Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	3	9	23	63	26	**116**
Destruction of agent in retired equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	16	7	**29**
Release of agent from retired equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	7	18	47	20	**87**
Bank	-	-	-	-	-	0.02	0.14	0.76	1.75	2.73	2.78	2.71	3.06	3.98	9.14	18.51	21.88	23.95	41.04	55.26	370.38	409.13	448.42	479.11	477.53	524.92	**487.60**
Emission	-	-	-	-	-	0.00	0.02	0.11	0.26	0.41	0.42	0.41	0.46	0.60	1.37	2.79	3.36	4.00	6.85	9.05	56.55	63.86	73.89	89.41	118.82	98.27	**159.77**

Tier 1 Refrigeration
Georgia - HFC-125

HFC-125

Current Year	2022
	Data Used Here
Use in current year - 2022 (tonnes)	
Production of HFC-125	0
Imports in current Year	67
Exports in current year	0
Total new agent to domestic market	*67*
Year of Introduction of HFC-125	2001
Growth Rate in New Equipment Sales	10.0%
Tier 1 Defaults	
Assumed Equipment Lifetime (years)	10
Emission Factor from installed base	15%
% of HFC-125 destroyed at End-of-Life	25%

Summary
Country: Georgia
Agent: HFC-125
Year: 2022
Emission: 159.8 tonnes
In Bank: 487.6 tonnes



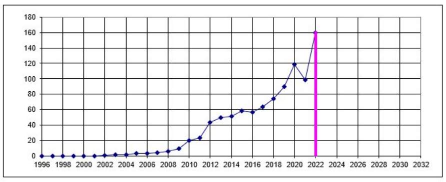
Estimated data for earlier years	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	**2022**
Production	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Agent in Exports	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Agent in Imports	0	0	0	0	0	0	0	1	2	3	1	1	3	3	22	15	9	9	26	25	86	98	109	121	133	145	**67**
Total New Agent in Domestic Equipment	0	0	0	0	0	0	0	1	2	3	1	1	3	3	22	15	9	9	26	25	86	98	109	121	133	145	**67**
Agent in Retired Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0	3	9	23	63	26	**116**
Destruction of agent in retired equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	6	16	7	**29**
Release of agent from retired equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	2	7	18	47	20	**87**
Bank	-	-	-	-	-	0.11	0.45	1.52	3.37	5.54	5.29	5.10	7.36	9.69	30.63	40.62	43.54	44.80	62.44	76.34	370.38	409.13	448.42	479.11	477.53	524.92	**487.60**
Emission	-	-	-	-	-	0.02	0.07	0.23	0.51	0.83	0.79	0.76	1.10	1.45	4.59	6.16	6.76	7.45	10.66	13.06	56.55	63.86	73.89	89.41	118.82	98.27	**159.77**

Tier 1 Refrigeration
Georgia - HFC-134a

HFC-134a

Current Year	2022
	Data Used Here
Use in current year - 2022 (tonnes)	
Production of HFC-134a	0
Imports in current Year	157
Exports in current year	0
Total new agent to domestic market	*157*
Year of Introduction of HFC-134a	2001
Growth Rate in New Equipment Sales	2.5%
Tier 1 Defaults	
Assumed Equipment Lifetime (years)	10
Emission Factor from installed base	15%
% of HFC-134a destroyed at End-of-Life	25%

Summary
Country: Georgia
Agent: HFC-134a
Year: 2022
Emission: 159.8 tonnes
In Bank: 487.6 tonnes



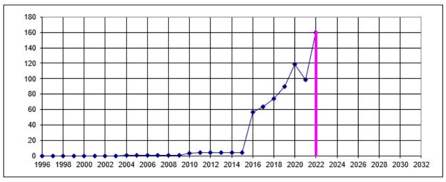
Estimated data for earlier years	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	**2022**
Production	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Agent in Exports	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Agent in Imports	0	0	0	0	0	1	2	5	5	13	4	7	17	32	79	39	152	71	66	74	86	98	109	121	133	145	**157**
Total New Agent in Domestic Equipment	0	0	0	0	0	1	2	5	5	13	4	7	17	32	79	39	152	71	66	74	86	98	109	121	133	145	**157**
Agent in Retired Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	4	10	1	3	9	23	63	26	**116**
Destruction of agent in retired equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	0	1	2	6	16	7	**29**
Release of agent from retired equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	3	8	1	2	7	18	47	20	**87**
Bank	-	-	-	-	-	0.56	2.37	7.51	11.01	22.28	22.99	26.34	39.30	65.21	134.86	153.21	280.81	304.53	320.89	336.38	370.38	409.13	448.42	479.11	477.53	524.92	**487.60**
Emission	-	-	-	-	-	0.08	0.36	1.13	1.65	3.34	3.45	3.95	5.90	9.78	20.23	23.34	43.33	49.18	50.94	58.18	56.55	63.86	73.89	89.41	118.82	98.27	**159.77**

Tier 1 Refrigeration
Georgia - HFC-143a

HFC-143a

Summary
Country: Georgia
Agent: HFC-143a
Year: 2022
Emission: 159.8 tonnes
In Bank: 487.6 tonnes

Current Year	2022
Use in current year - 2022 (tonnes)	**Data Used Here**
Production of HFC-143a	0
Imports in current Year	49
Exports in current year	0
Total new agent to domestic market	*49*
Year of Introduction of HFC-143a	2001
Growth Rate in New Equipment Sales	10.0%
Tier 1 Defaults	
Assumed Equipment Lifetime (years)	10
Emission Factor from installed base	15%
% of HFC-143a destroyed at End-of-Life	25%



Estimated data for earlier years	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Production	0	0	0	0	0	0	0	0	0	0	0	0	0
Agent in Exports	0	0	0	0	0	0	0	0	0	0	0	0	0
Agent in Imports	0	0	0	0	0	0	0	1	1	2	0	0	3
Total New Agent in Domestic Equipment	0	0	0	0	0	0	0	1	1	2	0	0	3
Agent in Retired Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0
Destruction of agent in retired equipment	0	0	0	0	0	0	0	0	0	0	0	0	0
Release of agent from retired equipment	0	0	0	0	0	0	0	0	0	0	0	0	0
Bank	-	-	-	-	-	0.10	0.35	0.82	1.73	3.03	2.68	2.54	4.76
Emission	-	-	-	-	-	0.02	0.05	0.12	0.26	0.46	0.40	0.38	0.71

Estimated data for earlier years	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	**2022**
Production	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Agent in Exports	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Agent in Imports	2	19	4	4	3	5	4	86	98	109	121	133	145	**49**
Total New Agent in Domestic Equipment	2	19	4	4	3	5	4	86	98	109	121	133	145	**49**
Agent in Retired Equipment	0	0	0	0	0	1	1	0	3	9	23	63	26	**116**
Destruction of agent in retired equipment	0	0	0	0	0	0	0	0	1	2	6	16	7	**29**
Release of agent from retired equipment	0	0	0	0	0	1	1	0	2	7	18	47	20	**87**
Bank	6.33	24.40	24.96	24.98	24.01	24.47	23.96	370.38	409.13	448.42	479.11	477.53	524.92	**487.60**
Emission	0.95	3.66	3.81	3.91	3.93	4.31	4.51	56.55	63.86	73.89	89.41	118.82	98.27	**159.77**

Figure V-1. Decision Framework for Land Category GHG Inventory Calculations

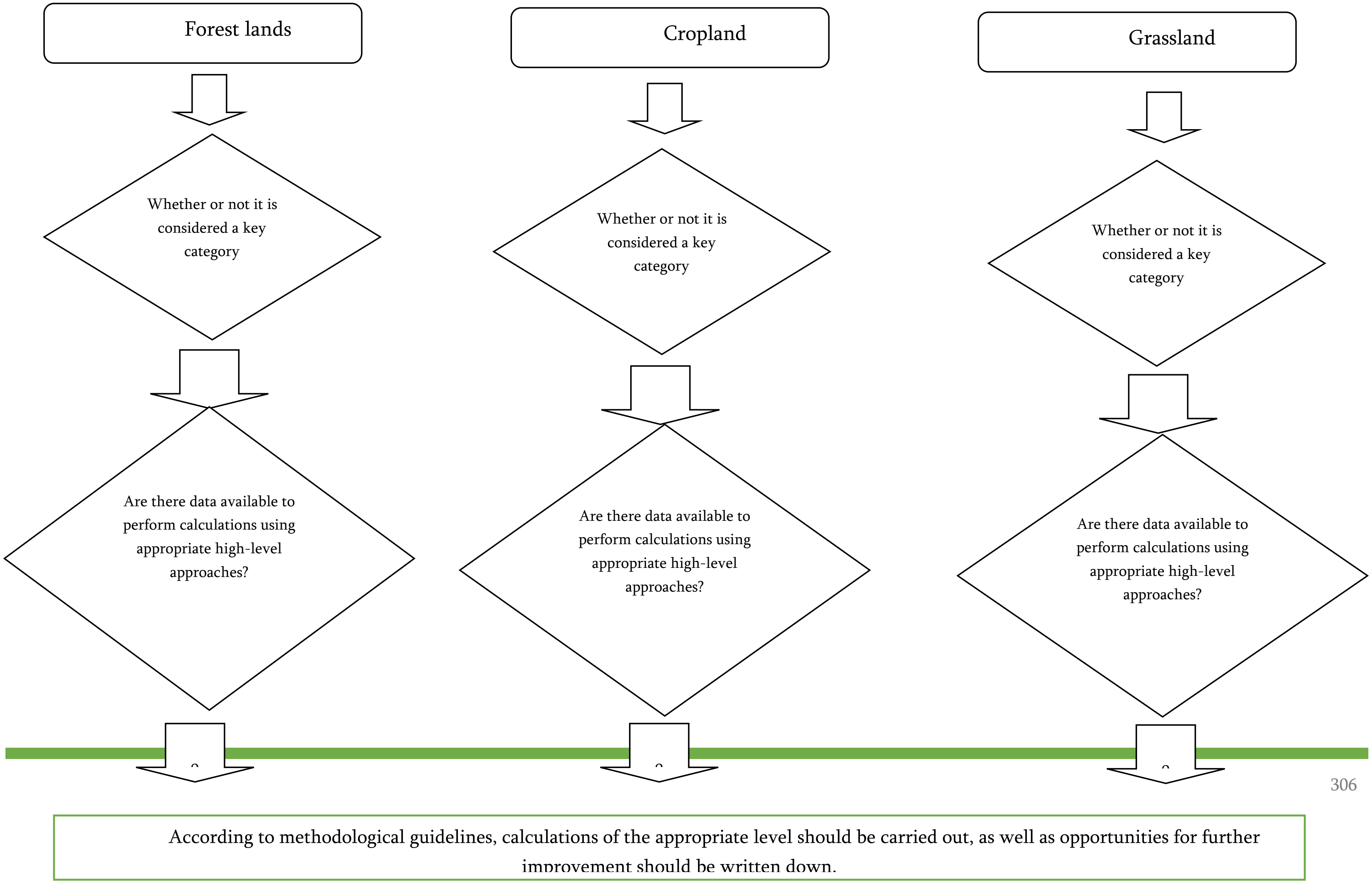


Figure V-2. Calculation of the percentage distribution of firewood and roundwood, conifers and deciduous trees in forest clearings

Year	Total cuts, across Georgia	Logging, National Forestry Agency	Volume of forest felling from forest clearings, thousand cubic meters						The proportion of succulents and broadleaf plants in the cuttings			
			roundwood			Firewood			roundwood (14%)		Firewood (86%)	
			Coniferous	Deciduous	Total	Coniferous	Deciduous	Total	Coniferous%	Deciduous%	Coniferous%	Deciduous%
2012	416.3	357.3	34.4	1.1	35.5	41.1	280.7	321.8	97.0	3.0	13.0	87.0
2013	630.7	506.0	21.6	0.7	22.3	52.6	431.1	483.7	97.0	3.0	11.0	89.0
2014	615.5	517.6	24.0	0.6	24.6	61.1	432.0	493.0	98.0	2.0	12.0	88.0
2015	632.6	549.1	29.7	1.2	31.0	63.6	454.5	518.1	96.0	4.0	12.0	88.0
2016	565.8	463.4	36.8	2.7	39.5	59.6	364.3	423.9	93.0	7.0	14.0	86.0
2017	574.5	466.4	35.4	14.6	50.0	61.6	354.7	416.4	71.0	29.0	15.0	85.0
2018	533.7	433.4	50.2	14.3	64.5	75.2	293.7	368.9	78.0	22.0	20.0	80.0
2019	553.8	446.5	45.8	10.8	56.6	77.9	311.9	389.9	81.0	19.0	20.0	80.0
2020	464.4	416.4	63.7	16.9	80.6	69.7	266.1	335.8	79.0	21.0	21.0	79.0
2021	435.2	387.8	94.8	16.3	111.1	54.2	222.5	276.7	85.0	15.0	20.0	80.0
2022	505.7	466.9	147.8	24.4	172.2	53.7	241.0	294.7	86.0	14.0	18.0	82.0
Average percentage									**87.4**	**12.6**	**16.0**	**84.0**

Figure V-3. Calculation of the average annual increase rate based on data received from the LEPL National Forestry Agency (as of January 1, 2023)

Region			Thousand hectares		Average annual increase m^3 per 1 ha	Weighted average rate, m^3 per 1 ha
			Forest fund area	forest cover area		
1	Western Georgia	Samegrelo-Zemo Svaneti	271.6	255.3	2.4	2.1
2		Guria (443 ha of Pontus forest reserve)	85.4	82.1	1.9	
3		Imereti	280.2	269.0	1.7	
4		Racha-Lechkhumi and Lower Svaneti (protected)	267.9	254.5	2.4	
5	Eastern Georgia	Shida Kartli (protected)	101.1	90.9	1.7	1.7
6		Mtskheta-Mtianeti (12,510 ha of forested area transferred to the Agency for Protected Areas)	181.9	169.2	1.6	
7		Kakheti	283.6	263.7	1.6	
8		Kvemo Kartli (natural monuments)	145.1	132.0	1.5	
9		Samtskhe-Javakheti (Borjomi-Kharag National Park)	122.2	117.3	2.4	

Figure V-4. Calculation of the weighted average BCEFI coefficient.

	Main forest-forming species	Timber stock, m³/ha	Average annual m³ of wood increment (net annual increment) converted into average annual aboveground biomass increment ($BCEF_I$)
1	Beech (Fagus orientalis)	300.10	0.48
2	Hornbeam (Carpinus caucasica)	185.90	0.60
3	Oriental spruce (Picea orientalis)	346.40	0.60
4	Caucasian Fir (Abies nordmanniana)	517.20	0.60
5	Chestnut (Castanea satina)	219.80	0.48
6	Alder (Alnus barbata)	136.20	0.60
7	Oak (Quercus iberica)	147.80	0.60
8	Caucasian Pine (Pinus hamata)	271.80	0.69

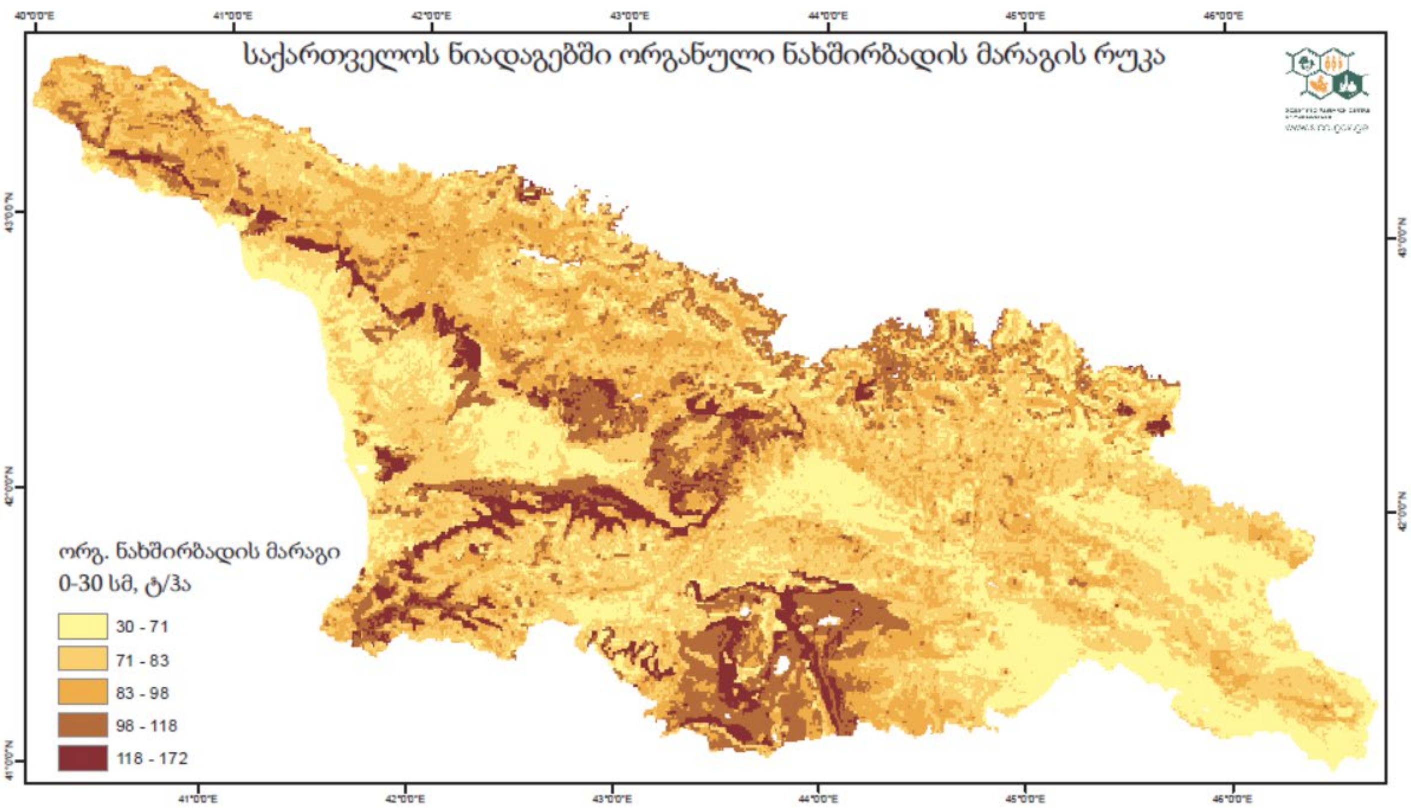
Figure V-5. Calculation of the weighted average BCEFR ratio

	Main forest-forming species	Timber stock, m³/ha	Biomass conversion factor ($BCEF_R$) of the volume of woody biomass produced (m^3)
1	Beech (Fagus orientalis)	300.10	0.89
2	Hornbeam (Carpinus caucasica)	185.90	1.17
3	Oriental spruce (Picea orientalis)	346.40	0.77
4	Caucasian Fir (Abies nordmanniana)	517.20	0.77
5	Chestnut (Castanea satina)	219.80	0.89
6	Alder (Alnus barbata)	136.20	1.17
7	Oak (Quercus iberica)	147.80	1.17

Figure V-6. Calculation of the weighted average of the aboveground biomass to belowground biomass conversion coefficient

	Main forest-forming species	Timber stock[1], m^3/ha	"BASIC WOOD DENSITIES"[2], tons of dry mass/m^3	Aboveground biomass, tons ha[1]	„RATIO OF BELOW-GROUND BIOMASS TO ABOVE-GROUND BIOMASS (R)“[3]
1	Beech (Fagus orientalis)	300.10	0.58	174.06	0.24
2	Hornbeam (Carpinus caucasica)	185.90	0.74	137.57	0.23
3	Oriental spruce (Picea orientalis)	346.40	0.44	152.42	0.20
4	Caucasian Fir (Abies nordmanniana)	517.20	0.41	212.05	0.20
5	Chestnut (Castanea satina)	219.80	0.54	118.69	0.23
6	Alder (Alnus barbata)	136.20	0.40	54.48	0.46
7	Oak (Quercus iberica)	147.80	0.66	97.55	0.30
8	Caucasian Pine (Pinus hamata)	271.80	0.42	114.16	0.29
9	Caucasian Lime (Tilia begonifolia)	236.70	0.47	111.25	0.23
10	oriental hornbeam (carpinus orientalis)	71.20	0.74	52.69	0.46
Weighted average rate					**0.25**
[1]National Forest Inventory data; [2]Makhviladze S.E. Wood science, Tbilisi 1962 (in Georgian); [3]IPCC 2006 AFOLU Table 4.4.					

Figure V-7. Map of organic carbon stocks in Georgian soils



West-cropland 77.8 tC/ha
West-grassland 82.8 tC/ha
East-cropland 81.1 tC/ha
East-grassland 81.2 tC/ha

Figure V-8. Calculation of the reference carbon stock index for agricultural land

Land areas under private ownership	Grassland, thousand hectares	Carbon stock in grasslands, tCha	Cropland, thousand hectares	Carbon stock on cropland, tCha
Eastern Georgia				
Tbilisi	0.6		0.1	
Kakheti	100.5		72.0	
Mtskheta-Mtianeti	5.2		3.0	
Samtskhe-Javakheti	34.7		19.0	
Kvemo Kartli	50.5		22.0	
Shida Kartli	5.7		25.0	
	197.2	81.2	141.1	81.1
Western Georgia				
Adjara	4.8		15.0	
Guria	1.7		19.0	
Imereti	6.8		46.0	
Racha-Lechkhumi and Lower Mossvaneti	2.6		2.0	
Samegrelo-Zemosvaneti	1.9		37.0	
	17.8	81.1	119.0	77.8
Weighted indicator		**81**		**79**

Figure V-9. Peat extraction data according to documents received from the National Agency of Mineral Resource

№	Name of the object	District	License holder	License registration and validity period	Annual average extraction, tons	Total extraction, tons	Area, ha
1	"Otsantsalesh" group (labor) peat extraction (in Martvili, near the village of Didi Chkoni)	Martvili	F/P Vakhtang Abzianidze	22.06.10 11.12.22	1,023.1	13,300.0	16.3
2	"Maltakvi" peat extraction (in Lanchkhuti municipality, village Grigoleti)	Lanchkhuti	JSC "Potitorfi"	31.12.10 13.12.22	1,897.5	24,668.0	3.4
3	"Velispiri" peat extraction (in Dmanisi municipality, village Velispiri)	Dmanisi	LLC "Metalon Georgia"	12.04.10 13.04.22	7,836.4	101,873.0	5.5
4	"Bazaklo" peat extraction (in Dmanisi municipality, near the village of Bazaklo)	Dmanisi	LLC "Kartli Flora"	22.05.17 23.05.22	1,287.0	7,722.0	2.3
5	"Menchaeri" peat extraction (in Tsalka municipality, village Damba)	Tsalka	RC "Mashpro"	26.09.17 22.01.22	617.0	3,703.0	0.3
6	"Menchaeri" peat extraction (I district) (in Tsalka municipality, near the village of Dashbashi)	Tsalka	RC "Mashpro"	26.09.17 14.01.21	1,016.0	5,087.0	0.9
7	"Menchaeri" peat extraction (II district) (in Tsalka municipality, village Dashbashi) (in the vicinity)	Tsalka	LLC "Synergia +"	15.03.18 14.01.21	1,899.0	7,597.0	1.5
8	Extraction of peat of the "Otsantsalesh" group (district Otsantsalesh) (in Martvili	Martvili	LLC "Cap Georgia"	10.08.18 11.08.20	3,430.0	2,572.0	1.0

	municipality, in the vicinity of the village of Didi Chkoni)						
9	Extraction of peat of the "Menchaeri" group (in Tsalka municipality, in the vicinity of the village of Dashbashi)	Tsalka	LLC "Lagi 21"	05.02.19 06.02.22	4,980.0	10,856.0	2.0
10	Extraction of peat of the "Pantiani" group (in Dmanisi municipality, in the vicinity of the village of Pantiani)	Dmanisi	LLC "Georgian Flora"	08.10.19 09.10.20	1,680.0	1,730.0	0.5
11	Extraction of peat of the "Aralikhi" group (in Martvili municipality, in the vicinity of the village of Didi Chkoni)	Dmanisi	LLC "Georgian Flora"	08.10.19 09.10.21	5,085.0	13,089.0	1.5
12	Total peat extraction and total area of deposits in 2010-2022	Martvili	LLC "Novator"	27.08.21 28.08.22	3,580.0	7,160.4	2.8
	"Otsantsalesh" group (labor) peat extraction (in Martvili, near the village of Didi Chkoni)					199,357.40	38.0

Annex VI. **Common reporting tables**

The general reporting tables are provided in Excel format and are part of the national inventory report.