



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



MINISTRY OF ENVIRONMENTAL PROTECTION
AND AGRICULTURE OF GEORGIA



LEPL ENVIRONMENTAL
INFORMATION AND
EDUCATION CENTRE



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.

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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 CO₂ 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 CO₂ eq., representing an 80% reduction from 1990 levels. From 2003 onward, emissions gradually increased, stabilizing around 17,000–18,000 Gg CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ eq. in 1990 to 2,571 Gg CO₂ eq. in 2022. The Agriculture sector has remained relatively stable, with emissions fluctuating between 2,300 and 2,800 Gg CO₂ eq. in recent years. The Waste sector has shown a steady increase in emissions, reflecting urbanization and waste generation trends. Among specific GHGs, CO₂ remains the dominant contributor, accounting for 63.9% of total emissions in 2022, with methane (CH₄) contributing 29.4%, nitrous oxide (N₂O) at 4.4%, and hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF₆) 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 (N₂O) emissions are estimated from agriculture, specifically from manure management and managed soils.

Indirect N₂O emissions result primarily from nitrogen volatilization in the form of ammonia (NH₃) 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	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
1B2b	Fugitive Emissions from Natural Gas	CH4	L	L	T
4A	Forest Land Remaining Forest Land	CO2	L	L	T
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	CO2	L	L	T
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	CO2	L	L	T
1A3e	Fuel Combustion - Transport - Other Transport - Gaseous fuels	CO2		L	T
1A4b	Fuel Combustion - Residential - Gaseous fuels	CO2	L	L	
3A1	Enteric Fermentation - Cattle	CH4	L	L	
4B	Cropland Remaining Cropland	CO2	L		T

IPCC Category Code	IPCC Category	Greenhouse Gas	Level Assessment (1990) Lx,t	Level Assessment (2022) Lx,t	Trend Assessment Tx,t
1A1	Fuel Combustion - Manufacture of Solid Fuel and Other Energy Industries - Solid Fuels	CO2	L		T
1B1	Fugitive Emissions from Solid Fuels	CH4	L		
1B2c	Fugitive Emissions from Natural Gas	CH4		L	
1A4b	Fuel Combustion - Residential - Liquid fuels	CO2	L		
1A4a	Fuel Combustion - Commercial/Institutional- Liquid fuels	CO2	L		
3D1	Direct N2O Emissions from Managed Soils	N2O	L	L	
2B1	Chemical Industry - Ammonia Production	CO2	L	L	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
1B2b	Fugitive Emissions from Natural Gas	CH4	L	L	T
1A1	Fuel Combustion - Energy Industries - Gaseous fuels	CO2	L	L	T
1A3b	Fuel Combustion - Transport - Road Transport - Liquid fuels	CO2	L	L	T
1A3b	Fuel Combustion - Transport - Road Transport - Gaseous fuels	CO2		L	
1A3e	Fuel Combustion - Transport - Other Transport - Gaseous fuels	CO2		L	T
1A4b	Fuel Combustion - Residential - Gaseous fuels	CO2	L	L	T
3A1	Enteric Fermentation - Cattle	CH4	L	L	T
1A1	Fuel Combustion - Manufacture of Solid Fuel and Other Energy Industries - Solid Fuels	CO2	L		T
1B1	Fugitive Emissions from Solid Fuels	CH4	L		T
1A4b	Fuel Combustion - Residential - Liquid fuels	CO2	L		T
1A4a	Fuel Combustion - Commercial/Institutional-Liquid fuels	CO2	L		T
3D1	Direct N2O Emissions from Managed Soils	N2O	L	L	
2B1	Chemical Industry - Ammonia Production	CO2	L	L	T
2B2	Chemical Industry - Nitric Acid Production	N2O		L	T
2A1	Mineral Industry - Cement Production	CO2	L	L	T
1A4c	Fuel Combustion - Agriculture/Forestry/Fishing/Fish Farms - Liquid 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
5A3	Solid Waste Disposal -Uncategorised	CH4	L	L	T
5A1	Solid Waste Disposal - Managed	CH4	L	L	T
5A2	Solid Waste Disposal - Unmanaged	CH4		L	
3A4	Enteric Fermentation - Other Cattle	CH4	L	L	
5D1	Domestic Wastewater Treatment	CH4	L	L	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 CO₂, CH₄, and N₂O emissions. In fugitive emissions from oil and natural gas, Tier 2 is applied specifically for CH₄ emissions from natural gas.

For industrial processes and product use, Tier 2 and Tier 3 methods are utilized in the mineral industry for CO₂ emissions, while Tier 3 methods are applied in the chemical industry. In metal production, Tier 2 methods are used for CO₂ emissions. Additionally, certain industrial

processes apply Tier 2 methods for N₂O emissions. Country-specific emission factors are applied primarily in the mineral and chemical industries for CO₂ emissions.

Within the agriculture sector, Tier 2 method is used for enteric fermentation. Tier 2 method is applied for CH₄ and N₂O emissions from manure management.

In the land use, land use change, and forestry sector, Tier 2 methods are applied for CO₂ emissions from forest lands.

For the waste sector, Tier 2 methods are used for CH₄ emissions from solid waste disposal.

Country-specific data is applied in fugitive emissions from oil and natural gas, specifically for CH₄ emissions. In the agriculture sector, country-specific emission factors are used for CH₄ emissions from enteric fermentation and manure management, as well as for N₂O emissions from manure management. The waste sector also incorporates country-specific data for CH₄ 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 CO ₂ eq.)
Total GHG emissions without LULUCF	20,096
thereof 0.1 %	20.10
thereof 0.05 %	10.05
CRT code and name	Expected or estimated emissions
2G3b Propellants in pressurized and aerosol products (7.8.3.2.)	<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	CO ₂	1
Methane	CH ₄	28
Nitrous Oxide	N ₂ O	265
HFC-32	CH ₂ F ₂	677
HFC-125	CHF ₂ CF ₃	3,170
HFC-134a	CH ₂ FCF ₃	1,300
HFC-143a	CH ₃ CF ₃	4,800
HFC-227ea	CF ₃ CHFCF ₃	3,350
Sulphur hexafluoride	SF ₆	23,500
Nitrogen trifluoride	NF ₃	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 CO₂ 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 CO₂ 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

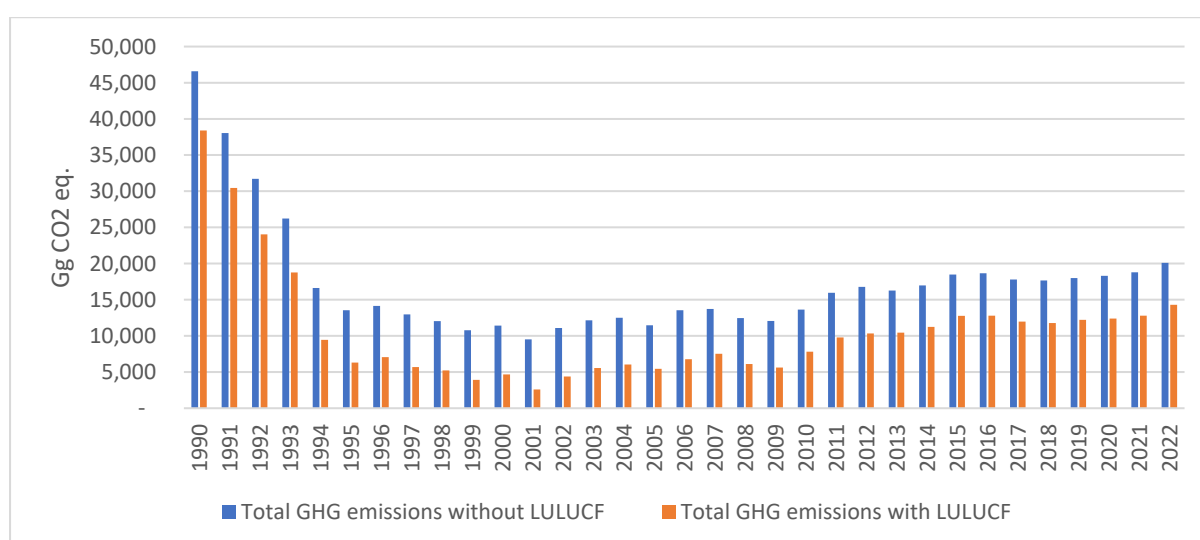
Year	Total GHG emissions without LULUCF (Gg CO ₂ eq.)	Total GHG emissions with LULUCF (Gg CO ₂ eq.)	Year	Total GHG emissions without LULUCF (Gg CO ₂ eq.)	Total GHG emissions with LULUCF (Gg CO ₂ eq.)
1990	46,575	38,396	2007	13,733	7,528
1991	38,039	30,458	2008	12,470	6,103
1992	31,714	24,043	2009	12,064	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 CO₂ 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 CO₂ 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 CO₂ eq., helping offset emissions. During the early 1990s, LULUCF removals remained relatively high, ranging between 6,000 and 9,000 Gg CO₂ eq. However, by the early 2000s, the removals dropped to their lowest point, reaching just 2,581 Gg CO₂ eq. in 2001. From 2002 onward, LULUCF removals began increasing again, reaching over 10,000 Gg CO₂ eq. by 2012. The highest recorded removals were in 2022, at 14,295 Gg CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ eq. and decreased sharply during the 1990s due to industrial decline, reaching a low of 387 Gg CO₂ eq. in 1994. Emissions gradually increased after 2000, reaching 2,571 Gg CO₂ 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 CO₂ eq., with a decline throughout the 1990s. By 2007, emissions had dropped to 2,331 Gg CO₂ eq., marking a decrease in agricultural activities. From 2010 onwards, emissions fluctuated but remained relatively stable, peaking at 2,822 Gg CO₂ eq. in 2015 before decreasing to 2,310 Gg CO₂ 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 CO₂ eq. in 1990, waste-related emissions consistently rose due to urbanization and waste generation, reaching 1,996 Gg CO₂ 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 CO₂ eq., significantly reducing net emissions. Over time, removals slightly decreased, reaching a low of -5,807 Gg CO₂ eq. in 2013. However, the trend remained relatively stable, with removals at -5,801 Gg CO₂ 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).

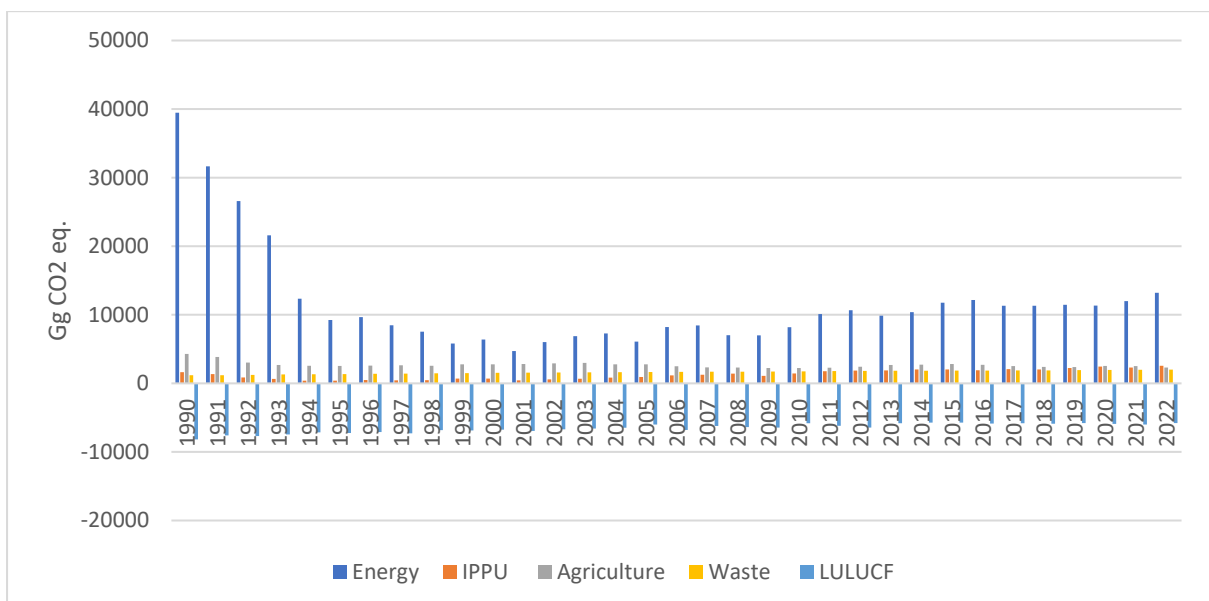
Table 2-2. Sectoral GHG emission and removal trends from 1990 to 2022

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 (CO₂)

Carbon dioxide (CO₂) emissions have been the dominant contributor to total GHG emissions. In 1990, CO₂ emissions stood at 32,543 Gg CO₂ eq. but dropped significantly in the 1990s due to economic collapse, reaching a low of 3,377 Gg CO₂ eq. in 2002. Emissions then gradually increased due to economic recovery and industrial growth, reaching 12,829 Gg CO₂ eq. in 2022, marking a fourfold increase from their lowest level.

Methane (CH₄)

Methane (CH₄) emissions followed a different trend. In 1990, CH₄ emissions were 12,775 Gg CO₂ eq., primarily from agriculture and waste sectors. They declined through the 1990s, reaching a low of 4,869 Gg CO₂ eq. in 1999. Afterward, emissions fluctuated, peaking at 7,523 Gg CO₂ eq. in 2003 before stabilizing around 5,900–6,800 Gg CO₂ eq. in recent years. In 2022, CH₄ emissions were recorded at 5,906 Gg CO₂ eq., showing an overall decrease from 1990 but stability in recent years.

Nitrous oxide (N₂O)

Nitrous oxide (N₂O) emissions exhibited a moderate decline. In 1990, they were 1,258 Gg CO₂ eq. and fell to around 800–900 Gg CO₂ eq. during the early 2000s. The highest recorded emissions were in 2015 at 1,051 Gg CO₂ eq., after which they remained relatively stable. By 2022, N₂O emissions had slightly declined to 879 Gg CO₂ eq.

Hydrofluorocarbons (HFCs)

Hydrofluorocarbons (HFCs) were not recorded in the inventories until 2001, when emissions first appeared at 0.24 Gg CO₂ eq. Since then, they have steadily increased, reaching 480 Gg CO₂ eq. in 2022, reflecting the rising use of refrigerants and other industrial applications.

Sulfur hexafluoride (SF₆)

Sulfur hexafluoride (SF₆) emissions were first recorded in 2010 at 0.55 Gg CO₂ eq. and have remained minimal. By 2022, they had slightly increased to 1.14 Gg CO₂ eq., showing a slow but steady rise.

CO₂ emissions have experienced the most significant fluctuations, while CH₄ and N₂O have been relatively stable over time. HFCs and SF₆ 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 CO₂ emissions, there are no equivalent large-scale removal processes for CH₄, N₂O, HFCs, or SF₆, making CO₂ the only gas with a substantial offset potential through forestry and land-use changes (.).

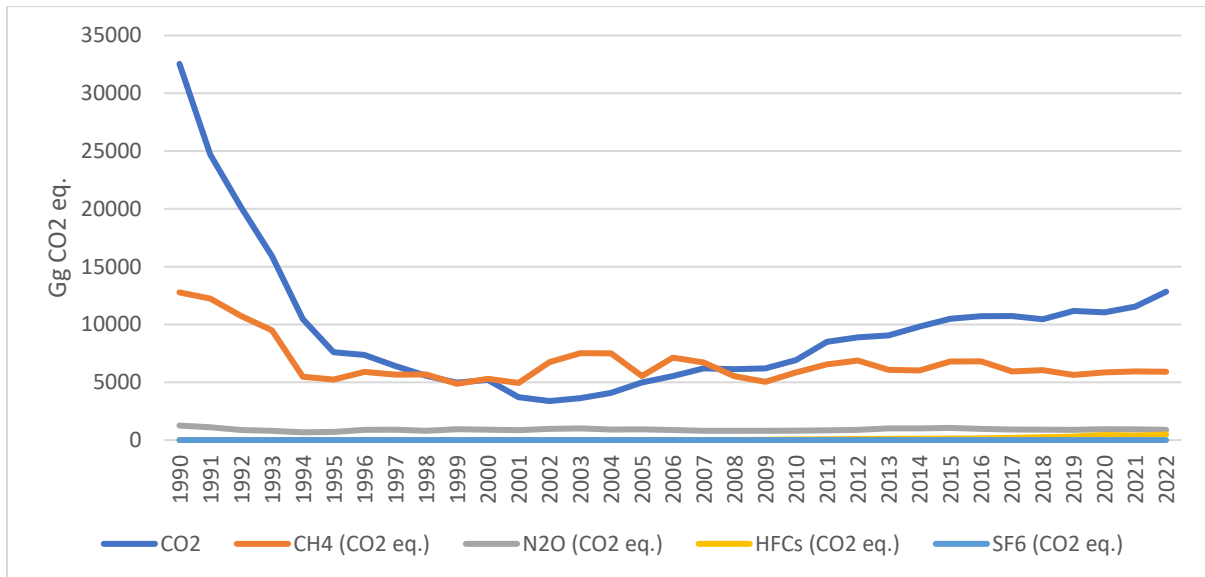
Table 2-3. GHG emissions trend in Georgia by gases from 1990 to 2022

Year	CO ₂	CH ₄ (CO ₂ eq.)	N ₂ O (CO ₂ eq.)	HFCs (CO ₂ eq.)	SF ₆ (CO ₂ 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
2022	12,829	5,906	879	480	1.14

In 1990, CO₂ accounted for 71.2% of total emissions, CH₄ contributed 28.0%, and N₂O made up 2.8%. HFCs and SF₆ were not recorded. By 2022, CO₂ emissions had increased their share to 63.9%, CH₄ had declined to 29.4%, N₂O represented 4.4%, HFCs accounted for 2.4%, and SF₆

remained at only 0.01%. These changes indicate that while CO₂ 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



Chapter 3. Energy (CRT sector 1)

3.1. Overview of the sector and background 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), CH₄ (methane), N₂O (nitrous oxide), NO_x (nitrogen oxide), CO (carbon monoxide), and non-methane Fugitive organic compounds (NMVOCs) are produced during the processes.

Table 3-1 shows the approaches and levels used to estimate these emissions.

Table 3-1. Methodologies used in the energy sector

Categories	CO ₂		CH ₄		N ₂ O	
	Used method	Emission factor	Used factor	Emission factor	Used factor	Emission factor
1.A - Fuel combustion	T1	D	T1	D	T1	D
1.A.1 - Energy industry	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/Public	T1	D	T1	D	T1	D
1.A.4.b - Household	T1	D	T1	D	T1	D
1.A.4.c - Agriculture/Forestry/ Fishing/ Fish Farming	T1	D	T1	D	T1	D
1.A.5 Unspecified	T1	D	T1	D	T1	D
1.B - Fugitive emissions from fuel	T1	D	T1, T2	D, CS	T1	D
1.B.1 - Solid fuel	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
	NO	NO				

Note: D: IPCC standard, T1: Level 1, T2: Level 2, T3: Level 3, CS: Country-specific method or EF

In 2022, greenhouse gas (CO₂, CH₄, N₂O) emissions from the energy sector amounted to 13,218 Gg CO₂ equivalent, which equals to almost 67% of Georgia's total greenhouse gas emissions (excluding LULUCF). In 2022, the largest share of total greenhouse gas emissions from the energy

sector were as follows: Transport - 34%, other sub sectors- 25%, oil and natural gas - 15%, energy industry - 11.5%, manufacturing industries and construction - 13.5%. Compared to 1990, total greenhouse gas emissions from the energy sector have decreased by 66.5%.

Table 3-2. Greenhouse gas emissions from the energy sector for 1990 and 2022

Categories	1990 emissions			2022 emissions		
	(gg)			(gg)		
	CO2	CH4	N2O	CO2	CH4	N2O
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 industry	13,731.86	0.41	0.09	1,522.86	0.03	0.00
1.A.2	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/Public	1,076.52	0.45	0.01	518.37	0.06	0.00
1.A.4.b – Household	3,688.24	4.79	0.06	2,661.19	2.83	0.04
1.A.4.c – Agriculture/ Forestry/ Fishing/ Fish Farming	518.23	0.24	0.00	54.28	0.02	0.01
1.A.5 Unspecified		1.13	0.02			
1.B Fugitive emissions from fuel	66.56	288.11	0.00	7.30	73.68	0.00
1.B.1 – Solid fuel	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

Significant decline in greenhouse gas emissions in the 1990s was a result of the collapse of the Soviet Union and the fundamental changes in the country's economy. However, the national economy began to grow since 2000, and the average annual growth rate of real GDP amounted to 8.4% per year until 2008. During 2008-2009, economic growth in Georgia slowed due to the Russian and Georgian war. Since 2010, the country's real GDP has been growing again, averaging 5.2% per year until 2020. In the first year of the Covid pandemic - 2020, GDP fell by 6.3%, which was followed by a 10% growth rate in subsequent years.¹

In 2010, hydropower generation reached its peak capacity, while thermal power stations generation was at its lowest level in a decade. Since 2011, emissions from the energy sector have increased, mainly due to increased thermal power generation and improved economic conditions. The table below shows energy sector emissions in CO₂ equivalent. The global warming potentials used to convert greenhouse gases into CO₂ equivalents are presented in the Fifth Assessment Report.

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

Table 3-3. Greenhouse gas emissions from the energy sector (Gg CO₂ equiv.)

Year	1A – fuel combustion	1B - Fugitive emissions from fuel	1C - CO ₂ transportations 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 the table indicates, the majority of emissions from the energy sector result from fuel combustion (84% in 2022), with the remaining 16% stemming from Fugitive emissions. Among the various emission sources, the most significant increase related to

2000 occurred while the transformation ² of solid fuels among Fugitive emissions (30 gg CO₂ equiv. 2000 year, 170 gg CO₂ equiv. 2017 year), This increase was driven by the activation of coal mining activities in recent years. However, since 2018, these operations have decreased substantially due to fatal accidents and a subsequent technical inspection of miners' safety standards.³

Emissions by greenhouse gas are shown in the table below.

Table 3-4. Table 3-4 Greenhouse gas emissions from the energy sector (Gg)

YEAR	CO ₂ GG	CH ₄	CH ₄ CO ₂ equiv.	N ₂ O	N ₂ O CO ₂ equiv.	Total CO ₂ equiv.
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
2016	9,125	106	2,957	0.305	81	12,162

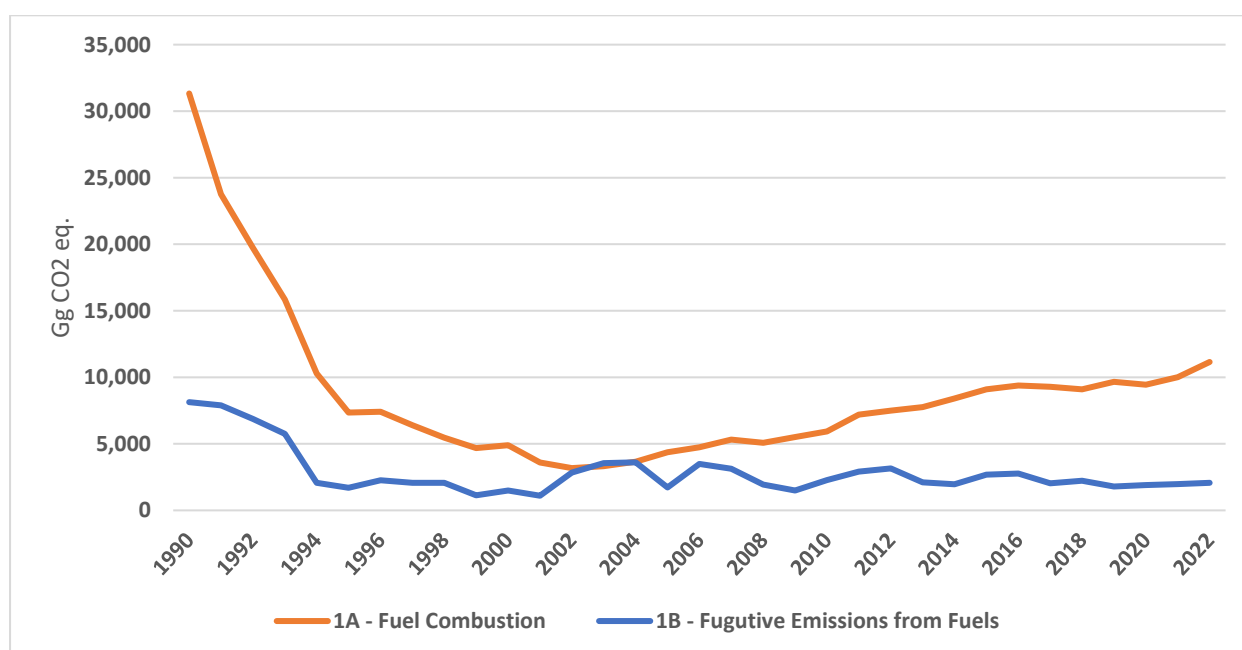
² See the table 3-32.

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

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

During 2000-2022, emissions from the industrial and transport sectors increased by almost 2.6 times and 4.2 times, respectively. Greenhouse gas emissions in the transport sector increased due to the growth of the vehicle fleet, which mainly consists of used cars. The number of vehicles in Georgia increased from 319,600 to 1,563,165⁴ between 2002-2022. Since 2006, the construction of energy transit pipelines (South Caucasus Gas Pipeline, Baku-Tbilisi-Erzurum Oil Pipeline) through Georgia has required additional gas and diesel to operate the pipelines. Figure 1 shows the trends in greenhouse gas emissions in the energy sector over the period 1990-2022.

Figure I-1. Greenhouse gas emissions trends in the energy sector, 1990-2022 (Gg O2 equiv.)



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 CO₂ equivalent. In that year, carbon dioxide, methane and nitrous 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

⁴ National Statistics Office of Georgia 2023 <https://automobile.geostat.ge/ka/>

household 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 Guidelines methodology Tier 1 and Tier 2 sectoral and ethological approaches. The sectoral approach to verifying emissions from stationary fuel combustion source categories is based on sector-by-sector actual fuel consumption data provided in the country's energy balance and an emission factor. Tier 1 emission factors are derived from the 2006 IPCC Guidelines standard values, which are provided with their associated uncertainty ranges.

The sectoral approach calculates greenhouse gas emissions from stationary combustion using the following formula:

$$Emission_{\text{greenhouse gasses, fuel}} = \text{fuel consumption}_{\text{fuel}} \times \text{emission factor}_{\text{greenhouse gasses, fuel}}$$

where:

$Emission_{\text{greenhouse gasses, fuel}}$ – Given greenhouse gas emissions by fuel type (kg greenhouse gas)

$Fuel\ consumption_{\text{fuel}}$ – Amount of fuel burned (T)

$Emission_{\text{greenhouse gasses, fuel}}$ – The standard emission factor for a given greenhouse gas by fuel type (kg gas/T). For CO₂, it also includes the carbon oxidation factor- 1.

For calculating emissions by Tier2, country-specific emission factors are used instead of standard emission factors. Country-specific emission factors can be developed taking into account country-specific data, such as the carbon content of the fuel used, carbon oxidation factors, fuel quality and the state of technological development. Emission factors may change over time.

It is common practice to compare country-specific emission factors with standard values. The country-specific emission factor may be identical to the standard value, or it may differ. If the country-specific emission factors fall outside the 95 percent confidence intervals given for the standard emission factor values, an explanation should be provided as to why the specific emission factor value differs from the standard value. In practice, the uncertainty interval of country-specific emission factors is generally shorter than the interval of standard emission factors. Accordingly, a Tier 2 assessment provides an emission estimate with lower uncertainty than a Tier 1 assessment.

Greenhouse gas emissions from stationary combustion are calculated under "Tier 1" using the same formula as "Tier 2", with the difference that the emission factor is taken as standard.

Not all fuels used in the economy are consumed for the production of thermal energy. Some of them are used as raw materials to produce products such as plastics, or even bitumen for road construction without carbon oxidation (emissions). This is called stored carbon and is excluded from carbon emissions calculations. Estimating stored carbon requires data on fuel consumption by activities where fuel is used as a raw material, in sectors such as petrochemical production, construction, other industries, and agriculture.

The recalculation of the greenhouse gas emission inventory for previous years is mainly due to changes in historical data, as well as the availability of new data sources. In addition, emissions were calculated at a higher level in some source categories.

Emission factors

An emission factor is a coefficient that relates activity data to the amount of the chemical substance that is subsequently the source of the emission. For CO₂ from fossil fuel combustion, the emission factor is expressed on a per unit energy basis, since the carbon content of a fuel expressed per unit energy is usually less variable than on a per mass basis. Therefore, the net calorific value of fuel (NCV) is used to convert fuel consumption data from mass units to energy units. The net calorific value data for various fuels specific to the country were taken from the Energy Balance (2013-2022) of the National Statistics Office of Georgia.

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

Fuel type	Unit	Net calorific value of fuel (terajoules (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 CO₂ are given in kg CO₂/GJ based on net calorific value and reflect the carbon content of the fuel. The CO₂ emission factors for all levels reflect the total carbon content of the fuel, excluding the unoxidized portion of carbon remaining in ash, particulate matter or soot. Since this fraction is usually small, the Tier 1 standard emission factors ignore the impact of the unoxidized fraction by assuming complete oxidation of the carbon in the fuel (the carbon oxidation factor is equal to 1). The emission factors for CH₄ and N₂O are different for different source categories, which is due to the differences in the combustion technologies used in each source

category. The Tier 1 standard factors are used for technologies for which there are no emission control mechanisms⁵.

Activity Data

Typically, the basis for estimating greenhouse gas emissions from fuel combustion in the energy sector is the national energy balance. The energy balance is given in physical units (tonnes or m³) or energy units (terajoules or kilotonnes of oil equivalent) for fuel production, import, export, changes in supplies and consumption. For data comparison, the physical units in the energy balance are converted into energy units, for which the net calorific value (NCV) of the fuel is used.

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 Georgia⁶;
- 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 Link!;
- Information on natural gas and crude oil transit was provided by the Georgian Oil and Gas Corporation⁷;
- Electricity balances for 2007-2022 were obtained from the electricity market operator⁸;
- Information on natural gas transmission and distribution losses was provided by the Georgian National Energy and Water Regulatory Commission⁹;
- Data on natural gas and diesel consumption for the operation of energy transit pipelines for 2010-2017 were provided by British Petroleum Georgia¹⁰;
- 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 Development¹¹.

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

3.2.3. Comparison of the sectoral approach with the reference approach

This chapter explains the comparison between the reference and sectoral approaches according to the United Nations Framework Convention on Climate Change (UNFCCC) Inventory Reporting Guidelines (Decision 24/CP.19 Annex I, paragraph 40). The reference approach is a descending approach that uses data on a country's energy resources mainly to calculate CO₂

⁵ Emission Factor Database.

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

emissions from fossil fuels. The reference approach is a straightforward method that can be used based on relatively readily available energy statistics. The improved ability to compare sectoral and reference approaches allows a country to develop a second independent estimate of CO₂ emissions from fuel combustion with little additional effort and data. The reference approach determines the upper limit of CO₂ emissions resulting from the supply of fossil fuels in a country by determining the carbon content, subtracting the excluded carbon - carbon stored in non-energy products and in products for the production of which the fuel is used as a raw material - and multiplying by 44/12. Under the reference approach, carbon dioxide emissions are calculated using the following formula:

$$\begin{aligned} \text{Carbon dioxide emissions (gg CO}_2\text{)} = & \\ \sum_i \{ & [\text{Domestic Consumption of Fuel (Unit)} \\ & \times \text{Fuel energy content (TJ/unit)} \times \text{Carbon emission factor (t C/TJ)} / 1000 - \text{excluded} \\ & \text{carbon}] \\ & \times \text{Oxidized carbon fraction}\} \times 44/12 \end{aligned}$$

where the lower index *i* denotes the fuel type, and for each primary fuel, the consumption is calculated as follows:

$$\textit{Real consumption} = \textit{Production} + \textit{Imports} - \textit{Exports} - \textit{International bunkers} - \textit{Change in inventories}$$

For secondary fuels, domestic consumption is calculated as follows:

$$\textit{Real consumption} = \textit{Imports} - \textit{Exports} - \textit{International bunkers} - \textit{Change in inventories}$$

Typically, the share of oxidized carbon is 1, which reflects complete oxidation. The calculation of excluded carbon is done using the following formula:

$$\begin{aligned} \text{Excluded Carbon (Gg C)} = & \text{Non-energy use (103t)} \times \text{Fuel energy content (TJ/103t)} \times \\ & \text{Carbon emission factor (t C/TJ)} \times \text{Excluded Carbon share} \times 103 \end{aligned}$$

The reference approach is an upper limit on emissions because carbon is sometimes emitted in forms other than CO₂, partly because fuel combustion is not always complete and partly because fuel can leak or evaporate. Therefore, the CO₂ emissions figure derived from the reference approach includes carbon emitted in the form of CH₄, CO, N₂O or Non methane Fugitive organic compounds (NMVOC).

The reference approach is based on the simple idea that when carbon enters a national economy with a fuel, it is either stored in some form or released into the atmosphere. To calculate the carbon released into the atmosphere, it is not necessary to know exactly how the fuel was used or what intermediate transformations it underwent. In this sense, the methodology can be called a “Descending” approach, in contrast to the “Ascending” methods used for other gases. Ascending methods represent a higher-level approach, where information on fuel consumption or emission factors is collected at the level of specific enterprises. The sectoral approach is an intermediate approach between the two above-mentioned approaches, as it uses information on fuel consumption at the level of sectors of the economy.

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		
	BA * gg	SA* gg	%	BA gg	SA gg	%	BA gg	SA gg	%	BA gg	SA 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	2,052	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 difference in liquid fuels arises from small inaccuracies in the data of the petroleum products subsector of the National Statistics of Georgia energy balances. For example, the reference approach is based on production, imports and exports of products. For other categories of petroleum products, National Statistics Office of Georgia publishes export statistics, while their production in the country is not recorded in numbers. The mentioned products are a product obtained as a result of mixing several petroleum products, including imported crude oil, which in turn is not used in the calculations of the sectoral approach. Thus, an error arises between the reference and sectoral approaches.

The difference in gaseous fuels is mainly due to losses of natural gas during transportation and distribution, which are considered as methane emissions, while in the reference approach it is considered as combusted and converted to carbon dioxide.

International Bunker Fuels

All emissions from international aviation and maritime fuel (bunkers) are excluded from the national sum and are reported separately as a note. Emissions from international aviation are defined as emissions from flights operated from one country to another, including take-offs and landings for these flights.

Emissions from international maritime navigation arise from the fuel used by ships engaged in international maritime navigation under all flags. International navigation can take place at sea, on inland lakes and reservoirs, and in coastal waters. It includes emissions from voyages from one country to another.

The table below shows emissions from international aviation and maritime bunkers.

Table 3-7. Greenhouse gas emissions from fuel consumed by international bunkers

Year	International aviation bunkers				International Maritime Bunkers			
	CO2 (GG)	CH4 (GG)	N2O(GG)	Total CO2 equiv. GG	CO2 (GG)	CH4 (GG)	N2O (GG)	Total CO2 equiv.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 shipping 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. Supplies and non-energy fuel consumption

Fuels supplied to the economy are not used solely for heating purposes. Some are used as raw materials to produce products such as plastics, or for non-energy uses (e.g. bitumen for road construction, natural gas for the production of ammonia, kerosene, ethane, paraffin and candles), without the oxidation (emissions) of carbon. This is called excluded/stored carbon and is subtracted from carbon emissions calculations. Data on non-energy use of fossil fuels are given in the table below.

Table 3-8. Non-energy use of fossil fuels (TJ)

Year	Lubricant oils (TJ)	Bitumen (TJ)	Natural gas (TJ)	Year	Lubricating oils (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 the above fuels as raw materials are given in the source categories of the chapter “Industrial Processes and Product Consumption” (IPPU). Lubricating oil statistics typically include not only automotive lubricants, but also oils for industrial purposes, heating and cutting tools. Bitumen/asphalt is used for road paving and roofing, where the carbon contained is stored for a long time. Therefore, there are no greenhouse gas emissions from bitumen fuel combustion during the inventory year. Natural gas is mainly used in the 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 includes greenhouse gas emissions from the extraction, processing, or production of fossil fuels, which includes the following subcategories:

- Emissions from the primary activity of electricity and heat production (1.A.1.a) include emissions from primary producers of electricity generation, combined generation of heat and power and thermal power plants. Primary activity producers (formerly known as “utilities”) are defined as enterprises whose main activity is the production and supply of electricity and heat to the public. Such enterprises may be either publicly or privately owned.
- Petroleum refining (1.A.1.b) includes all combustion activities that contribute to the processing of petroleum products, including on-site electricity and heat production for own consumption.
- Solid fuel and other energy production (1.A.1.c) - Combustion emissions from fuels used in the production of primary and secondary products from solid fuels, including coal production. Emissions from own consumption of fuels on site should also be included; this also includes combustion in the generation of own electricity and heat in these industries.

Currently, electricity in Georgia is mainly generated by hydroelectric power plants and thermal power plants operated on natural gas. Georgia is a country rich in hydro resources, and a large part of energy generation is generated hydroelectric power plants. In 2022, there were 90 hydroelectric power plants (3,407 MW), 5 thermal power plants operated on natural gas (1,141.2 MW), and 1 wind power plant (20.7 MW) in Georgia.¹²

The largest share of hydroelectric power generation - 93% of total energy generation - was recorded in 2010 due to high precipitation levels. Starting from 2013, thermal power generation increased against the background of increasing consumption. The average annual growth rate of electricity consumption during 2010-2019 was 5%¹³, while a decrease of -10% was recorded in 2020, and a 13% increase in consumption was recorded in 2021. In 2013, the construction of four new hydroelectric power plants with an installed capacity of 46 MW (250 GWh of annual production) was completed. In 2015, a new thermal power plant operating on natural gas in

¹² The National Statistics Office of Georgia, Energy Balance 2022

¹³ Electricity Market Operator – Electricity Balance

Gardabani (with an installed capacity of 230 MW) was completed. Sixteen new hydroelectric power plants were commissioned in 2018-2022.

As for heat production, during the Soviet period (until 1991), centralized heating systems operated in large cities of Georgia. These systems used natural gas and heavy fuel oil as fuel. Later, these systems gradually became completely unusable, and, as a result, greenhouse gas emissions from this subsector dropped to almost zero. Currently, the majority of the population uses firewood and natural gas for heating. Emissions from the use of these fuels are reflected in the household subcategory.

Table 3-9. Greenhouse gas emissions from the energy industry (Gg)

GAS/SUBSECTORS	CO ₂ GG	CH ₄	CH ₄ (CO ₂ equiv)	N ₂ O	N ₂ O (CO ₂ equiv)	Total CO ₂ equiv	Electric power generation (GG CO ₂ equiv)	Thermal power stations (GG CO ₂ equiv)	Other energy industry (Gg CO ₂ equiv.)
1990	13,732	0.409	11.452	0.087	22.982	13,767	6,216	7,550	
1991	8,750	0.258	7.231	0.058	15.381	8,772	5,099	3,673	
1992	8,035	0.221	6.199	0.046	12.299	8,054	3,779	4,275	
1993	5,345	0.152	4.266	0.028	7.332	5,357	2,755	2,602	
1994	4,078	0.128	3.572	0.023	6.072	4,088	2,736	1,351	
1995	4,342	0.138	3.867	0.025	6.638	4,352	3,336	1,016	
1996	2,044	0.058	1.629	0.010	2.609	2,048	1,201	848	
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		136
2011	1,364	0.025	0.704	0.003	0.712	1,365	1,274		91
2012	1,424	0.025	0.711	0.003	0.679	1,426	1,379		47
2013	993	0.018	0.495	0.002	0.478	994	992		2
2014	1,130	0.020	0.564	0.002	0.541	1,131	1,129		2
2015	1,285	0.023	0.641	0.002	0.614	1,286	1,284		2
2016	1,077	0.019	0.527	0.003	0.666	1,078	1,076		2
2017	1,116	0.019	0.542	0.003	0.760	1,117	1,116		2

2018	1,028	0.018	0.505	0.002	0.613	1,029	1,028		1
2019	1,370	0.024	0.684	0.002	0.649	1,371	1,371		1
2020	1,244	0.022	0.621	0.002	0.591	1,245	1,244		1
2021	1,003	0.018	0.500	0.002	0.478	1,004	1,003		1
2022	1,523	0.027	0.760	0.003	0.724	1,524	1,523		1

Table 3-9 Data for other energy industries (1990-1996) and thermal power plants (2010-2022) are not presented due to data insufficiency and production suspension. The collection of statistical data for the 1990s was a significant difficulty, which was due to the difficult socio-economic and political background conditions of that time. The restoration of empty fields by the extrapolation method for 7 years of the time series (1990-1996) is less reliable, taking into account the transition from a planned economy to free market relations and the impact of the civil war. As for the operation of thermal power plants, since 2010 the operation of the plants in the country has not been recorded.

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				ფონჯ 2				Percentage Difference %
	CO ₂ (Gg)	CH ₄ (Gg)	N ₂ O (Gg)	Total CO ₂ equiv (Gg)	CO ₂ (Gg)	CH ₄ (Gg)	N ₂ O (Gg)	Total CO ₂ -equiv (Gg)	
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 standard emission factors:¹⁴.

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

Fuel/Greenhouse Gases	CO ₂	CH ₄	N ₂ O
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 ₂ O
Mtkvari	Boilers, 33-34% efficiency, natural gas	56,855	1	1
Tbilisresi	Boilers, 27-28% efficiency, natural gas	56,602	1	1

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

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: CO2 emission factor, MEPA. CH4 and N2O emission factors (IPCC, 2006), Table 2.6

Activity data

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 fuel (TJ)	Lignite (TJ)	Natural Gas (dry (TJ))	Other bituminous coal (TJ)	Household fuel (TJ)
1990		736.61		82,071.90	10,100	104,878.4
1991		511.00		49,172.00	8,700	66,280.0
1992		724.00		62,182.00	6,425	50,200.0
1993		724.00		43,967.00	1,225	35,000.0
1994		563.29		26,021.70		33,289.6
1995		384.00		25,723.00		37,080.0
1996				12,921.00		6,120.0
1997				12,947.00		4,720.0
1998				16,768.00		4,440.0
1999				16,078.00		3,720.0
2000		259.98		17,826.62		3,555.2
2001	168	1,022.00		16,897.75		
2002	168	1,065.00		11,978.69		
2003	421	1,065.00		13,545.88		
2004	463	1,491.00		16,973.97		
2005		2,383.15		20,788.63		
2006	253	852.00		25,661.00		
2007		852.00		24,334.90		
2008		725.00		19,631.46		
2009		2,812.00		19,598.82		
2010		2,300.39		6,889.99		
2011		511.29		22,008.41		

2012				24,557.38		
2013			24.12	17,660.24		
2014			20.79	20,111.55		
2015			19.40	22,867.62		
2016			468.86	18,386.31		
2017			649.40	18,693.06		
2018			370.60	17,674.08		
2019			6.10	24,408.70		
2020			8.40	22,157.14		
2021			11.70	17,859.36		
2022			11.90	27,123.99		

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 according to the 2006 IPCC Guidelines. Quality control for the general inventory focuses on checking activity data parameters and emission factors and archiving reference materials. Quality assurance procedures were carried out according to IPCC guidelines and included checking the text structure, completeness, clarity, as well as the accuracy and time intervals of calculations, emission factors and action data, in line with the guidelines. Activities related to quality assurance and quality control are summarized 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:

- In category 1.A.1.a.i (electricity production/generation), data for natural gas for 2013-2017 has been updated in the energy balance of the National Statistics Office, and data for 2018-2022 has also been added.

- In category 1.A.1.a.iii (heat production), empty fields for 1996-2000 were restored using the interpolation methodology.

- In category 1.A.1.c (solid fuel production and other energy industry), empty fields for 1999, 2000, 2010 - 2012 were restored using the interpolation methodology. Meanwhile, the energy balance of the National Statistical Office has been updated with data for 2013-2017, and data for 2018-2022 have been added.

Greenhouse gas emissions from thermal power plants in 2010-2022 are not estimated due to insufficient data. Oil refineries do not consume fuel, as processing is carried out using the natural sedimentation method. Solid fuel production is not estimated due to insufficient data and activity was minimal, therefore data are not recorded. Greenhouse gas emissions from other energy industry categories in 1990-1996 are not estimated due to insufficient data.

*Table 3-15. Results of greenhouse gas emissions recalculation from category 1.A.1.**

Years	GHG emissions before conversion (Gg CO2 equiv.)	GHG emissions after conversion (Gg CO2 equiv.)	Difference (Gg CO2 equiv.)
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 new global warming potential values: instead of 21 for methane and 310 for nitrous oxide, 28 and 265 were used, respectively.

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

3.2.6.1. *Source category description and calculated emissions*

The manufacturing industries and construction sub-sector includes emissions associated with fuel combustion in various industries, such as cast iron and steel, ferroalloys, chemicals, paper, food products, beverages, tobacco, etc., as well as emissions from the production of building materials.

After the collapse of the Soviet Union, almost a third of Georgia's factories ceased production. However, since 1995, political stabilization and the establishment of new industrial contacts have resulted in relative stability in key industrial indicators and GDP growth.

Georgia's heavy industry is one of the most important sectors in terms of value added for exports and employment. In 2023, the manufacturing and construction sectors accounted for 17.8% and 12% of GDP, respectively. Together, they account for 17.6% of Georgia's employment sector.¹⁵ The most important subsectors of heavy industry are the production of ferroalloys, steel/iron, fertilizers, and cement.

Four plants operate in the field of ferroalloy production - Georgian Manganese¹⁶ (also known as Zestaponi Ferroalloy Plant), „Rusalloys“¹⁷, „Rusmetali“¹⁸ and „GTM Group“¹⁹. The Zestaponi Ferroalloy Plant is the largest producer of silicon-manganese. Its annual production is almost 200,000 tons.

Fertilizers are one of Georgia's largest export products. Rustavi Azoti is the largest chemical enterprise producing mineral fertilizers and industrial chemicals in the Transcaucasus.²⁰

Heidelberg Cement, the largest non-metallic construction materials company in Georgia, owns 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 iron²² are produced in three factories - Geosteel²³, Rustavi Metallurgical Plant²⁴ and Iberia Steel. In these factories, steel is produced by melting scrap and slag in electric furnaces. The largest share (80-85%) is produced by melting scrap (secondary steel production).

In 2022, the value added created in the construction sector reached 5 billion GEL and amounted to 8% of the Georgian economy (gross domestic product - GDP). Over the past 10 years, the average share of construction in GDP has been approximately the same - 8%. In 2013-2017, the Georgian economy grew by an average of 3.8% annually, while the average annual growth of the construction sector during the same period was 3 times higher, at 12.8%. In 2018, 7.2% decline

¹⁵ National Statistics Office - www.geostat.ge

¹⁶ „Georgian Manganese“ - www.gm.ge

¹⁷ „Rusalloys“ - 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.A.1.c.ii) and not under the category of processing industries (1.A.2).

²³ „Geosteel“ - www.geosteel.com.ge

²⁴ Rustavi Metallurgical Plant- www.rmp.ge

was recorded in the construction sector, while in 2019 there was a slight increase of 0.7%. This 2-year decline was caused by tightened construction and banking regulations. In 2020, an 8% decline was recorded in the construction sector, and in 2021, a 24% decline. Despite the fact that the government subsidized the construction sector during the pandemic years, a significant decline was still observed. In the post-pandemic period, the construction sector began to grow rapidly, increasing by 14.8% in 2022²⁵.

Table 3-16 provides information on greenhouse gas emissions from the manufacturing and construction sectors. Greenhouse gas emissions from source categories decreased approximately 4 times between 1990 and 2022.

Table 3-16. Greenhouse gas emissions from manufacturing industries and construction (Gg)

Gas/ Sub-sectors	CO ₂ Gg	CH ₄	CH ₄ CO ₂ equiv	N ₂ O	N ₂ O CO ₂ equiv	Total CO ₂ equiv
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

²⁵ <https://forbes.ge/saqarthvelos-samsheneblo-seqtoris-machveneblebi-da-tendentsiebi/>

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. It is not possible to calculate emissions at a higher level in the absence of specialized laboratories and data.

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. Standard emission factors for stationary combustion in the manufacturing industries and construction (1.A.2.). (Based on kg/TJ net calorific value)

Fuel/Greenhouse Gases	CO2	CH4	N2O
Natural gas	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
Liquid fuel gas	63,100	1	0.1
Kerosene	71,900	3	0.6
Household heavy fuel oil	77,400	3	0.6
Firewood/firewood 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

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

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

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

Gas/ SUBSECTORS	Anthracite (TJ)	Furnace coke (TJ)	Coking coal (TJ)	Gas/diesel fuel (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)	Briquette fuel (TJ)	Household fuel (TJ)	Wood and wood products (TJ)
1990		23,858.34		519.96	7,225.00		88.00	35,789.55	2,500.00	561.73				24,846.00	
1991			9,856.00	4,516.00			88.00	64,139.00	2,425.00	430.00				17,200.00	
1992			3,968.00	1,576.00			88.00	44,595.45	2,125.00	430.00				8,000.00	
1993			3,200.00	2,044.00			88.00	33,198.55	900.00	430.00				6,840.00	376.00
1994		1,758.60		1,343.23	204.00		352.00	22,227.10	2,150.00	259.26				4,444.00	1,128.00
1995			192.00	724.00			748.00	8,165.65	275.00					2,320.00	380.00
1996				2,684.00			1,584.00	15,194.00	475.00					80.00	750.00
1997				2,045.00			1,716.00	9,052.00	375.00						1,000.00
1998			480.00	1,917.00			1,012.00	3,900.00	150.00					360.00	1,130.00
1999				1,406.00			704.00	2,030.25						280.00	1,316.00
2000				953.26			1,584.00	8,254.80	300.00					161.60	1,501.00
2001		477.00		554.00				2,937.00	150.00					720.00	1,501.00
2002		427.00		639.00				2,455.00	75.00					360.00	1,501.00
2003				554.00				2,788.00	150.00					400.00	1,501.00
2004				85.00				3,265.00	175.00					640.00	1,501.00
2005				86.66				3,833.10	325.00					646.40	
2006				85.00				6,223.00	200.00					640.00	
2007				85.00				6,858.00	50.00					1,120.00	
2008				85.00				7,497.00	1,125.00					1,200.00	
2009								7,574.00	1,250.00					1,200.00	
2010		2,835.35			1,030.88		262.24	5,692.39	1,683.35					19.39	
2011		3,778.72			5,141.82		766.94	8,118.85	2,026.46					252.68	
2012		3,828.19		2,482.72	7,076.51		376.00	8,945.86	1,892.42	21.61				52.00	10.00
2013	218.97	4,257.68		2,506.10	6,923.76		375.14	6,304.80	1,760.00	8.64				35.18	8.76
2014	76.84	3,943.68		2,787.24	4,999.80	0.80		6,582.90	3,058.13	0.07		0.20	34.73	22.90	13.25
2015	68.40	3,180.60		3,422.80	5,097.00	11.10		7,508.80	2,960.30		391.90	3.50		11.80	31.00
2016	55.69	3,701.27		3,195.90	4,349.28	1.35		6,881.10	2,290.00		286.90			20.50	63.18
2017	167.07	3,104.66		3,411.79	3,807.83			8,116.70	3,439.50		57.00	0.24		40.20	46.02
2018	177.30	3,674.81		3,957.00	1,960.10	3.70		8,079.80	5,477.50					101.70	70.90
2019	210.40	2,941.98		4,312.80	56.40	12.50		8,267.80	5,937.10					6.80	46.10
2020	132.20	2,185.12		3,851.70	1,423.00	6.10		8,704.90	4,424.10			2.80		27.50	36.30
2021	72.30	3,302.35		4,179.20	2,548.60	6.60		8,158.20	2,607.60					15.70	52.20
2022	149.60	3,003.77		4,914.10	2,389.50	1.20		9,436.40	3,327.80					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 according to the 2006 IPCC Guidelines. Quality control for the general inventory focuses on checking activity data parameters and emission factors and archiving reference materials. Quality assurance procedures were carried out according to IPCC guidelines and included checking the text structure, completeness, clarity, as well as the accuracy and time intervals of calculations, emission factors

and action data, in line with the guidelines. Activities related to quality assurance and quality control are summarized 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 the data from the previous report (1990-2017) for several reasons:

- The National Statistical Office's energy balance has updated data for 2013-2017, and data for 2018-2022 has also been added.
- In **category 1.A.2.a** (iron and steel), empty fields for 2010-2012 were restored using the interpolation methodology.
- In **category 1.A.2.c** (Chemical and Petrochemical Industry), empty fields for 1996, 2000 - 2005, 2010-2012 were restored using the interpolation methodology.
- In **category 1.A.2.d** (Cellulose-paper and printing activities), empty fields for 2006-2012 were restored using the interpolation methodology.
- In **category 1.A.2.e** (Food products, Beverages and Tobacco), empty fields for 2009-2012 were restored using the interpolation methodology.
- In **category 1.A.2.f** (non-metallic mineral products), empty fields for 2010-2012 were restored using the interpolation methodology.
- In **category 1.A.2.g** (transport equipment), empty fields for 2006-2012 were restored using the interpolation methodology.
- In category 1.A.2.h (machinery and equipment), empty fields for 2006-2012 were restored using the interpolation methodology.
- In **category 1.A.2.k** (construction), empty fields for 1995, 2009-2012 were restored using the interpolation methodology.
- In **category 1.A.2.l** (textiles and leather), empty fields for 1990, 1991, 1993-2000, 2006-2012 were restored using the interpolation methodology.

In **category 1.A.2.m** (Other industries), based on the amount of fuel provided by the International Energy Agency, it was determined that emissions in 2010-2012 amounted to 900-2000 CO₂ Gg, while emissions in previous and subsequent years varied in the range of 200-300 and 1-3 CO₂ Gg. Accordingly, the International Energy Agency data for 2010-2012 were considered unreliable, and the existing data were replaced with new data using an interpolation methodology.

Greenhouse gas emissions in 1990-2000 in cast iron and steel (1.A.2.a); Celulose-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); machinery and equipment (1.A.2.h); as well as in mining (1.A.2.i) (1990-2012), wood and wood products (1.A.2.j) (1990-2012) are not estimated due to insufficient data. In the 1990s, due to the country's fragile and unstable political and economic situation, it was difficult to reconstruct data over a multi-year time interval using existing interpolation methodologies.

In this document, emissions from fuel combustion in coke ovens are considered in the iron and steel industry (1.A.2.a), which differs from the fourth inventory report, where 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 for electricity generation in the iron and steel industry (1.A.2.a) should be considered in the other energy activity category (1.A.1.c) and not in the manufacturing industries.²⁷ In Georgia, only Rustavi Azoti produces its own electricity, which belongs to the chemical industry and not to the iron and steel industry; therefore, emissions from fuel combustion in coke ovens should be considered in the manufacturing industries.

*Table 3-19. Results of recalculation of greenhouse gas emissions from category 1.A.2.**

Years	GHG emissions before recalculation (Gg CO2 equiv.)	GHG emissions after recalculation (Gg CO2 equiv.)	Difference (gg CO2equiv)
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%)

²⁷ IPCC 2006, Table 8.2

2017	1,015	1,783	768 (54.9%)
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*Emissions were recalculated using new global warming potential values: instead of 21 for methane and 310 for nitrous oxide, 28 and 265 were used, respectively.

3.2.7. Transport (1.A.3.)

3.2.7.1. Source category description and calculated emissions

Georgia is a transport hub for the South Caucasus region (Georgia, Armenia and Azerbaijan) and Central Asia (Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan and Turkmenistan), with routes to Russia, Turkey and (via the Black Sea) Europe. Georgia's oil and gas pipelines, Black Sea ports, developed railway system and airports with direct air routes to 20 destinations also play an important role in connecting the East and the West.

The transport sector in Georgia, as in most countries around the world, is one of the most important sources of greenhouse gas emissions, and therefore great attention is paid to inventorying emissions from this sector and implementing emission reduction measures.

The growth of emissions from the transport sector in Georgia is mainly driven by several factors: the annual growth of the vehicle fleet, the large share of used cars in this fleet, and the growth of transit. Since Georgia is a transit country, the number of moving transit trucks that consume fuel purchased on the territory of Georgia is also increasing along with the growth of the local vehicle fleet. The annual growth of local and transit transport leads not only to an increase in carbon dioxide and other greenhouse gases, but also to an increase in local pollutants, which have a serious impact on human health. In addition, energy transit pipelines pass through Georgia - Baku-Tbilisi-Supsa, Baku-Tbilisi-Ceyhan oil pipeline and South Caucasus gas pipeline. The provider company "British Petroleum" consumes natural gas and diesel at substations for the operation of the pipelines.

The Georgian GHG inventory in the transport sector includes road transport, rail transport, civil aviation, inland navigation and pipelines.

The trends in greenhouse gas emissions from the transport sector are presented in Tables 3-20 and 3-21. As can be seen from the tables, as in other fuel combustion source categories, the dominant greenhouse gas is carbon dioxide (97.9% of emissions in 2022).

Table 3-20. Greenhouse gas emissions from the transport sector (Gg)

Year/gas	CO2 gg	CH4 gg	CH4 CO2equiv. gg	N2O gg	N2O CO2equiv.gg	Total CO2equiv. gg
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-categories for 1990-2022 are presented by sub-sector in Table 3-21. The dominant sub-sector is road transport (85% of emissions in 2022). Since Georgia's railway transport is practically completely electrified, its share in terms of emissions is not large. Greenhouse gas emissions in civil aviation (1990-2010) and inland navigation (1990-2011) are not estimated due to insufficient data.

Table 3-21. Greenhouse gas emissions from transport subcategories (CO2 equiv. Gg)

Year /gas	1.A.3.a Civil aviation total CO2equiv. GG	1.A.3.b Road transport total CO2equiv. Gg	1.A.3.c Rail transport total CO2equiv. GG	1.A.3.d Inland navigation Total CO2equiv. gg	1.A.3.e Other transport (pipelines, off- road) Total CO2equiv. Gg	Total CO2equiv. 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 for all subcategories were calculated using the IPCC “Tier 1” sectoral approach. Carbon dioxide emissions for this sector were calculated based on fuel consumption statistics using the “Tier 1” (“top-down”) approach, as the carbon dioxide emission factor depends only on the type of fuel consumed and not on the type of transport used. Methane and nitrous oxide emissions depend on the type of vehicle, the type of catalysts and the operating mode, and it is recommended to use higher-level methods to calculate their emissions. Such detailed information is not available in Georgia, therefore the “Tier 1” sectoral approach is used 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. Standard emission factors for transport category (based on kg/TJ net calorific value)

Fuel/Greenhouse Gases	CO2	CH4	N ₂ O
Civil Aviation			
Aviation Kerosene	71,500	0.5	2

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

Road Transport			
Gasoline	69,300	33	3.2
Diesel	74,100	3.9	3.9
Natural Gas	56,100	92	3
Liquefied Petroleum Gas	63,100	62	0.2
Railway			
Sub-bituminous Coal	96,100	2	1.5
Other Petroleum Products	NA	5	0.6
Marine 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 Batumi and Poti seaports.

Table 3-23. Activity data in the transport subsector

Year	Gas/diesel fuel (TJ)	Aviation Kerosene (TJ)	Lignite (TJ)	Liquefied petroleum gas (LPG) (TJ)	Gasoline (TJ)	Natural gas (dry)(TJ)	Natural gas liquid compounds (NGL)	Other petroleum products (TJ)	Household fuel (TJ)	Semi-bituminous coal (TJ)
1990	776.26	8,512.37		3.00	824.00	1,405.80			1,089.00	450
1991	1590.00	8,256.00		3.00	702.00	1,406.00			5,240.00	450
1992	1292.00	7,095.00		2.00	520.00	1,496.00			3,200.00	450
1993	960.00	5,418.00		2.00	419.00	599.00			2,320.00	150
1994	720.60	2,765.44		1.00	258.00	747.90			3,032.00	300
1995	492.00	172.00			115.00				4,320.00	
1996	131.00	3,354.00			722.00	90.00			480.00	
1997	89.00	2,967.00			615.00	85.00				125
1998	86.00	4,128.00			356.00				560.00	75
1999	80.00	3,483.00			315.00				440.00	
2000	101.00	648.15			225.00			404		
2001	57.00	559.00			311.00	487.00				
2002	874.00	989.00			323.00	407.00				
2003	68.00	1,118.00			328.00	462.00				
2004	92.00	1,591.00			290.00	541.00				
2005	143.00	1,598.77			334.00	502.00				
2006	165.00	1,591.00			328.00	963.00				

2007	211.00	2,021.00	18		409.00	1,122.00			
2008	174.00	1,720.00			351.00	1,244.00			
2009	304.00	1,720.00			350.00	649.00			
2010	628.91	1,773.09			350.00	3,503.31			
2011	600.00	2,290.13			399.00	3,878.55			
2012	1054.50	2,973.71			424.00	3,931.28			
2013	17,413.72	3,687.31		93.60	16,434.60	12,078.40			
2014	19,845.11	3,504.20		94.50	16,746.60	15,442.80			17.39
2015	22,357.52	3,031.10		11.50	18,602.30	15,982.70			18.90
2016	24,009.53	3,095.13		31.50	26,250.80	12,874.90			18.09
2017	21,084.86	4,112.95		128.80	23,553.20	3,405.50	8,848.70		18.49
2018	19,042.99	4,420.40		165.60	23,706.30	12,448.60			19.30
2019	20,342.59	4,371.90		793.90	24,173.30	12,055.50			10.00
2020	19,649.79	2,381.20		925.30	23,911.30	10,965.10			15.10
2021	20,558.42	4,085.80		1,306.70	26,181.80	13,451.60			10.80
2022	19,066.34	5,716.00		1,703.00	26,830.10	18,409.30			

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*

The quality control procedures for the general inventory were carried out according to the 2006 IPCC Guidelines. The quality control for the general inventory focuses on checking the activity data parameters and emission factors and archiving the reference materials. The quality assurance procedures were carried out according to the IPCC guidelines and included checking the text structure, completeness, transparency and the accuracy and time intervals of the calculations, emission factors and activity data in accordance with the guidelines. The activities related to quality assurance and quality control are summarized 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 the data from the previous report (1990-2017) for several reasons:

- The data for 2013-2017 has been updated in the National Statistics Office's energy balance and data for 2018-2022 has also been added.
- In category **1.A.3.a** (civil aviation), based on the amount of fuel provided by the International Energy Agency, it was determined that the 2011 emissions were 55.61 Gg CO₂, while the emissions in subsequent years varied in the range of 1.7-3.5 Gg CO₂. Accordingly, the 2011 data from the International Energy Agency were considered unreliable, and the 2012 data were copied into the 2011 field.
- In **category 1.A.3.b** (road transport), based on the recommendation, from the existing subcategories in other sectors (1.A.4): Private and public services (1.A.4.a) and households (1.A.4.b) Motor gasoline was completely transferred to road transport.

- In **category 1.A.3.c** (rail transport), the empty fields for 2001-2011 were restored using the interpolation methodology. Although it is recommended to use the interpolation methodology for small intervals, since the data for the previous (1999, 2000) and subsequent (2012, 2013) years of interpolation are similar, indicating that the data are stable and less variable, we assume that the data for the 2001-2011 interval is also less fluctuating and its variability is consistent with both the previous and subsequent years.
- In **category 1.A.3.d** (inland navigation), emissions for 2014-2022 were recalculated based on fuel data provided by the ports of Poti and Batumi.
- In **category 1.A.3.e** (Other transport (pipelines, off-road)), empty pipeline data for 1995, 1998, 1999, 2000, 2005 was restored using an interpolation methodology.

*Table 3-24. Results of recalculation of greenhouse gas emissions from category 1.A.3.**

Years	GHG emissions before recalculation (Gg CO2 equiv.)	GHG emissions after recalculation (Gg CO2 equiv.)	Difference (gg CO2 equiv.)
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 new global warming potential values: instead of 21 for methane and 310 for nitrous oxide, 28 and 265 were used, respectively.

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);
- Household sector (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 high, which is due to high rates of firewood consumption in the household sector.

Table 3-25. Greenhouse gas emissions from the category "Other sectors" (GG)

Year/gas	CO ₂ gg	CH ₄ gg	CH ₄ CO ₂ equiv.gg	N ₂ O gg	N ₂ O CO ₂ equiv.gg	Total CO ₂ equiv.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 dominant sub-sector is the household sector (1.A.4.b) (82.6% of emissions in 2022), while greenhouse gas emissions from the commercial (1.A.4.a) and agricultural (1.A.4.c) sub-sectors amounted to 15.6% and 1.8%, respectively.

Table 3-26. Greenhouse gas emissions from commercial/institutional/household/agricultural/fisheries/forestry source categories by subcategories (Gg of CO₂ equiv.)

Year/gas	1.A.4.a - Commercial total CO₂equiv.	1.A.4.b – household total CO₂equiv.	1.A.4.c – Agriculture/Forestry/Fishing, Total CO₂equiv.	Total from sector CO₂equiv.
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. It is not possible to calculate emissions at a higher level in the absence of specialized laboratories and data.

Emission coefficient

To convert the physical units of fuel consumed into energy units, the country-specific net calorific value of the fuel was used (Table 3-5). The following standard emission factors are given in Table 3-27.²⁹

Table 3-27. Standard emission factors for commercial/institutional/household/agriculture/forestry/fishery categories (based on kg/TJ net calorific value)

Fuel/Greenhouse Gas Emissions	CO ₂	CH ₄	N ₂ O
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
Liquid Gas	63,100	5	0.1
Residual Fuel	77,400	10	0.6
Household			
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
Liquid Gas	63,100	5	0.1
Other Oil	71,900	10	0.6
Coal	112,000	200	1
Agriculture/Forestry/Fisheries			
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
Liquid Gas	63100	5	0.1

Activity Data

²⁹ IPCC 2006, Volume 2, Tables 2.4, 2.5

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			1,906.52	1,581.00	3,006.00	2,992.00	52,163.10	600.0	2,290.13		10,059.60	15,430.00
1991			5,709.00	1,514.00	2,208.00	4,444.00	43,249.00	600.0	2,236.00		8,080.00	18,054.00
1992			4,558.00	1,637.00	1,518.00	880.00	51,444.00	600.0	2,279.00		6,560.00	28,210.00
1993			8,648.00	1,619.00	1,564.00	616.00	50,249.00	450.0	3,913.00		5,600.00	42,879.00
1994			4,939.62	2,924.00	1,485.00	352.00	13,339.80	600.0	3,500.01		3,918.80	11,021.00
1995			1,235.00	598.00	1,702.00	88.00	2,393.00	25.0	3,612.00		2,560.00	27,830.00
1996			5,027.00	229.00	1,196.00		3,051.00	25.0	2,236.00			39,270.00
1997			4,260.00	88.00	2,576.00	1,012.00	3,289.00		1,935.00			31,810.00
1998			4,175.00	281.00	4,140.00	616.00	3,127.00	50.0	4,558.00		360.00	28,285.00
1999			2,769.00	370.00	3,404.00	440.00	4,354.00		3,741.00		280.00	26,899.00
2000			1,863.19	323.00	2,430.00	484.00	9,067.60		3,283.96		525.20	25,513.00
2001			1,066.00	106.00	966.00		6,670.00		2,924.00			25,513.00
2002			1,194.00	106.00	966.00		5,578.00		1,204.00			25,513.00
2003			938.00	106.00	736.00		6,332.00		1,118.00			25,513.00
2004			1,364.00	141.00	690.00		7,418.00		1,118.00			25,513.00
2005			2,253.16	85.00	1,125.00		11,455.20		1,123.46			14,612.00
2006			2,513.00	158.00	1,288.00		10,814.00		1,118.00			15,617.00
2007			3,238.00	246.00	1,794.00		11,342.00	350.0	1,118.00			16,287.00
2008			2,982.00	563.00	2,162.00		13,038.00	275.0	1,118.00			15,616.00
2009			426.00	1,848.00	2,162.00		10,627.00	450.0	1,118.00			15,408.00
2010			1,115.31	1,091.40	786.15	524.04	19,855.10		2,778.40			14,932.55
2011			3,621.95		844.65		24,619.48		2,464.70			13,019.76
2012			349.74	21.42	706.77	36.31	26,964.13		2,182.11		39.49	12,404.82
2013	12.96		505.57	20.95	652.42	36.22	24,351.90		8.64	306.08	26.71	19,828.09
2014	23.50		457.80	22.40	721.40	35.20	28,353.70		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		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		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			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		166.40		11,092.90
2019	1.80	0.70	453.70	0.30	464.60	40.90	43,212.10	12.1		168.80		10,054.20
2020		3.80	292.30	0.90	405.10	27.60	46,309.70	4.9		71.70		9,416.60
2021			320.20	3.50	341.30	29.90	52,778.60			50.20		9,746.90
2022			328.70	48.70	237.80	68.20	56,770.70			50.50		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 according to the 2006 IPCC Guidelines. Quality control for the general inventory focuses on checking activity data parameters and emission factors and archiving reference materials. Quality assurance procedures

were carried out according to IPCC guidelines and included checking the text structure, completeness, clarity, as well as the accuracy and time intervals of calculations, emission factors and action data, in line with the guidelines. Activities related to quality assurance and quality control are summarized 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 the data from the previous report (1990-2017) for several reasons:

- The data for 2013-2017 has been updated in the National Statistics Office balance, and data for 2018-2022 has also been added.
- **In the Category 1.A.4.a** (Public Services), based on the recommendation, motor gasoline was completely transferred to road transport (1.A.3.b);
- Wood and wood products were not included in the previous inventory report, so they were added to the new report.
- **In the Category 1.A.4.b** (Households) Based on the recommendation, motor gasoline was completely transferred to road transport (1.A.3.b).
- Wood and wood products were not included in the previous inventory report, so they were added to the new report
- In category **1.A.4.c.i** (agriculture, forestry and fishing), data for 1997, 2002-2004 were not estimated, therefore, empty fields were restored using interpolation methodology.

*Table 3-29. Results of recalculation of greenhouse gas emissions from category 1.A.4.**

Years	GHG emissions before recalculation (Gg CO2 equiv.)	GHG emissions after recalculation (Gg CO2 equiv.)	Difference (Gg CO2 equiv.)
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 new global warming potential values: instead of 21 for methane and 310 for nitrous oxide, 28 and 265 were used, respectively.

3.2.9. Unspecified (1.A.5.)

3.2.9.1. Source category description and calculated emissions

Includes all other emissions from fuel combustion that are not identified elsewhere. In this case, the same emission factors were used as in the commercial and residential sectors.

Table 3-30. Greenhouse gas emissions from unspecified/unidentified source categories (GG)

Year/gas	CO2 gg	CH4 gg	CH4 CO2equiv.gg	N2O gg	N2O CO2equiv.gg	Total CO2equiv.gg
1990	0	1.128	31.584	0.015	3.986	36
1991						
1992						
1993						
1994						
1995						
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						
2014						
2015						
2016						
2017						
2018						
2019						
2020						
2021						
2022						

3.2.9.2. *Methodological issues*

Assessment method

The IPCC “Tier 1” sectoral approach was used to calculate emissions. The IPCC “Tier 1” sectoral approach was used to calculate emissions. It is not possible to calculate emissions at a higher level in the absence of special laboratories and data.

Activity data

Information on the unspecified subsector was 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 fuel (TJ)	Household fuel (TJ)	Other bituminous coal (TJ)	Lignite (TJ)	Natural gas (dry) (TJ)	Wood and wood products (TJ)
1990						3760.00
1991						
1992						
1993						
1994						
1995						
1996	298				1178.00	
1997						
1998						
1999	128		700			
2000						
2001					490.00	
2002					410.00	
2003					465.00	

2004					545.00	
2005						
2006					226.00	
2007			450	141.00		209.00
2008			800		715.00	209.00
2009			1325		791.00	586.00
2010		9.7		2172.88	363.65	696.70
2011				736.95	201.25	696.77
2012						440.00
2013						
2014						
2015						
2016						
2017						
2018						
2019						
2020						
2021						
2022						

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 series.

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

Quality control procedures for the general inventory were conducted according to the 2006 IPCC Guidelines. Quality control for the general inventory focuses on checking activity data parameters and emission factors and archiving reference materials. Quality assurance procedures were carried out according to IPCC guidelines and included checking the text structure, completeness, clarity, as well as the accuracy and time intervals of calculations, emission factors and action data, in line with the guidelines. Activities related to quality assurance and quality control are summarized 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 the data from the previous report (1990-2017) for several reasons:

In the Category 1.A.5.a - Stationary

Wood and wood products were not included in the previous inventory report, so they were added to the new report, which is why the data for 1990, 2007-2012 were updated.

Data for 1997, 1998, 2000, and 2005 were not estimated, therefore, empty fields were restored using interpolation methodology.

*Table 3-32. Results of recalculation of greenhouse gas emissions from category 1.A.5.**

Years	GHG emissions before recalculation (gg CO2 equiv)	GHG emissions after recalculation (gg CO2 equiv)	Difference (gg CO2 equiv.)
1990	28.34	36	7.66 (23.81%)
1991			
1992			
1993			
1994			
1995			
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			
2014			
2015			
2016			
2017			

*Emissions were recalculated using new global warming potential values: instead of 21 for methane and 310 for nitrous oxide, 28 and 265 were used, respectively.

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

Waste is not burned for energy production in Georgia.

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

Fugitive emissions include all intentional and unintentional emissions of greenhouse gases (mainly methane) during the extraction, processing, and transportation of fossil fuels to their final point of use. Fugitive emissions are calculated according to the following categories and subcategories:

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

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

1.B.2. Oil and natural gas

- **1.B.2a Oil**
 - Ventilation;
 - Flaring;
 - Production and upgrading of petroleum products;
 - Oil transportation;
- **1.B.2a Natural gas**
 - Ventilation;
 - Flaring;
 - Production;
 - Transmission and storage;
 - Distribution;

The trend of greenhouse gas emissions from the Fugitive emissions category is given in Table 3-33.

Table 3-33. Fugitive emissions (gg)

Year /category	1B1 Solid fuel total CO2equiv.	CO2	CH4 CO2equiv.	1B2a Oil Total CO2equiv.	CO2	CH4 CO2equiv.	N2O CO2equiv.	1B2b Natural gas total	CO2	CH4 CO2equiv.	N2O CO2equiv.	Total Fugitive
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, the dominant sub-sector is natural gas, where high emissions are caused by high losses of natural gas in the transportation and distribution process. Emissions from coal mining and processing have also increased in recent years, which is due to the activation of coal mining activities in Georgia. All source sub-categories are described separately below.

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)

Year/gas	1.B.1. Solid fuel total CO2equiv.	1.B.1.a.i.1 Mining Total CO2equiv.	1.B.1.a.i.2 Post-mining emissions total CO2equiv	1.B.1.a.i.3 Abandoned underground mines total CO2equiv.
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 mining has been going on for 158 years: since 1847 in Tkibuli-Shaori, since 1929 in Tkvarcheli, and since 1947 in Akhaltsikhe.³⁰ Surface coal mining is carried out only in Tkvarcheli. However, information about its volume, technologies, and producers is not available, since the region in which Tkvarcheli is located 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

The IPCC Tier 1 approach is used to calculate Fugitive emissions from solid fuels in all subsectors. The Tier 1 approach requires countries to choose global average (standard) emission factors and use country-specific activity data to calculate total emissions.

To estimate emissions under the Tier 1 approach, based on data from underground coal mining and post-mining emissions, the following equation is used:

Estimation of emissions from underground coal mines using Tier 1 and Tier 2 approaches, without methane use or flaring corrections

³⁰ Coal Production and its Development Perspective – Green Alternative

³¹ Surface mining of coal in Georgia and Related Problems – Green Alternative

Greenhouse gas emissions = raw coal extraction x emission factor x unit conversion factor
Below is the basic equation for estimating emissions from abandoned underground coal mines:

General equation for estimating Fugitive emissions from abandoned underground coal mines

CH4 emission= Emissions from abandoned mines – CH4 recovered emissions.

Emission factors

The Tier 1 emission factors for underground mining are given below.

Tier 1”: Global average method - underground extraction - before adjustment for methane use or flaring;

CH4 emissions = CH4 emission factor × underground coal mining × conversion factor
where the units are:

Methane emissions (Gg/year)

CH4 emission factor (m3/ton)

Underground coal mining (tons/year)

Emission factor:

CH4 Low emission factor = 10 m3/ton

CH4 Average emission factor= 18 m3/ton

CH4 High Emission Factor = 25 m3/ton

Conversion factor

The conversion factor is the CH4 density and converts the volume of CH4 to the mass of CH4. The density is obtained at 20°C and 1 atmosphere of pressure and amounts to 0.67×10^{-6} gg/m³.

Countries using the Tier 1 approach should consider country-specific variables, such as the depth of the coal mine, to determine the emission factor to use. Since the gas content of coal increases with depth, a lower value should be used for mines less than 200 m deep, and a higher value should be used for mines greater than 400 m deep. For mines with moderate depth, an average figure can be used. According to information provided by the Georgian Industrial Group (GIG), the average depth of mines in Georgia is approximately 800-1200 m, which is why a high CH4 emission factor of = 25 m3/tonne was chosen.

Below are the post-mining emission factors along with the estimation method for the “Tier 1” approach:

“Tier 1”: Global Average Method – Post-mining Emissions – Underground Mines

Methane emissions = CH4 emission factor × underground coal mining × conversion factor

Where the units are:

Methane emissions (Gg/year)

CH4 emission factor (m3/ton)
Underground coal mining (ton/year)

Emission factor:

CH4 Low Emission Factor = 0.9 m3/ton
CH4 Average Emission Factor = 2.5 m3/ton
CH4 High Emission Factor = 4.0 m3/ton

Conversion Factor:

The conversion factor is the CH4 density and converts the volume of CH4 to the mass of CH4. The density is taken at 20 °C and 1 atmosphere of pressure and amounts to 0.67×10^{-6} gg/m³.

The estimation of emissions from abandoned underground coal mines requires the existence of a historical record. The two main parameters used to estimate emissions from abandoned mines for each mine (or group of mines) are the time (years) since the mine was abandoned, which is to be compared to the year of the emissions inventory, and the emission factors that take into account the mine's aeration. The Tier 1 approach includes standard values and longer time intervals. For the Tier 1 approach, emissions for a given year of the inventory can be calculated using the following equation:

“Tier 1” approach for abandoned underground mines Methane emissions = Number of unflooded abandoned coal mines × Gaseous fraction × Coal mine emission factor × Conversion factor

Where units are:

Methane emissions (Gg/year)
Emission factor (m3/year)

Note: Here, the emission factors have different units compared to those for underground, surface and post-mining emissions. This is because different methods are used to estimate emissions from abandoned mines and from underground or surface mining processes.

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

Conversion factor

The conversion factor is the density of CH4 and converts the volume of CH4 to the mass of CH4. The density is taken at 20 °C and 1 atmosphere pressure and amounts 0.67×10^{-6} g/m³.

The “Tier 1” approach for determining emissions from abandoned underground mines is described below and is based primarily on United States Environmental Protection Agency (USEPA) methods (Franklin et al, 2004).

Given that 6 underground mines were abandoned in Georgia between 1976 and 2000, the standard percentage of coal mines containing gas was assumed to be 30%, selected from the range of 8%-100% (IPCC 2006, Vol. 2, Table 4.1.5). As for the emission factors, they are given in Table 4.1.6 of IPCC 2006, Vol. II.

Activity data

Information on coal mining and its specifics was 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 series.

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

Quality control procedures for the general inventory were conducted according to the 2006 IPCC Guidelines. Quality control for the general inventory focuses on checking activity data parameters and emission factors and archiving reference materials. Quality assurance procedures were carried out according to IPCC guidelines and included checking the text structure, completeness, clarity, as well as the accuracy and time intervals of calculations, emission factors and action data, in line with the guidelines. Activities related to quality assurance and quality control are summarized in Chapter 1.

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:

- The National Statistical Office's energy balance has updated data for 2013-2017, and data for 2018-2022 has also been added.
- In **category 1.B.1.a.i.1** Mining (total, CO₂equiv.) data for 1991-1993 and 2017 were not estimated, therefore these fields were restored.
- In **category 1.B.1.a.i.2**, post-mining emissions (total, CO₂equiv.) data for 1991-1993 and 2017 were not estimated, therefore these fields were restored.
- In **category 1.B.1.a.i.3** Abandoned underground mines (total, CO₂equiv.), emission values for methane (CH₄) were erroneously used, requiring a million-fold increase in each emission factor for the period 1990-2017. Accordingly, they were recalculated based on the recommendation, and the results for 2018-2022 were also added.

*Table 3-36. Results of recalculation of greenhouse gas emissions from category 1.B.1.**

Years	GHG emissions before recalculation (Gg CO ₂ equiv.)	GHG emissions after recalculation (Gg CO ₂ equiv.)	Difference (gg CO ₂ equiv.)
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 new global warming potential values: instead of 21 for methane and 310 for nitrous oxide, 28 and 265 were used, respectively.

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

3.3.2.1. Source category description and calculated emissions

Sources of Fugitive emissions from oil and natural gas systems include, but are not limited to, equipment leaks, evaporation, ventilation, waste combustion, flaring, and accidental releases. Although such emission sources are sometimes technological and sometimes intentional and are therefore relatively well characterized, in such cases the amount and composition of emissions are generally subject to uncertainty due to the limited use of measurement systems.

Fugitive emissions are calculated from the following subcategories:

CRT 1B2a. Oil

- Ventilation - emissions of gas and waste gas/vapor streams from ventilation at oil facilities;
- Flaring - Emissions of natural gas and waste gas/steam streams from flaring at oil facilities;
- Petroleum Production and Upgrading – Fugitive emissions associated with oil extraction (excluding ventilation and flaring) occur through the operation of the oil transfer system at the oil well. This includes well maintenance, transportation of crude oil to treatment or extraction facilities, associated gas reinjection systems, and

with spill systems for water removed along with the oil. Grouping Fugitive emissions from oil refining facilities with emissions from the production process is more appropriate than with emissions from the refining process, as oil refining facilities are often integrated into extraction facilities and it is difficult to determine their estimated share of emissions;

- Oil transportation - Fugitive emissions (excluding ventilation and flaring) associated with the transportation of crude oil for sale to refining and processing facilities. Transportation systems include pipelines, marine tankers, road tankers, and rail cars. The primary sources of these emissions are evaporation during storage, loading, and unloading, as well as fugitive emissions from equipment;

CRT 1B2b. Natural gas

- Ventilation - emissions of gas and waste gas/vapor streams from ventilation at natural gas facilities;
- Flaring - emissions of natural gas and waste gas streams from flaring at natural gas facilities;
- Production – Fugitive emissions (excluding venting and flaring) from the natural gas well valve to the inlet to natural gas processing facilities or to the point of connection to natural gas distribution systems, if processing is not required. This includes Fugitive emissions associated with well maintenance, natural gas gathering, processing, and associated activities related to the disposal of produced water and gases containing hydrogen sulfide;
- Transmission and Storage - Fugitive emissions from systems used to transport processed natural gas to market. This category includes Fugitive emissions from natural gas storage systems;
- Distribution – Fugitive emissions (excluding ventilation and flaring) during the distribution of natural gas to end users.

Table 3-37. Greenhouse gas emissions from oil and natural gas activities (Gg)

Year	1B2 Oil and natural gas total CO ₂ equiv.	1B2a1 Ventilation during oil extraction Total CO ₂ equiv.	1B2a11 Flaring of oil, total CO ₂ equiv.	1B2a112 Oil extraction and upgrading total CO ₂ equiv.	1B2a113 Oil transportation total CO ₂ equiv.	1B2a114 Oil refining total CO ₂ equiv.	1B2b1 Natural gas ventilation total CO ₂ equiv.	1B2b11 Natural gas flaring total CO ₂ equiv.	1B2b112 Natural gas extraction total CO ₂ equiv.	1B2b114 Natural gas transmission and storage total CO ₂ equiv.	1B2b115 Natural gas distribution total CO ₂ equiv.
1990	7,124	5.580	11.129	189.812		1.764	59.824	0.084	20.130	1,968	4,868
1991	7,487	5.644	11.249	191.976		1.406	55.822	0.084	20.133	1,341	5,860
1992	6,697	3.950	7.908	134.366		0.328	55.119	0.070	16.630	1,326	5,153
1993	5,623	1.247	2.499	42.428		0.236	44.408	0.070	16.630	1,080	4,435
1994	1,926	1.380	2.760	46.942		0.138	21.312	0.004	0.877	701	1,151
1995	1,653	1.485	2.970	50.520		0.037	13.058	0.015	3.503	926	655
1996	2,223	3.802	2.760	129.331		0.017	11.437	0.005	1.103	376	1,699
1997	2,040	3.980	7.968	135.377		0.029	9.8270	0.032	7.613	323	1,552
1998	2,039	3.535	7.075	120.229		0.023	10.020	0.059	14.123	330	1,555
1999	1,102	2.703	5.409	91.938		0.031	9.654	0.086	20.633	318	654
2000	1,463	3.300	6.603	112.255		0.016	12.658	0.114	27.143	416	884
2001	1,075	2.941	5.880	100.030		0.018	10.670	0.057	13.489	351	591
2002	2,811	2.198	4.395	74.770		0.021	8.925	0.024	5.705	294	2,421
2003	3,529	4.159	8.319	141.456		0.026	10.132	0.026	6.251	333	3,026
2004	3,588	2.911	5.820	99.028		0.027	11.870	0.017	4.049	391	3,074

2005	1,694	2.010	4.024	68.370		0.015	13.939	0.026	6.251	459	1,141
2006	3,460	1.901	3.803	64.666		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

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

Oil and natural gas extraction in Georgia is carried out on a small scale, which was taken into account when selecting the methodology. To estimate Fugitive emissions from natural gas extraction, a “Tier 1” approach was used. This approach involves applying a standard emission factor to the relevant activity parameter (usually a cost) for each relevant segment or subcategory of the country’s oil and natural gas industry. The “Tier 1” approach uses the following equation:

“Tier 1”: Estimation of Fugitive emissions from the industry segment

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

“Tier 1”: Estimation of Fugitive emissions from the total industry segment

$$E_{\text{გაზი}} = \sum_{\text{მრეწველობის სეგმენტები}} E_{\text{გაზი, მრეწველობის სეგმენტები}}$$

Where:

$E_{\text{GAS, industry segment}}$ = annual emissions (GG)

$EF_{\text{GAS, industry segment}}$ = emission factors (GG/activity unit)

$A_{\text{industry segment}}$ = activity volume (activity data)

Emissions from natural gas transmission and distribution were calculated using the values of losses in the transmission and distribution systems and the following formula:

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

This methodology is consistent with the methodology recommended for calculating emissions from natural gas losses under the Clean Development Mechanism. The conversion factor in the formula, methane density (ρ), converts methane volume to weight. The value obtained in the Clean Development Mechanism methodology (0.64512 gg CH₄/million m³) was used, at standard conditions (0°C and 101.3 kPa pressure), $\rho = 0.0007168$ (tonnes CH₄/m³ CH₄). The 90% was taken as the value of methane content in natural gas³².

Emission coefficients.

Table 3-38³³ below presents the standard emission factors for the Tier 1 methodology. All emission factors are expressed in units of mass per unit volume of oil or gas. Cost statistics are a continuously available set of activity data that should be used in Tier 1 calculations. Emission factors apply to systems in developing and transition economies, where Fugitive emissions per unit of activity i.e. on the activity data are much higher (often ten times higher or more). In these cases, the reasons for higher emissions may be the existence of less stringent standards, the use of lower-quality components, limited access to natural gas markets, and in some cases, artificially low energy prices, which result in reduced energy conservation..

Table 3-38. Fugitive emission factors from oil and natural gas activities (including ventilation and flaring)

Category	Subcategory	Emission Source	CH4 volume	CO2 volume	N2O volume	Units of measurement
Natural 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
Natural gas transmission and storage	TRANSMISSION	Fugitive	0.64512	5.04E-06	-	Gg / MILLION M ³ ON GAS TRANSPORTATION
		Ventilation	3.9E-04	5.2E-06	-	Gg / MILLION M ³ ON MARKET GAS
Natural gas distributon	All	All	0.64512	5.73E-04	-	Gg / MILLION M ³ ON DISTRIBUTED GAS
Oil extraction	Fossil fuel	Fugitive	3.0E-02	2.0E-03	-	Gg / 10 ³ m ³ on fossil fuel extraction
		Ventilation	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 transportation	Pipes	All	5.4E-06	4.9E-07	-	GG / 10 ³ M ³ ON OIL TRANSPORTED IN PIPELINES
	Truck and rail transportation	Ventilation	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 Commission.³⁴ 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, by its Resolution N26 of 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 postulates of natural gas dynamics. According to this rule, the loss norm was determined for natural gas supply licenses.

In the annual reports of the Georgian National Energy and Water Supply Regulatory Commission (2012 and 2013), natural gas losses during the distribution process amounted to approximately 9% of the natural gas distributed in Georgia. This figure was used to calculate natural gas distribution losses in previous years during the inventory of greenhouse gas emissions. The IPCC “Tier 1” sectoral approach was used to calculate emissions.

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 transportation) (1000 m3)	Oil transportation (pipelines) (1000 m3)	Oil refining (1000 m3)	Natural gas transmission and storage - ventilation (10 ⁶ Sm3)	Natural gas production - flaring (10 ⁶ Sm3)	Natural gas transportation (10 ⁶ Sm3)	Natural gas distribution (10 ⁶ m3)
1990	225.43		2889.41	5,447.85	58.96	108.96	269.46

³⁴ <https://www.geostat.ge/ka/modules/categories/308/sakmianobis-angarishi>

1991	228.00		2303.88	5,083.37	58.97	74.26	324.38
1992	159.58		537.56	5,019.43	48.71	73.40	285.25
1993	50.39		386.39	4,043.97	48.71	59.80	245.52
1994	55.75		225.43	1,940.73	2.57	38.81	63.73
1995	60.00		60.00	1,189.14	10.26	51.29	36.26
1996	153.60		27.61	1,041.54	3.23	20.83	94.03
1997	160.78		46.80	894.86	0.00	17.90	85.90
1998	142.79		38.38	912.43	0.00	18.25	86.07
1999	109.19		51.59	879.11	0.00	17.58	36.19
2000	133.32		25.452	1,152.66	79.50	23.05	48.95
2001	118.80		30.03	971.66	39.51	19.43	32.74
2002	88.80		33.59	812.74	16.71	16.25	134.03
2003	168.00		42.01	922.66	18.31	18.45	167.49
2004	117.61		44.40	1,080.94	11.86	21.62	170.18
2005	81.20		24.24	1,269.33	18.31	25.39	63.15
2006	76.80		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		7,334.23	8.10	21.78	86.29
2011	60.53	45,595.24		7,111.69	5.80	33.86	107.41
2012	53.45	43,928.57		7,031.40	5.40	35.81	117.04
2013	58.01	44,047.62		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 according to the 2006 IPCC Guidelines. Quality control for the general inventory focuses on checking activity data parameters and emission factors and archiving reference materials. Quality assurance procedures were carried out according to IPCC guidelines and included checking the text structure, completeness, clarity, as well as the accuracy and time intervals of calculations, emission factors and action data, in line with the guidelines. Activities related to quality assurance and quality control are summarized 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 the data from the previous report (1990-2017) for the following reasons:

- The National Statistics Office energy balance has updated data for 2013-2017, and data for 2018-2022 has also been added.
- Changes have been made to the data of the Georgian Oil and Gas Corporation, and data for 2018-2022 has also been added.
- The annual reports of the Georgian Energy and Water Regulatory Commission were supplemented with reports for 2018-2022, from which the necessary data was collected.

In **category 1.B.2.a.iii.2** – (Petroleum extraction and upgrading), based on the recommendation, the CH₄ emission factor was adjusted for 1991. Instead of the number 0.00000059, 0.03 was used as in other years.

- **In category 1.B.2.a.iii.4** – (Oil processing)
 - Data for 2010-2013 was not evaluated, therefore these fields were restored.
 - Based on the recommendation, the CH₄ emission factors were adjusted for the entire time series. Instead of the number 0.00004, 0.0000218 was used.
- In category **1.B.2.b.ii** – (Natural gas flaring) Data for 1997-1999 were not assessed, therefore these fields were restored.
- **In category 1.B.2.b.iii.2** – (natural gas extraction), data for 1997-1999 were not assessed, therefore these fields were restored.

*Table 3-40. Results of recalculation of greenhouse gas emissions from category 1.B.2.**

Years	GHG emissions before recalculation (Gg CO ₂ equiv.)	GHG emissions after recalculation (Gg CO ₂ equiv.)	Difference (Gg CO ₂ equiv.)
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 new global warming potential values: instead of 21 for methane and 310 for nitrous oxide, 28 and 265 were used, respectively.

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.)

There is no transportation or storage of CO2 in Georgia (NO).

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

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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 land 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, field burning of agricultural waste, liming, 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 croplands	Total Gg CH ₄	3.A.2 Direct N ₂ O emissions from manure management	3.C.6 Indirect N ₂ O 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 croplands	Total Gg N ₂ O	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.2 Manure management	3.C.1.b Biomass burning in croplands	Total Gg CH ₄	3.A.2 Direct N ₂ O emissions from manure management	3.C.6 Indirect N ₂ O 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 croplands	Total N ₂ O	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 subcategories 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 N₂O 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 croplands	Total Gg CH ₄	3.A.2 N ₂ O direct emissions from manure management	3.C.6 Indirect N ₂ O 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 croplands	Total Gg N ₂ O	3.C.3 Urea application	Total CO ₂	Total
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 Tiers

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 N₂O emissions from managed soils, 3.C.5 Indirect N₂O emissions from managed soils and 3.C.6 Indirect N₂O 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 ₂ O	
	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		
3.A.2 Direct N ₂ O emissions from manure management					T2	CS
3.C.6 Indirect N ₂ O emissions from manure management					T1, T2	D, CS
3.C.4 Direct N ₂ O emissions from managed soils					T1	D
<i>Synthetic N fertilizers</i>					T1	D
<i>Organic N fertilizer is applied to the soil.</i>					T1	D
<i>Emissions from animal manure on pastures</i>					T1	D
<i>Decomposition of crop residues</i>					T1	D
3.C.5 Indirect N ₂ O emissions from managed soils					T1	D
<i>N₂O from atmospheric deposition of N volatilized from managed soils</i>					T1	D
<i>N₂O emissions from nitrogen leaching and runoff</i>					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 N₂O emissions from managed soils, 3.C.5 Indirect N₂O emissions from managed soils, 3.C.6 Indirect N₂O 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

No	IPCC category code	Category	CO ₂	CH ₄	N ₂ O
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 ₂ O emissions from managed soils			X
5	3.C.5	Indirect N ₂ O emissions from managed soils			X
6	3.C.6	Indirect N ₂ O 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), fetching and 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
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.³⁵ 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 CH₄/head/year.

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 included in the 2006 IPCC Guidelines.

Category-specific quality control and quality assurance and validation

³⁵ <https://www.geostat.ge/en/single-categories/102/agriculture-of-georgia>

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

Methane emissions from enteric fermentation in dairy cattle have been calculated for the first time.

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

Year	Brown Caucasian	Georgian Mountain	Mingrelian Red	3.A.1.a.ii Total	
				Gg CH ₄	Gg CO ₂ -eq
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 Guidelines 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

Category	year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
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	

Category	Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
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 CH₄ emission factor for enteric fermentation from livestock:³⁶:

³⁶ 2006 IPCC, Chapter 10, p. 10.31, equation 10.21

$$EF = \left[\frac{GE \cdot \left(\frac{Y_m}{100}\right) \cdot 365}{55.65} \right]$$

Where:

EF Emission factor, kg CH₄/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 CH₄)

The following equation is used to calculate GE:³⁷

$$GE = \frac{\left(\frac{NE_m + NE_a + NE_l + NE_{work} + NE_p}{REM} \right) + \left(\frac{NE_g}{REG} \right)}{\frac{DE\%}{100}}$$

Where:

NE_m net energy required by the animal for maintenance, (MGJ/day)³⁸.

$$NE_m = C_{fi} \cdot (Weight)^{0.75}$$

C_{fi}=0.322 for non-lactating cows, C_f=0.386 for lactating cows, and C_{fi}=0.370 for bulls (IPCC 2006, Chapter 10, p.10.16, Table 10.4)

NE_a net energy for animal activity, MJ/day³⁹.

$$NE_a = C_a \cdot NE_m$$

C_a coefficient corresponding to animal's feeding situation, (MGJ/day/kg).

NE_l net energy for lactation, MGJ/day⁴⁰.

$$NE_l = Milk \cdot (1.47 + 0.40 \cdot Fat)$$

Where:

Milk amount of milk produced, kg milk/day

The fat content of milk, % of weight.

NE_{work} net energy for work, MJ/day.

$$NE_{work} = 0.10 \cdot NE_m \cdot Hours$$

NE_p net energy required for pregnancy, MJ/day⁴¹.

$$NE_p = C_{pregnancy} \cdot NE_m$$

³⁷ 2006 IPCC, Chapter 10, p. 10.21, Equation 10.16

³⁸ 2006 IPCC, Chapter 10, p. 10.15, Equation 10.3

³⁹ 2006 IPCC, Chapter 10, p. 10.16, Equation 10.5

⁴⁰ 2006 IPCC, Chapter 10, p.10.18, Equation 10.8

⁴¹ 2006 IPCC, chapter 10, p. 10.20, equation 10.13

Where:

$C_{\text{pregnancy}}$ pregnancy coefficient.

For cattle $C_{\text{pregnancy}}=0.1$ (2006 IPCC, chapter 10, p.10.20, table 10.7).

REM ratio of net energy available in the diet for maintenance to digestible energy⁴².

$$REM = \left[1.123 - (4.092 \cdot 10^{-3} \cdot DE\%) + [1.126 \cdot 10^{-5} \cdot (DE\%)^2] - \left(\frac{25.4}{DE\%} \right) \right]$$

Where:

DE% digestibility of feed expressed as a fraction of gross energy (digestible energy/gross energy).

NE_g net energy needed for growth⁴³, MJ/Day

$$NE_g = 22.02 \cdot \left[\left(\frac{BW_o}{C \cdot BW_{365}} \right) \right]^{0.75} \cdot WG^{1.097}$$

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).

BW_{365} 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

REG ratio of net energy available for growth in a diet to digestible energy consumed.⁴⁴

$$REG = \left[1.164 - (5.160 \cdot 10^{-3} \cdot DE\%) + \left[1.308 \cdot 10^{-5} \cdot (DE\%)^2 - \left(\frac{37.4}{DE\%} \right) \right] \right]$$

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, and several cows by maximum daily milk yield, types of feed used to feed cattle, and specific feeding conditions for livestock. A proportion of different types of feed was used to feed livestock. To clarify the value of Y_m , the proportion of different types of food was used for livestock feeding.

⁴² 2006 IPCC, chapter 10, p.10.20, equation 10.14

⁴³ 2006 IPCC, chapter 10, p.10.17, equation 10.6

⁴⁴ 2006 IPCC, chapter 10, p. 10.21, equation 10.15

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 diet⁴⁵

	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

$$Ym = 6.83\% (7\% \times 7.1 + 63\% \times 7.4 + 29.9\% \times 5.6)$$

Ca - 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. Ca - 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
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** $(0 \times 3.1 + 0.085 \times 386 + 0.09 \times 49.9) / (3.1 + 386 + 49.9)$

DE – absorbed 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.

⁴⁵ 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

Table 5-20. NE_{ma} attitude towards typical livestock feed

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), NE_{ma} can also be estimated using the equation: $NE_{ma} = REM \times 18.45 \times DE\% / 100$.	

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

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
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	
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.

CH₄ 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 CH₄ between 1990 and 2022. CH₄ 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)

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	Gg CH ₄	Gg CO ₂ -eq	Share of livestock species in total methane emissions from enteric fermentation, %					
									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
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:

$$EM_i = EF_i \cdot Pop_i$$

Where:

EM_i Methane emission from animal type i, kg CH₄

i The index indicates the type of animal

EF_i Methane emission factor for animal type i, kg CH₄/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
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.

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-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

CH₄ 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 CH₄ 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 CH₄ and N₂O 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 CH₄ but smaller amounts of N₂O, while well-aerated systems produce less CH₄ but more N₂O.

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 CH₄. The quantity of CH₄ 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
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

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
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 approach⁴⁶.

$$CH_{4Manure} = \sum_{(T)} \frac{(EF_{(T)} \cdot N_{(T)})}{10^6}$$

$$EF_{(T)} = (VS_{(T)} \cdot 365) \cdot \left[B_{o(T)} \cdot \frac{0.67 \text{ kg}}{\text{m}^3} \cdot \sum_{S,K} \frac{MCF_{S,k}}{100} \cdot MS_{(T,S,k)} \right]^{47}$$

Where:

$CH_{4Manure}$ CH₄ emissions from manure management, Gg CH₄/year

$EF_{(T)}$ CH₄ emission factor for livestock category T, kgCH₄/head/year

$N_{(T)}$ Number of livestock Category T

T Category of Livestock

$VS_{(T)}$ daily Fugitive solid excreted for livestock category T, kg dry mass/head/day

365 basis for calculating annual VS production, days/year

$B_{o(T)}$ maximum methane-producing capacity for manure produced by livestock category

T,

m³ CH₄/kg VS emitted

0.67 Conversion factor of m³ CH₄ to kg CH₄, kg CH₄/m³ CH₄

$MCF_{S,k}$ 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)

$VS_{(T)}$ 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.⁴⁸

⁴⁶ 2006 IPCC, Chapter 10, p. 10.37, equation 10.22; 2006 IPCC, Chapter 10, p. 10.41, equation 10.23

⁴⁷ 2006 IPCC, Chapter 10, p. 10.41, Equation 10.23

⁴⁸ 2006 IPCC, Chapter 10, p. 10.42, Equation 10.24

$$VS_{(T)} = \left[GE_{(T)} \cdot \left(1 - \frac{DE\%}{100} \right) + (UE \cdot GE_{(T)}) \right] \cdot \left[\frac{(1 - ASH)}{18.45} \right]$$

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). $UE \cdot GE_{(T)} = 0.04 \cdot GE_{(T)}$ (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: $Bo=0.17 \text{ m}^3 \text{ CH}_4 / (\text{kg VS})$ (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
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

CH₄ 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 Fugitive 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
NCS	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 N₂O emissions occur through nitrification and denitrification of nitrogen in manure. Indirect emissions are caused by losses of Fugitive nitrogen, which are mainly formed as ammonia and NO_x.

Source Category Description

During manure storage and processing, before application to the soil, direct N₂O 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 N₂O produced also increases. The manure management system (MMS) is an important controlling factor for N₂O emissions. N₂O 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 N₂O 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									Total Gg N ₂ O	Total Gg CO ₂ -eq
	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		
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

Year	Livestock										Total Gg N ₂ O	Total Gg CO ₂ -eq
	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			
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	
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 N₂O 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 formula⁴⁹:

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T (N_{(T)} \cdot Nex_{(T)} \cdot MS_{(T,S)}) \right] \cdot EF_{3(S)} \right] \cdot \frac{44}{28}$$

Where:

$N_2O_{D(mm)}$ Direct N₂O emissions from manure management, kg N₂O/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)

⁴⁹ 2006 IPCC, chapter 10, p. 10.54, equation 10.25

$EF_{3(S)}$ emission factor for direct N₂O emissions from manure management system S
[kg(N₂O-N)/kgN]

S Manure Management System

T Livestock Category

44/28 conversion of (N₂O-N)_(mm) emissions to N₂O_(mm) emissions

$N_{ex(T)}$ is calculated by the formula⁵⁰

$$N_{ex(T)} = N_{rate(T)} \cdot \frac{TAM_{(T)}}{1000} \cdot 365$$

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 N₂O 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 ₂ O-N)/kg N	0.005	0.02	0.0	0.02	0.01

For dairy cattle, N_{ex} was calculated using default values for parameters (values for EU countries): $N_{rate(T)}=0.34$, weight=550 kg. For cattle breeds, N_{ex} was calculated using the age and weight of the cattle.

Table 5-44. N_{ex} defined for cattle breeds

Cattle	Dairy Cattle	Georgian Mountain	Mingrelian Red	Brown Caucasian
N_{ex} , kg N/Cattle year	68.3	21.4	30.6	52.0

N_{ex} 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.

$$N_{ex_i} = \frac{\sum_T N_{ex(T)} \times N_{(T,i)}}{N_{(Cattle,i)}}$$

Where

N_{ex_i} N excretion for “other cattle” livestock category T

I inventory year

T Indicates the type of Cattle

$N_{ex(T)}$ N_{ex} 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

⁵⁰ 2006 IPCC, chapter 10, p. 10.57, equation 10.30

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.

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 “N₂O 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 N₂O 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 N₂O emissions from manure management (3.C.6)

Source Category Description

Indirect N₂O emissions are caused by losses from nitrogen volatilization, which are mainly formed in the form of ammonia (NH₃) and nitrogen oxides (NO_x). 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 ₂ O	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

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 ₂ O	Total Gg CO ₂ -eq
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 formulas⁵¹:

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

$$N_{volatilization-MMS} = \sum_S \left[\sum_T \left[(N_{(T)} \cdot Nex_{(T,S)}) \cdot MS_{(T,S)} \cdot \left(\frac{Frac_{GASM}}{100} \right)_{(T,S)} \right] \right]$$

Where:

$N_2O_{G(mm)}$ indirect N₂O emissions due to volatilization of N from Manure Management in the country, kg N₂O/year

EF_4 emission factor for N₂O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N₂O-N (kg NH₃-N + NO_x-N vol)

$N_{volatilization-MMS}$ amount of manure nitrogen that is lost due to volatilisation of NH₃ and NO_x, (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 NO_x in the manure management system S , %

⁵¹ 2006 IPCC, chapter 10, p. 10.54, equation 10.26

Activity data: Livestock numbers and categories are given in Tables 5-13, 5-14, 5-15, and 5-32.

Emission factors: $N_{ex(T)}$ 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 $Frac_{GASM}$ (Fraction of N Losses Due to Volatility from Manure Management Systems) and other parameters

Livestock	Solid storage				Drylot		Daily Spread	
	N_{ex}	MS	$Frac_{GASM}$	EF_4	MS	$Frac_{GASM}$	MS	$Frac_{GASM}$
Dairy breed 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
Of 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

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-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 N₂O emissions from manure management were recalculated for the years 1990-2017. As in the case of direct N₂O 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 N₂O emissions from soils (3.C.4)

The methodology for estimating direct N₂O 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 N₂O emissions from soils were calculated using the following formula:⁵²:

$$N_2O_{Direct-N} = N_2O-N_{N\ inputs} + N_2O-N_{OS} + N_2O-N_{PRP}$$

$$N_2O_{Direct-N} = (F_{SN} + F_{ON} + F_{CR} + F_{SOM}) \cdot EF_1 + (F_{SN} + F_{ON} + F_{CR} + F_{SOM})_{FR} \cdot EF_{1FR}$$

⁵² 2006 IPCC, chapter 11, p. 11.7, equation 11.1

$$N_2O-N_{OS} = \left[\begin{array}{l} (F_{OS,CG,Temp} \bullet EF_{2,CG,Temp}) + (F_{OS,CG,Trop} \bullet EF_{2,CG,Trop}) + \\ (F_{FOS,F,Temp,NR} \bullet EF_{2F,Temp,NR}) + (F_{FOS,F,Temp,NP} \bullet EF_{2F,Temp,NP}) + \\ (F_{FOS,F,Trop} \bullet EF_{2F,Trop,NR}) \end{array} \right]$$

$$N_2O-N_{PRP} = [(F_{PRP,CPP} \bullet EF_{3PRP,CPP}) + (F_{PRP,SO} \bullet EF_{3PRP,SO})]$$

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.

Where:

$N_2O-N_{Direct-N}$ annual direct N_2O-N emissions produced from managed soils, kg N_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, kg N_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/draind 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

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)

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. N₂O emissions were calculated using the formula

$$N_2O_{SN} = F_{SN} \cdot EF_1 \cdot \frac{44}{28}$$

Where:

N_2O_{SN} N₂O 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)

$F_{SN} = M_{Nfert} \cdot PercN$

M_{Nfert} Amount of synthetic fertilizers applied to soil, (kg N/year)

$PercN$ The N content in synthetic fertilizer, %

EF_1 emission factor for N₂O emissions from N inputs, kg N₂O–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 NH₃ 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 $EF_1=0.01$ kgN₂O–N/kg is used (2006 IPCC, p. 11.11, Table 11.1).

Emission: N₂O 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,	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

Gg N ₂ O-N																	
Ammonium sulfate, Gg N ₂ O-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 ₂ O-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 ₂ O-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 N₂O	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 CO₂-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 ₂ O-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 ₂ O-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 ₂ O-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 ₂ O-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 N₂O	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 CO₂-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 and time series consistency

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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/quality assurance and validation

For the subcategory “N₂O 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 N₂O 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 N₂O 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 N₂O 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 N₂O 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.

Year	Other Cattle	Dairy cattle	Buffalos	Sheep	Goats	Horses	Asses	Swine	Poultry	Total Gg N ₂ O-N	Total Gg N ₂ O	Total Gg CO ₂ -333
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
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

Year	Other Cattle	Dairy cattle	Buffalos	Sheep	Goats	Horses	Asses	Swine	Poultry	Total Gg N ₂ O-N	Total Gg N ₂ O	Total Gg CO ₂ -333
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-Fugitive fraction (which can transform to form N₂O) and the emission factor:

$$N_2O_{ON} = F_{ON} \cdot EF_1$$

$$F_{ON} = F_{AM} + F_{SEW} + F_{COMP} + F_{OOA}$$

Where:

F_{ON} total annual amount of organic N fertiliser applied to soils other than by grazing animals, kg N/year

EF_1 N₂O emission factor for applied organic nitrogen, kg N₂O–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:⁵³:

$$F_{AM} = N_{MMSAvb} \cdot [1 - (Frac_{FEED} + Frac_{FUEL} + Frac_{CNST})]$$

Where:

F_{AM} Nitrogen from animal manure applied to soil during the year, kg N/year

N_{MMSAvb} 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

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:⁵⁴:

⁵³ 2006 IPCC, Chapter 11, p. 11.13, Equation 11.4

⁵⁴ 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)

$$N_{MMSAvb} = \sum_S \left\{ \sum_T \left[(N_{(T)} \cdot Nex_{(T)} \cdot MS_{(T,S)}) \cdot \left(1 - \frac{Frac_{LossMS}}{100}\right) \right] \right\}$$

$$Frac_{LossMS} = Frac_{GAS} + Frac_{LEACH} + FRAC_{N2} + EF_3$$

$$FRAC_{N2} = RN_{2(N2O)} * EF_3$$

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 N₂) 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
	Swine	0.07	-	-	-	0.07
	Poultry	0.07	-	-	-	0.07
Drylot	Other Cattle	0.30	0.035	0.06	0.02	0.415

MMS	Category	Frac _{GAS}	Frac _{LEACH}	FRAC _{N2}	EF ₃	Frac _{LossMS}
	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 NH₃ 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 default emission factor EF₁=0.01 kg N₂O-N/kgN was used (2006 IPCC, Chapter 11, p.11.1, Table 11.1). Nitrogen excretion rates (N_{ex}) 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.

Consistency of time series

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 N₂O emissions from organic N fertilizers applied to agricultural soils have been recalculated for the period 1990-2017. The recalculated N₂O 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 N₂O emissions in NC5 (excluding 1990-1991) is due to the adjusted values of N_{ex} 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 pasture, range and paddock soils by grazing animals. The nitrogen in manure undergoes transformation, during which N₂O is formed. N₂O 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 ₂ O-N	Total Gg N ₂ O	Total gg CO ₂ -0.33
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

Year	Dairy cattle	Other cattle	Buffalo	Sheep	Goats	Horses	Asse	Swine	Poultry	Total gg N ₂ O-N	Total Gg N ₂ O	Total gg CO ₂ -333
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
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 formula⁵⁵:

$$N_2O - N_{PRP} = [(F_{PRP,CPP} \cdot EF_{3PRP,CPP}) + (F_{PRP,SO} \cdot EF_{3PRP,SO})]$$

$$F_{PRP} = \sum_T [(N_{(T)} \cdot Nex_{(T)}) \cdot MS_{(T,PRP)}]$$

Where:

F_{PRP} annual amount of urine and dung N deposited on pasture, range, paddock, and by grazing animals, kg N/year

EF_{3PRP, N_2O} emission factor for N₂O emissions from animals manure deposited on pasture range and paddock. The lower index CPP corresponds to cattle, poultry and swines, 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, range, and paddock.

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 and paddock 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 N₂O-N/kg N] for cattle (dairy, non-dairy and buffalo), poultry and swines and $EF_{3PRP,SO} = 0.01$ (kg N₂O-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.

⁵⁵ 2006 IPCC, chapter 11, p. 11.7, equation 11.1 ; 2006 IPCC, chapter 11, p. 11.13, equation 11.5

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 sub-category “Emissions from animal manure on pastures”, 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.

Recalculated emissions from animal manure deposited on pastures and paddock 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. N₂O emissions from the decomposing of agricultural residues are presented in Table 5-64.

Table 5-64. N₂O emission from agricultural crop residues decomposition

Year	Emissions	
	Gg N ₂ O	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

Year	Emissions	
	Gg N ₂ O	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

Year	Emissions	
	Gg N ₂ O	Gg CO ₂ -eq
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 ₂ O	Gg CO ₂ -eq
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 equation⁵⁶:

$$N_2O-N_{N\text{ inputs}} = F_{CR} \cdot EF_i$$

$$F_{CR} = \sum_T \left\{ C_{crop(T)} \cdot (Area_{(T)} - Area_{burnt(T)} \cdot C_f) \cdot Frac_{Renew(T)} \cdot \left[R_{AG(T)} \cdot N_{AG(T)} \cdot (1 - Frac_{Remove(T)}) + R_{BG(T)} \cdot N_{BG(T)} \right] \right\}$$

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 N₂O emissions from N inputs, kg N₂O–N/(kg N input)

$Crop_{(T)}$ harvested annual dry matter yield for crop T , (kg dry matter)/ha.

$$Crop_{(T)} = Yield_{Fresh(T)} \cdot DRY$$

$Yield_{Fresh(T)}$ 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 ($AG_{DM(T)}$) to harvested yield ($Crop_{(T)}$), kg dry matter/(kg dry matter)⁵⁷

$$R_{AG(T)} = AG_{DM(T)} \cdot 1000 / Crop_{(T)}; AG_{DM(T)} = (Crop_{(T)}/1000) \cdot slope_{(T)} + intercept_{(T)}$$

$N_{AG(T)}$ 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).

⁵⁶ 2006 IPCC, Chapter 11, p. 11.14, Equation 11.6

⁵⁷ 2006 IPCC, Chapter 11, Table 11.2, p. 11.17

$R_{BG(T)}$ ratio of below-ground residues to harvested yield for crop T , (kg dry matter)/(kg dry matter)

$$R_{BG(T)} = R_{BG-BIO(T)} \cdot [(A_{GDM(T)} \cdot 1000 + \text{Crop}(T)) / \text{Crop}(T)]$$

$N_{BG(T)}$ 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	
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 $EF_1=0.01 \text{ kg(N}_2\text{O-N)/(kg N applied)}$ is used for the emission factor. For annual crops, $\text{Frac}_{\text{Renew}} = 1$. There are no data on $\text{Frac}_{\text{Remove}}$, so $\text{Frac}_{\text{Remove}(T)} = 0$. 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.

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

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 N₂O 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 nitrogen suboxide. The N₂O 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 ₂ O emissions	
	Gg N ₂ O	Gg CO ₂ - eq	Gg N ₂ O	Gg CO ₂ - eq	Gg N ₂ O	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

Year	Deposition of N Volatilised from Managed Soils		Nitrogen leaching and runoff		Total indirect N ₂ O emissions	
	Gg N ₂ O	Gg CO ₂ - eq	Gg N ₂ O	Gg CO ₂ - eq	Gg N ₂ O	Gg CO ₂ - eq
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. *N₂O 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 N₂O 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 N₂O emissions from atmospheric deposition of N volatilised from managed soils. N₂O emissions from atmospheric deposition of volatilized nitrogen were calculated using the equation⁵⁸:

$$N_2O_{ATD-N} = [(F_{SN} \cdot Frac_{GASF}) + (F_{ON} + F_{PRP}) \cdot Frac_{GASM}] \cdot EF_4$$

Where:

N_2O_{ATD-N} annual amount of N₂O–N produced from atmospheric deposition of N volatilised from managed soils, (kgN₂O–N/year)

F_{SN} Annual amount of N synthetic fertilizer applied to the soil, kg N/year

⁵⁸ 2006 IPCC, Chapter 11, p 11.21, equation 11.9

F_{CGASF} fraction of synthetic fertiliser N that volatilises as NH_3 and NO_x , kg N volatilized/(kg of N applied), $\{[kg(NH_3-N) \text{ and } (NO_x-N)]/kgN \text{ applied}\}$.

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

F_{CGASM} fraction of applied organic N fertiliser materials (F_{ON}) and urine and dung N deposited by grazing animals (F_{PRP}) that volatilises as NH_3 and NO_x , 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, $[kg \text{ N-N}_2O/(kg \text{ NH}_3\text{-N} + \text{NO}_x\text{-N volatilised})]$

$$N_2O_{(ATD)}=N_2O_{(ATD)-N} \bullet 44/28$$

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	
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: $EF_4=0.01 \text{ kg}(N_2O-N)/\text{kg N}$ [IPCC 2006, chapter 11, p. 11.24, table 11.3]. $F_{CGASF} = 0.10 \text{ (kg N volatilized)/(kg N applied)}$ and $F_{CGASM} = 0.2 \text{ kg } [(NH_3-N)+(NO_x-N)]/(\text{kg N applied})$ [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.

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 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 N₂O 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. N₂O 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 N₂O outside the application site.

Methodological issues

N₂O emissions from nitrogen leaching and runoff are calculated using the 2006 IPCC Tier 1 approach. N₂O emissions from leaching and runoff are calculated using the following equation⁵⁹:

$$N_2O_{L-N} = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) \cdot Frac_{LEACH-(H)} \cdot EF_5$$

Where:

N₂O_{(L)-N} annual amount of N₂O–N produced from leaching and runoff of N additions to managed

soils, kg N₂O–N/year

F_{SN} Annual amount of synthetic N fertilizer applied to soil, kg N/year

⁵⁹ 2006 IPCC, chapter 2, equation 1.10, p/ 11.21

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, N₂O emissions from this source category occur only on a very small scale.

$F_{\text{LEACH-(H)}}$ 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 N₂O emissions from N leaching and runoff, kg N₂O–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: $F_{\text{LEACH-(H)}}=0.30$ (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 N₂O–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.

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 “N₂O 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 N₂O 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. Established 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-CO₂ emissions are considered, assuming that CO₂ emissions will be balanced by CO₂ 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 ₂ O	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 ₂ O	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 ₂ O	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-CO₂ emissions from burning of agricultural residues were estimated using the 2006 IPCC Tier 1 approach. The equation used is⁶⁰:

⁶⁰ 2006 IPCC, chapter 2, equation 2.27, p. 2.42

$$L_{fire} = A \cdot M_B \cdot C_f \cdot G_{ef} \cdot 10^{-3}$$

Where:

L_{fire} Non-CO₂ 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.⁶¹

Emission factors

Default emission factors (gram/kg dry mass burnt) for non-CO₂ 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 ₂ O	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). $C_f = 0.90$ (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

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

⁶¹ https://biodivers-southcaucasus.org/uploads/files/81206850_R_Westerberg_CBA%20Shiraki_2015-2016.pdf

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. 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 CO₂-eq) of non-CO₂ 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 is not estimated.

5.8. Urea application (3.C.3)

5.8.1. *Description of source-category*

CO₂ is produced by adding urea to the soil as a fertilizer. Urea CO(NH₂)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 CO₂ and water, similar to the reaction that occurs when lime is added to the soil.

CO₂ emissions from urea applied to agricultural soils in 2001-2022 are presented in Table 5-76. The results show that CO₂ 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

CO₂ 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.⁶²

$$CO_2 = M \cdot EF \cdot \frac{44}{12}$$

Where:

CO₂ Annual CO₂ emissions from urea application to soils, tonnes CO₂/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 N₂O 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

⁶² 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*

CO₂ emissions from Urea application” were calculated for the first time.

5.8.7. *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 definitions⁶³ 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;

⁶³ IPCC 2006, Chapter 3 - Consistent Representation Of Lands; 3.2 Land-Use Categories

Non-agricultural land is all land that does not fall into the category of agricultural land, including settlements.

Wetlands, according to the Law⁶⁴ 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 ⁶⁵on 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 Code⁶⁶ 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 Forest land	3B2 Cropland	3B3 Grassland	3B4 Wetlands	3B5 Settlements	3B6 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

⁶⁴ <https://faolex.fao.org/docs/pdf/geo137728.pdf#>

⁶⁵ Law of Georgia on Water, <https://matsne.gov.ge/ka/document/view/33448?publication=27>

⁶⁶ <https://matsne.gov.ge/ka/document/view/4874066?publication=6>

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
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 guidelines⁶⁷. 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 CO₂, in 2022 emissions amounted to -757.5 Gg CO₂.

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 GgCO₂.

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 GgCO₂ annually.

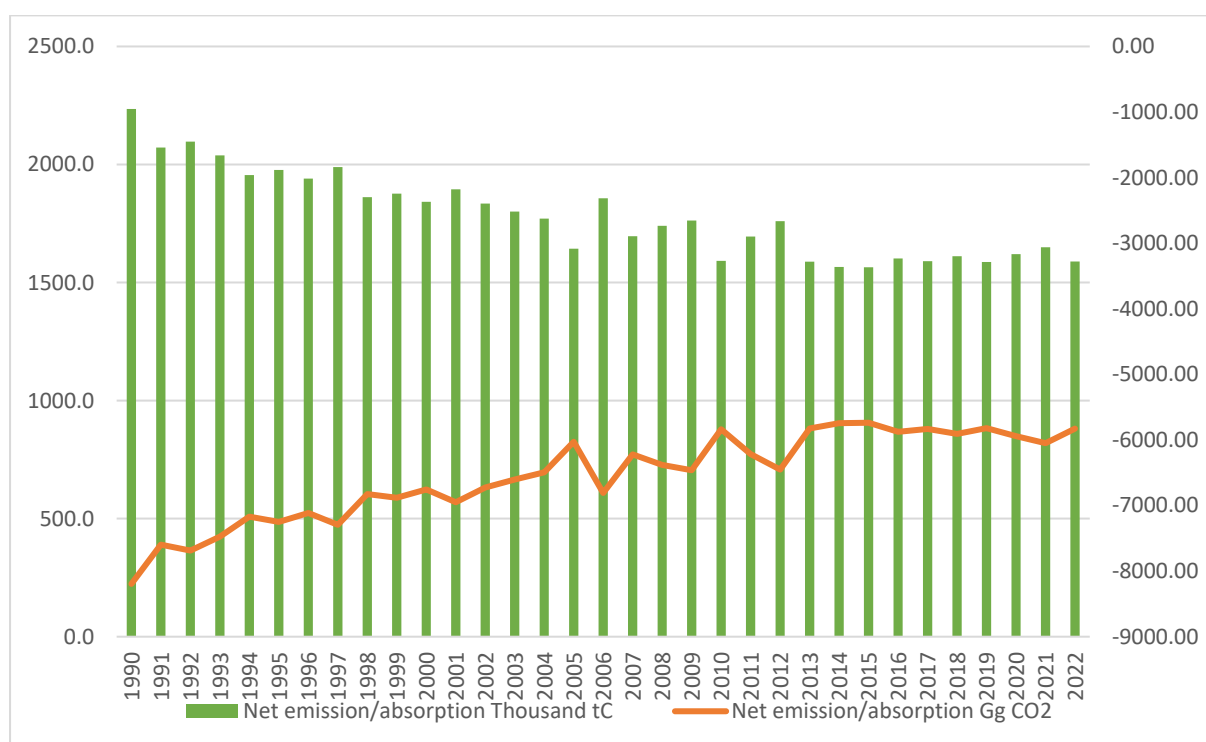
Table 6-2. Results of the LULUCF (Land use, land use change and forests) sector greenhouse gas inventory for 1990-2022

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 CO ₂	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

⁶⁷ 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

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
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 I-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 CO₂ 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 ₂ O		NO _x		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 exception is territories not controlled by Georgia (Abkhazia, South Ossetia), 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	288,122.1	-1,825.5

Figure I-1. Trend in net emissions from forest lands

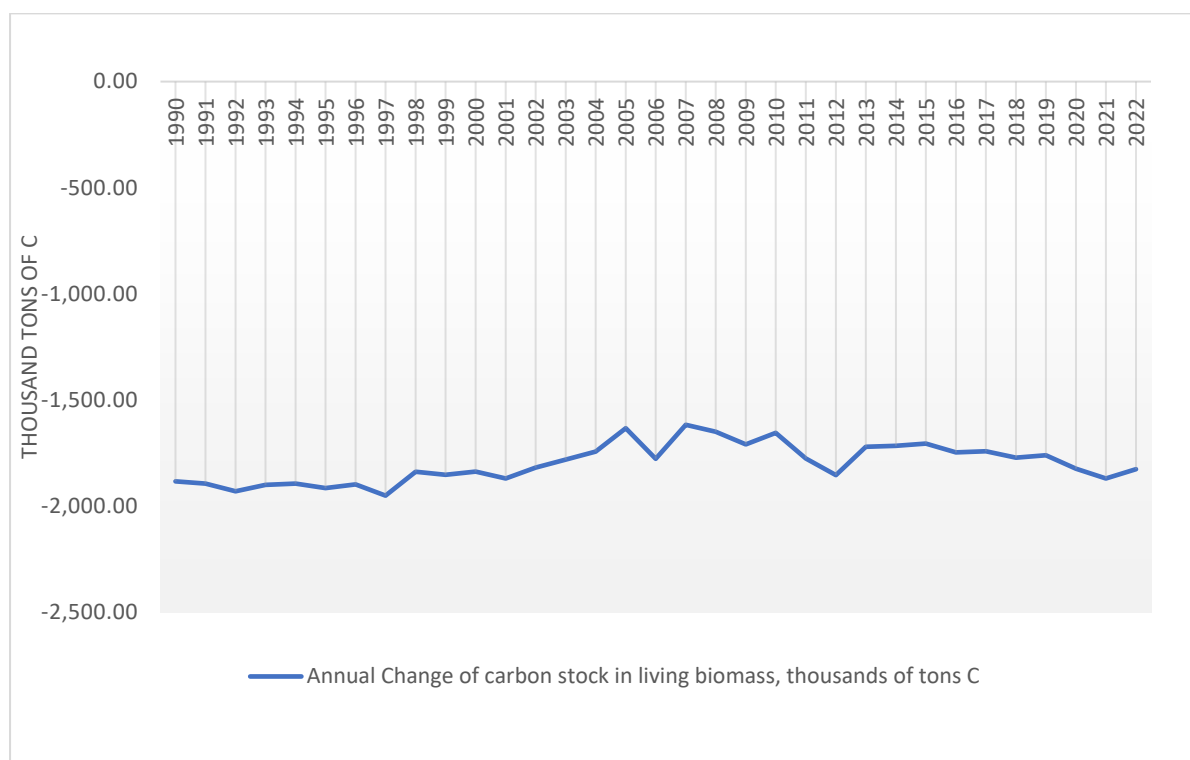


Table 6-5. Emissions of greenhouse gases other than carbon dioxide from forest fires

Year	Greenhouse gas emissions, 10 ⁻³ gg				Year	Greenhouse gas emissions 10 ⁻³ gg			
	CH ₄	CO	N ₂ O	NO _x		CH ₄	CO	N ₂ O	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 methodological⁶⁸ 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):

$$\Delta C = \Delta C_G - \Delta C_L$$

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):

$$\Delta C_G = A \cdot G_{TOTAL} \cdot CF$$

$$G_{TOTAL} = I_V \cdot BCEF_1 \cdot (1 + R)$$

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, m³ ha⁻¹ yr⁻¹

$BCEF_1$ - 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);

$$\Delta C_L = L_{wood-removals} + L_{fuelwood} + L_{disturbance}$$

$$L_{wood-removals} = H \cdot BCEF_R \cdot (1 + R) \cdot CF$$

$$L_{fuelwood} = \{ [FG_{trees} \cdot BCEF_R \cdot (1 + R)] + FG_{part} \cdot D \} \cdot CF$$

$$L_{disturbance} = A_{disturbance} \cdot B_W \cdot (1 + R) \cdot CF \cdot fd$$

WHERE:

⁶⁸ 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

H- annual wood removals, roundwood, m³ yr⁻¹ ;

BCEFR= 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

(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, m³ 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;

F_d- 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):

$$L_{\text{fire}} = A \cdot M_B \cdot C_f \cdot G_{\text{ef}} \cdot 10^{-3}$$

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.	South Ossetia	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

¹Natural Resources and Environmental Protection of Georgia, Statistical Collection; <https://www.geostat.ge/ka/single-categories/109/sakartvelos-bunebrivi-resursebi-dagaremos-datsva>

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)
Iv - Average annual increment, m3 /ha/year	2.1 Western Georgia - Eastern Georgia 1.7	LEPL National Forestry Agency, see Appendix, Table 2
BCEF _{F1}	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 dominated 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 GEL
2001	28	148.0	20,900.0 GEL
2002	36	607.0	23,000.0 GEL
2003	5	52.0	1,200.0 GEL
2004	21	32.0	20,600.0 GEL
2005		26.0	1,000.0 GEL
2006		93.0	35,000.0 GEL
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.

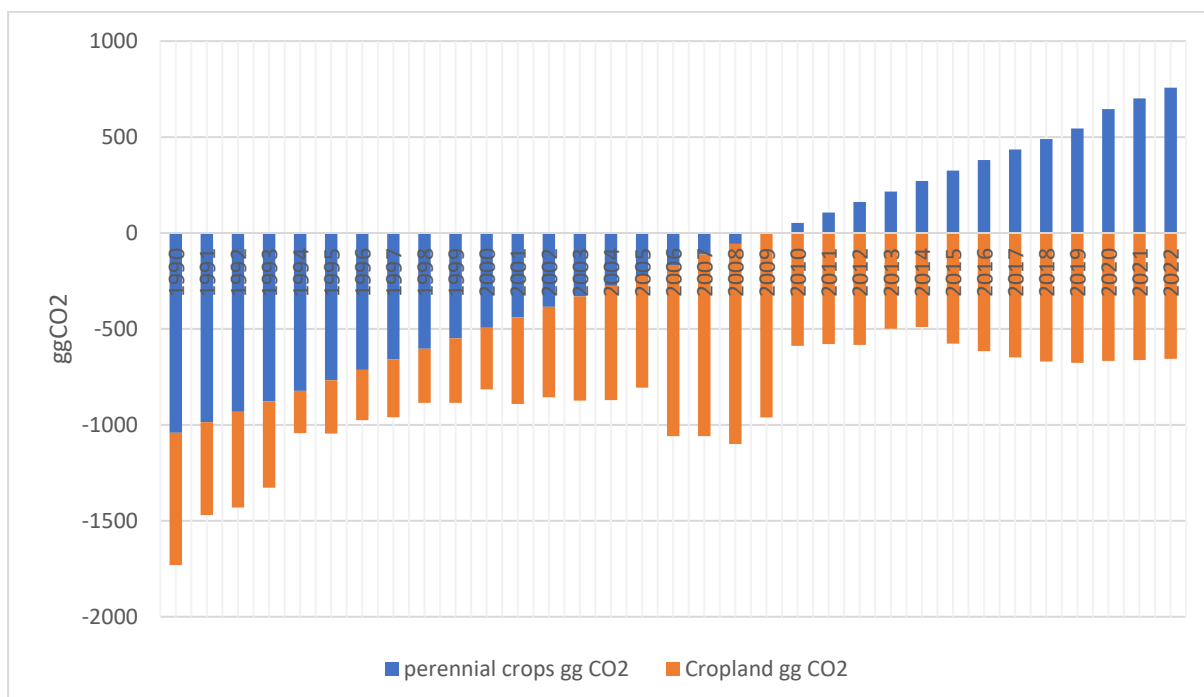
As for changes in carbon stocks in soils, it depends on land management practices, namely soil tillage, drainage, and the use of organic and mineral fertilizers.

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 I-1. Greenhouse gas emissions trend in cropland, including areas covered with perennial crops



Methodology

The equation below forms the basis⁶⁹ for calculating carbon stocks and emissions for cropland that does not change category and remains in the same category (3B2a):

⁶⁹ Good Practice Guidance for Land Use, Land-Use Change and Forestry, Chapter 3, Cropland, EQUATION 3.3.1. <http://www.ipcc->

$$\Delta C_{CC} = \Delta C_{CC_{LB}} + \Delta C_{CC_{soils}}$$

where:

ΔC_{CC} is the change in carbon stocks on cropland remaining in the same category), ton C/year;

$\Delta C_{CC_{LB}}$ - Change in carbon stocks in biomass, ton C/year;

$\Delta C_{CC_{soils}}$ 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 formula⁶:

$$\Delta C_{CC_{soils}} = \Delta C_{CC_{mineral}} + \Delta C_{CC_{organic}}$$

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:

$$\Delta C_{CC_{\text{Mineral}}} = [(SOC_0 - SOC_{(0-T)})] / D,$$

$$SOC = SOC_{\text{REF}} \cdot F_{\text{LU}} \cdot F_{\text{MG}} \cdot F_{\text{I}} \cdot A$$

where:

$\Delta C_{CC_{\text{mineral}}}$ = annual change in carbon stocks in mineral soils, tonnes C yr⁻¹

SOC₀- 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 ;

FLU - 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 (SOCREF =79; FLU =0.80; FMG=1; FI =1). For subsequent years, tillage lands for annual crops, average carbon supply, with shallow tillage (SOCREF =79; FLU =0.80; FMG=1.02; FI =1). For fallow lands, the corresponding coefficient is used - FLU =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:

$$\Delta C_{CCsoils} = \Delta C_{CCmineral} + \Delta C_{CCorganic} + \Delta C_{CClime}$$

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:

$$\Delta C_{CC_{\text{Mineral}}} = [(SOC_0 - SOC_{(0-T)})] / D,$$

$$SOC = SOC_{\text{REF}} \cdot F_{\text{LU}} \cdot F_{\text{MG}} \cdot F_{\text{I}} \cdot A$$

Where

$\Delta C_{CC_{\text{mineral}}}$ = annual change in carbon stocks in mineral soils, tonnes C yr⁻¹;

SOC₀- 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 ;

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:
¹1990-From 1997 to 1999: Environmental Protection and Natural Resources of Georgia (Statistical Collections), Tbilisi, 1997;
²From 1998 to 2004: Natural Resources and Environmental Protection of Georgia, Statistical Collection, Tbilisi, 2005;
³From 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:

$SOC_0 = 81$; $F_{LU} = 1$; $F_{MG} = 0.95$; $F_I = 1$;

During the cadastre of the meadows, the following was taken:

$SOC_0 = 81$; $F_{LU} = 1$; $F_{MG} = 1$; $F_I = 1$.

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 meters⁷⁰. 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.

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, GgCO ₂ 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

⁷⁰ Irakli Mikadze, Assessment of Georgia's Peat Resources, 2016.

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 equation⁷¹ :

$$CO_2-C_{WW_{peat}} = CO_2-C_{WW_{peat\ off-site}} + CO_2-C_{WW_{peat\ on-site}}$$

where:

$CO_2-C_{WW_{peat}}$ CO₂-C emissions from managed peatlands, GgCO₂/year

$CO_2-C_{WW_{peat\ on-site}}$ CO₂-C emissions from managed peatlands in GgCO₂/year

$CO_2-C_{WW_{peat\ off-site}}$ CO₂-C emissions from peat consumed outside managed peatlands GgCO₂/year

⁷¹ IPCC 2006, WETLANDS, (Table 7.3)

The calculations were performed using the Tier 1 method. The following equation⁷² was used to determine emissions from peatland operations.

$$CO_2-C_{WW\text{ peat on-site}} = \left[\frac{(A_{\text{peatRich}} \cdot EF_{CO_2\text{ peatRich}}) + (A_{\text{peatPoor}} \cdot EF_{CO_2\text{ peatPoor}})}{1000} \right] + \Delta C_{WW\text{ peatB}}$$

where:

$CO_2-C_{WW\text{ peat on-site}}$ CO₂-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

$EF_{CO_2\text{ peatRich}}$ CO₂ emission factors for nutrient-rich peat soils managed for peat extraction or abandoned after peat extraction, tonnes C ha⁻¹ yr⁻¹

$EF_{CO_2\text{ peatPoor}}$ CO₂ emission factors for nutrient-poor peat soils managed for peat extraction or abandoned after peat extraction, tonnes C ha⁻¹ yr⁻¹

$\Delta C_{WW\text{ peatB}}$ 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 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).

⁷² IPCC 2006, WETLANDS, (Table 7.4)

Table 6-16. Emission factor indicators⁷³

Emission Factors For CO ₂ -C And Associated Uncertainty For Lands Managed For Peat Extraction		
Nutrient – Rich EFCO ₂ peatRich	1.1	tonnes C ha ⁻¹ yr ⁻¹
Conversion Factors For CO ₂ -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.

6.8. Harvested wood products (LULUCF 3D1)

Category description

⁷³ IPCC 2006 GL, Vol.4, Ch.7 WETLANDS, TABLE 7.4; TABLE 7.5

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.

Chapter 7. Waste (CRT 5)

7.1. Overview of the sector 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.”

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 ₂ O			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	
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

Year	Gg CH ₄					Gg N ₂ O			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
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 ₂ O, 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
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 ₂ O			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	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

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 were used 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 ₂ O	
	Method	EF	Method	EF	Method	EF
4.A Solid waste Disposal			T2	CS, D		
4.B Biological Treatment of Solid Waste			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

7.1.1. 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. Details are provided in the subsections.

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.

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/FNC 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 recalculated 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 ₂ O / 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

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 ₂ O
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 uncategorized¹.

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	Kokhira	Dedoplistskaro	Telavi	Meria	Tagveti	Akhtala	Kizilajlo	Chacharaki	Hypothetic	Total, gg	
	Didi Lilo	Gldani	Iaghluji	Lilo																					CH ₄	CO ₂ eq
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	Σ
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 hypothetical 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 hypothetical 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 ₂ eq
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 CH₄ and CO₂ are formed.

Methane emissions

CH₄ is produced by the decomposition/decay of organic material under anaerobic conditions. Part of the CH₄ produced is oxidized in the landfill top layer or can be recovered for energy or flaring. In this case, the actual amount of CH₄ emitted from the landfill will be less than the amount produced. The equation used to calculate CH₄ emissions from a landfill in a given year is:

$$\text{CH}_4 \text{ emissions} = \left[\sum_x \text{CH}_4 \text{ generated}_{x,T} - R_T \right] \cdot (1 - \text{OX}_T)$$

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). DDOC_m represents the fraction of organic carbon that will decompose under anaerobic conditions in a landfill.

The amount of DDOC_m (where the index m indicates mass) is calculated by the equation¹:

$$\text{DDOC}_m = W \cdot \text{DOC} \cdot \text{DOC}_f \cdot \text{MCF}$$

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 DDOC_m, the CH₄ 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 equation¹:

$$L_o = \text{DDOC}_m \cdot F \cdot 12/16$$

Where:

L _o	CH ₄ generation potential, Gg CH ₄
----------------	----------------------------------------------------------

DDOC_m mass of decomposable DOC, Gg
 F fraction of CH₄ in generated landfill gas (volume fraction)
 16/12 molecular weight ratio CH₄/C (ratio)

$$DDOCma_T = DDOCmd_T + (DDOCma_{T-1} \cdot e^{-k})^{74}$$

$$DDOCm\ decomp_T = DDOCma_{T-1} + (1 - e^{-k})^{75}$$

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 CH₄ from decomposing DDOCm

The amount of CH₄ produced from the decomposing material is calculated by multiplying the CH₄ fraction in the generated landfill gas by the CH₄/C molecular weight ratio³.

$$CH_4\ generated_T = DDOCm\ decomp_T \cdot F \cdot 16/12$$

where:

CH₄ generated_T Amount of CH₄ 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 CH₄/C (ratio)

Delay time: Waste is deposited in landfills continuously throughout the year, usually daily. However, there is evidence that the production of CH₄ 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)

⁷⁴ 2006 IPCC, Volume 5, Chapter 3, p. 3.9, Equation 3.4

⁷⁵ 2006 IPCC, Volume 5, Chapter 3, p. 3.9, Equation 3.5

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

Degradable Organic Carbon (DOC): Degradable organic carbon represents the fraction of carbon in solid waste that is susceptible to biochemical decomposition³. 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 CH₄ 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
Σ				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.

$$DOC_p^k = DOC_{100\%}^k \cdot \frac{p}{100}; \quad DOC = \sum_k DOC_p^k$$

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 based⁵ 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 DOC_F for solid waste disposed of at various landfills

Landfill	Tbilisi	Rustavi	Other
DOC _F	0.5537	0.6024	0.4890

Fraction of CH₄ in generated landfill gas (F): The extended Buswell equation is used to calculate the fraction of methane in landfill gas⁷⁶. The calculation results are presented in Table 7-14.

⁷⁶ Buswell A.M., Hatfield W.D. (ed.) (1937): *Anaerobic Fermentations. State of Illinois, Department of Registration and Education, Bulletin No. 32.*

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 DOC_m 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 $k=0.055$ ($t_{1/2}=12.7$ 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.

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.

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
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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 is 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
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Degradable organic carbon – DOC.

DOC of waste disposed in Batumi landfills = 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	DOC _i * DOC _F
	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
Σ				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

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.

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.

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, $k=0.108$ ($t_{1/2}=6.4$ 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.

7.3. Uncategorized landfills (waste disposal sites) (5.A.3)

7.3.1. *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.

7.3.2. *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 $k=0.06$ ($t_{1/2}=11.55$ 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
	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	

7.3.2.1. Description of any flexibility used

Flexibility is not used

7.3.2.2. 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.

7.3.2.3. 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.

7.3.2.4. 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 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

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

No improvements are planned.

7.4. Biological treatment of solid waste (4.B)

7.4.1. *Composting (4.B.1)*

7.4.1.1. *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 (CO₂). CO₂ emissions are of biogenic origin and should only be reported as an information point in the energy sector. CH₄ is produced in the anaerobic areas of the compost, but it is largely oxidized in the aerobic areas of the compost. The amount of CH₄ 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 N₂O. 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 CH₄ and N₂O.

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	
Emission	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 ₂ O	Gg N ₂ O	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

7.4.1.2. *Methodological Issues*

CH₄ and N₂O emissions from composting were estimated using the 2006 IPCC default method⁶:

$$CH_4 \text{ Emissions} = \sum (M_i \cdot EF_i) \cdot 10^{-3} - R$$

Where:

CH₄ Emissions Total methane emissions in the inventory year, Gg CH₄

M_i Mass of organic waste treated by biological treatment type i, Gg

EF emission factor for treatment i, gram CH₄/kg treated waste

i Composting or anaerobic digestion

R Total amount of CH₄ recovered in the inventory year, Gg CH₄

$$N_2O \text{ Emissions} = \sum(M_i \cdot EF_i) \cdot 10^{-3}{}^{77}$$

Where:

N₂O Emissions Total N₂O emissions in the inventory year, Gg N₂O

M_i Mass of organic waste treated by biological treatment type I, Gg

EF Emission factor for Treatment i, gr N₂O/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
CH ₄	4 grams CH ₄ /kg of waste processed (on a wet weight basis)
N ₂ O	0.3 grams N ₂ O/kg of waste processed (on a wet weight basis)

7.4.1.3. Description of any flexibility used

Flexibility was not used

7.4.1.4. 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.

7.4.1.5. 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.

⁷⁷ 2006 IPCC, volume 5, chapter 4, 03. 4.5, equation 4.2

7.4.1.6. 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.

7.4.1.7. 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.

7.4.2. 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.

7.5. Waste incineration and open burning (4.C)

7.5.1. Waste incineration (4.C.1)

7.5.1.1. 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 CO₂ 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.

7.5.1.2. Methodological issues

Since CO₂ 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).

CO₂ emissions from waste incineration and open burning are calculated using the following equation⁷⁸:

$$CO_2 \text{ Emissions} = \sum_i (SW_i \cdot dm_i \cdot CF_i \cdot FCF_i \cdot OF_i) \cdot \frac{44}{12}$$

Where:

CO₂ Emissions CO₂ Emissions in the inventory year, Gg/year

SW_i Amount of waste type i (wet weight) incinerated or open burned, Gg/year

⁷⁸ 2006 IPCC, volume 5, chapter 5, pg. 5.7, equation 5.1

- 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 CO₂ 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) $CF_i = 0.6$; 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.

7.5.1.3. Description of any flexibility used

Flexibility was not used.

7.5.1.4. 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.

7.5.1.5. 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.

7.5.1.6. 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.

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

No improvements are planned.

7.5.2. *Open burning of waste (4.C.2)*

NE Not estimated.

7.6. *Wastewater treatment and disposal (4.D)*

7.6.1. *Domestic wastewater treatment and discharge (4.D.1)*

7.6.1.1. *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.

7.6.1.2. *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 equation⁷⁹ is used to calculate methane emissions from wastewater treatment :

$$CH_{4,emission} = \left[\sum_{i,j} (U_i \cdot T_{i,j} \cdot EF_j) \right] (TOW - S) - R$$

Where:

CH₄ Emissions CH₄ emission from wastewater in the inventory year, kg CH₄/year
TOW Total organic matter in wastewater in the inventory year, kg BOD/year
S Organic component removed as sludge in the inventory year, kg BOD/year
U_i fraction of population in income group i in inventory year

⁷⁹ 2006 IPCC, volume 5, chapter 6, pg. 6.11, equation 6.1

$T_{i,j}$	degree of utilization of treatment/discharge pathway or system, j, for each income group
fraction i	fraction i in inventory year
R	amount of CH ₄ recovered in inventory year, kgCH ₄ /year
i	income group: rural, urban high income and urban low income
j	each treatment/discharge pathway or system
EF _j	Emission factor, kg CH ₄ /kgBOD

The emission factor of a wastewater treatment system is a function of the maximum CH₄-producing potential (B_o) and the methane correction factor (MCF) for the wastewater treatment and discharge system⁸⁰:

$$EF_j = B_o \cdot MCF_j$$

Where:

EF _j	Emission factor, kg CH ₄ /kg BOD
j	Each treatment/discharge pathway or system
B_o	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 formula¹⁰:

$$TOW = P \cdot BOD \cdot 0.001 \cdot I \cdot 365$$

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 B_o of 0.25 kg CH₄/kg COD or 0.6 kg CH₄/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).

⁸⁰ 2006 IPCC, volume 5, chapter 6, pg. 6.12, equation 6.2

Activity data: The source of information on urban and rural populations is the National Statistical Office of Georgia.

Table 7-29. Urban and rural population in 1990-2022 years

Year	Population in thousands			Year	Population in thousands		
	Urban	Rural	Total		Urban	Rural	Total
1990	2,999	2,426	5,424	2007	2,212	1,720	3,932
1991	3,005	2,449	5,453	2008	2,199	1,649	3,848
1992	2,983	2,484	5,467	2009	2,188	1,641	3,829
1993	2,914	2,432	5,346	2010	2,172	1,628	3,800
1994	2,653	2,277	4,930	2011	2,157	1,617	3,774
1995	2,568	2,226	4,794	2012	2,137	1,602	3,739
1996	2,483	2,191	4,675	2013	2,125	1,593	3,718
1997	2,413	2,146	4,558	2014	2,124	1,593	3,717
1998	2,366	2,139	4,505	2015	2,127	1,595	3,722
1999	2,338	2,132	4,470	2016	2,131	1,598	3,729
2000	2,308	2,127	4,435	2017	2,130	1,597	3,726
2001	2,293	2,102	4,395	2018	2,175	1,555	3,730
2002	2,278	2,078	4,356	2019	2,184	1,539	3,724
2003	2,265	2,006	4,271	2020	2,195	1,522	3,717
2004	2,252	1,935	4,186	2021	2,216	1,513	3,729
2005	2,238	1,863	4,102	2022	2,201	1,488	3,689
2006	2,225	1,792	4,017				

Table 7-30. CH₄ emissions from Domestic wastewater treatment and discharge

Year	CH ₄ From the population		Emission		Year	CH ₄ From the population		Emission	
	Urban	Rural	Gg CH ₄	Gg CO ₂ -eq		Urban	Rural	Gg CH ₄	Gg CO ₂ -eq
1990	7.11	3.03	10.14	284.0	2007	5.25	2.15	7.39	207.0
1991	7.13	3.06	10.18	285.2	2008	5.22	2.06	7.27	203.7
1992	7.07	3.10	10.18	284.9	2009	5.19	2.05	7.24	202.7
1993	6.91	3.04	9.95	278.5	2010	5.15	2.03	7.18	201.1
1994	6.29	2.84	9.13	255.8	2011	5.12	2.02	7.13	199.7
1995	6.09	2.78	8.87	248.3	2012	5.07	2.00	7.07	197.9
1996	5.89	2.74	8.62	241.5	2013	5.04	1.99	7.03	196.8
1997	5.72	2.68	8.40	235.3	2014	5.04	1.99	7.03	196.7
1998	5.61	2.67	8.28	231.9	2015	5.05	1.99	7.04	197.0
1999	5.55	2.66	8.21	229.8	2016	5.05	1.99	7.05	197.4
2000	5.47	2.66	8.13	227.6	2017	5.05	1.99	7.04	197.2
2001	5.44	2.62	8.06	225.8	2018	5.54	1.94	7.48	209.4
2002	5.40	2.59	8.00	223.9	2019	5.94	1.92	7.86	220.2
2003	5.37	2.50	7.88	220.5	2020	6.36	1.90	8.26	231.2
2004	5.34	2.42	7.76	217.2	2021	6.80	1.89	8.69	243.4
2005	5.31	2.33	7.63	213.8	2022	7.14	1.86	9.00	252.0
2006	5.28	2.24	7.51	210.4					

7.6.1.3. Description of any flexibility used

Flexibility was not used.

7.6.1.4. 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.

7.6.1.5. *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.

7.6.1.6. *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

7.6.1.7. *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.

7.6.2. *Nitrous oxide emissions from wastewater*

7.6.2.1. *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 ₂ O	Gg CO ₂ .eq	Year	Population, thsd persons	Protein consumption, g/person/day	Gg N ₂ O	Gg CO ₂ .eq
1990	5,424	56	0.19	50.8	2007	3,932	77	0.19	50.6
1991	5,453	56	0.19	51.1	2008	3,848	78	0.19	50.2
1992	5,467	56	0.19	51.2	2009	3,829	79	0.19	50.6
1993	5,346	60	0.20	53.6	2010	3,800	80	0.19	50.8
1994	4,930	65	0.20	53.6	2011	3,774	81	0.19	51.1
1995	4,794	69	0.21	55.3	2012	3,739	82	0.19	51.3
1996	4,675	69	0.20	53.9	2013	3,718	83	0.19	51.6
1997	4,558	69	0.20	52.6	2014	3,717	84	0.20	52.2
1998	4,505	70	0.20	52.7	2015	3,722	83	0.19	51.6
1999	4,470	71	0.20	53.1	2016	3,729	83	0.20	51.9
2000	4,435	72	0.20	53.4	2017	3,726	84	0.20	52.4
2001	4,395	72	0.20	52.9	2018	3,730	85	0.20	52.7
2002	4,356	72	0.20	52.4	2019	3,723	86	0.20	53.2

Year	Population, thsd persons	Protein consumption, g/person/day	Gg N ₂ O	Gg CO ₂ -eq	Year	Population, thsd persons	Protein consumption, g/person/day	Gg N ₂ O	Gg CO ₂ -eq
2003	4,271	74	0.20	52.8	2020	3,717	86	0.20	53.6
2004	4,186	76	0.20	53.2	2021	3,729	87	0.21	54.4
2005	4,102	77	0.20	52.8	2022	3,689	85	0.20	52.2
2006	4,017	77	0.20	51.7					

7.6.2.2. 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 equation⁸¹:

$$N_2O \text{ Emissions} = N_{EFFLUENT} \cdot EF_{EFFLUENT} \cdot 44/28$$

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 -N to kg N_2O

Nitrogen in the effluent is estimated as follows:

$$N_{EFFLUENT} = (P \cdot Protein \cdot F_{NPR} \cdot F_{NON-CON} \cdot F_{IND-COM}) - N_{SLUDGE} \quad 82$$

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

⁸¹ 2006 IPCC, volume 5, chapter 6, pg. 6.25, equation 6.7

⁸² 2006 IPCC, volume 5, chapter 6, pg. 6.25, equation 6.8

Food	Year							
	2015	2016	2017	2018	2019	2020	2021	2022
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, $F_{\text{NPR}} = 0.16$ kg N/kg protein, $F_{\text{NON-COM}} = 1.1$, $F_{\text{IND-COM}} = 1.25$ (2006 IPCC, Vol. 5, Chapter 6, p. 6.27, Table 6.11)

7.6.2.3. *Description of any flexibility used*

Flexibility was not used.

7.6.2.4. *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.

7.6.2.5. *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.

7.6.2.6. *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

7.6.2.7. *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.

7.6.3. Industrial wastewater treatment and discharge (5.D.2)

7.6.3.1. Source 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.

7.6.3.2. 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 (m³/tonne of product) by industry. The formula⁸³ used to calculate methane emissions from industrial wastewater is:

$$CH_4 \text{ Emissions} = \sum_i [(TOW_i - S_i) \times EF_i - R_i]$$

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 CH₄/year

Emission factor: The emission factor depends on the maximum methane-producing capacity for each industry and the methane correction factor¹³.

$$EF_j = B_o \cdot MCF_j$$

Where:

EF_j Emission factor of the cleaning/discharge system, kg CH₄/kg COD

j each treatment/discharge pathway or system

B_o maximum CH₄ producing capacity, kg CH₄/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 (B_o=0.25 kg CH₄/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 formula⁸⁴:

$$TOW = P_i \cdot W_i \cdot COD_i$$

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 (m³/ton of product)

⁸³ 2006 IPCC, volume 5, chapter 6, 6.20, equation 6.4

⁸⁴ 2006 IPCC, volume 5, chapter 6, 6.22, equation 6.6

COD: chemical oxygen demand (industrial degradable organic component in wastewater), kg COD/m³

Activity data: The source of data on production from industries is the National Statistical Office of Georgia.

CH₄ 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
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

7.6.3.3. Description of any flexibility used

Flexibility was not used.

7.6.3.4. 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.

7.6.3.5. *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.

7.6.3.6. *Category-specific recalculations, explanatory information and justification for recalculations, changes made in response to the review/ verification process, and impacts*

The recalculated CH₄ 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

7.6.3.7. *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 CO₂, CH₄, and N₂O 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 CH₄ 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 CO₂ 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 CO₂ emissions, ensuring more precise calculations through industry-specific data.

Other Industrial Processes: In select cases, Tier 2 methodologies are employed to estimate N₂O 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 CO₂ 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 CH₄ emissions, incorporating country-specific livestock data to enhance accuracy.

Manure Management: Tier 2 methods are applied for both CH₄ and N₂O 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 CH₄ emissions from enteric fermentation and manure management, as well as for N₂O emissions from manure management, ensuring that estimates reflect Georgia's agricultural conditions more accurately.

In the LULUCF sector, Tier 2 methodologies are applied for CO₂ 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 CH₄ 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 CH₄ 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 CO₂, 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 CH₄ emissions from various types of landfills. For example, managed landfills generate substantially higher CH₄ 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

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
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
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
1A4b	Fuel Combustion - Residential - Gaseous fuels	CO2	2,786.65	2,786.65	0.060	0.729
3A1	Enteric Fermentation - Cattle	CH4	2,657.20	2,657.20	0.057	0.786
1A1	Fuel Combustion - Manufacture of Solid Fuel and Other Energy Industries - Solid Fuels	CO2	955.76	955.76	0.021	0.806
1B1	Fugitive Emissions from Solid Fuels	CH4	954.73	954.73	0.020	0.827
1A4b	Fuel Combustion - Residential - Liquid fuels	CO2	762.13	762.13	0.016	0.843
1A4a	Fuel Combustion - Commercial/Institutional- Liquid fuels	CO2	626.90	626.90	0.013	0.857
3D1	Direct N2O Emissions from Managed Soils	N2O	604.20	604.20	0.013	0.870
2B1	Chemical Industry - Ammonia Production	CO2	C	C	C	C
2A1	Mineral Industry - Cement Production	CO2	C	C	C	C
1A4c	Fuel Combustion - Agriculture/Forestry/Fishing/Fish Farms - Liquid fuels	CO2	390.99	390.99	0.008	0.900
5A3	Solid Waste Disposal -Uncategorised	CH4	375.20	375.20	0.008	0.908
5A1	Solid Waste Disposal - Managed	CH4	334.32	334.32	0.007	0.916
3A4	Enteric Fermentation - Other Cattle	CH4	323.12	323.12	0.007	0.922
5D1	Domestic Wastewater Treatment	CH4	283.92	283.92	0.006	0.929

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
1A4b	Fuel Combustion - Residential - Solid Fuels	CO2	273.83	273.83	0.006	0.934
3B1	Manure Management - Cattle	CH4	247.24	247.24	0.005	0.940
1A4a	Fuel Combustion - Commercial/Institutional-Gaseous fuels	CO2	228.21	228.21	0.005	0.945
2C1	Metal Production - Iron and Steel Production	CO2	203.89	203.89	0.004	0.949
1A2	Fuel Combustion - Manufacturing Industries and Construction - Liquid fuels	CO2	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

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Estimate Ex,t Gg CO2 eq.	Year	Latest Estimate Absolute Value [Ex,t]	Year	Level Assessment Lx,t	Cumulative Total Value
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
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
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

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
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,t-Ex,0 $	$Ex,t-Ex,0$	$ t / Ex,0 $	$(\Sigma Ex,t-\Sigma Ey,0)/(\Sigma Ey,0)$	J-K	Trend Assessment Ex,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

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	$\frac{ Ex,0 }{\Sigma Ey,0 }$	$Ex,t-Ex,0$	$\frac{I}{ Ex,0 }$	$\frac{(\Sigma Ey,t-\Sigma Ey,0)}{\Sigma Ey,0}$	J-K	Trend Assessment Tx,t	Contribution %	Cumulative Total Contribution
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
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	$\frac{ Ex,0 }{\Sigma Ey,0 }$	$Ex,t-Ex,0$	$\frac{I}{ Ex,0 }$	$\frac{(\Sigma Ey,t-\Sigma Ey,0)}{\Sigma Ey,0}$	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

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	$ \text{Ex},0 / \text{Ex},0 $	$\text{Ex},t-\text{Ex},0$	$I/ \text{Ex},0 $	$(\sum \text{Ex},t-\sum \text{Ex},0)/ \sum \text{Ex},0 $	J-K	Trend Assessment I_x,t	Contribution %	Cumulative Total Contribution
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
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 Farms - Liquid fuels	CO2	391	391	29	29	0.01	-362	-0.93	-0.57	0.36	0.003	0.007	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

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	$ \text{Ex},0 /\sum \text{Ey},0 $	$\text{Ex},t-\text{Ex},0$	$I/ \text{Ex},0 $	$(\sum\text{Ey},t-\sum\text{Ey},0)/\sum\text{Ey},0 $	J-K	Trend Assessment Tx,t	Contribution %	Cumulative Total Contribution
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.⁸⁵

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
			$\frac{\partial E_{1990}}{\partial G}$	$\frac{\partial E_{2022}}{\partial G}$	$\frac{\partial E}{\partial A}$	$\frac{\partial E}{\partial F}$	$\sqrt{E^2 + F^2}$	$\frac{(G \times D)^2}{(\sum D)^2}$		$\left \frac{D}{\sum C} \right $	$I * F$	$J * E\sqrt{2}$	$K^2 + L^2$
			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

⁸⁵IPCC 2006, Vol 1, Chapter 3, table 3.4

	A	B	C	D	E	F	G	H	I	J	K	L	M
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
1A1	Fuel Burning - Electricity And Heat Production - Liquid Fuel	N ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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
1A3c	Fuel Combustion - Transport - Railway - Liquid Fuel	N ₂ O	0.2	0.4	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
1A3c	Fuel Combustion - Transport - Railways - Solid Fuel	N ₂ O	0.2	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A3d	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
1A3d	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
1A3d	Fuel Combustion - Transport - Domestic Watercraft Navigation	N ₂ O	0.0	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A3e	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
1A3e	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
1A3e	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
1A3e	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
1A3e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	N ₂ O	3.9	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A3e	Fuel Combustion - Transport - Other Transport - Air Fuel	N ₂ O	0.0	0.3	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4a	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
1A4a	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
1A4a	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
1A4a	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
1A4a	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
1A4a	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
1A4a	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
1A4a	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
1A4a	Fuel Combustion - Commercial / Institutional - Solid Fuel	N ₂ O	0.3	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	N ₂ O	1.6	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4a	Fuel Combustion - Commercial / Institutional - Gas Fuel	N ₂ O	0.1	0.2	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1A4a	Fuel Combustion - Commercial / Institutional - Biomass	N ₂ O	16.4	9.2	5	100	100.12	0.00	0.00	0.00	0.03	0.00	0.00
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

	A	B	C	D	E	F	G	H	I	J	K	L	M
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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	0.0	0.0	5	100	100.12	0.00	0.00	0.00	0.00	0.00	0.00
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 ₂ O	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	CO ₂	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	CH ₄	954.7	93.4	5	50	50.25	0.11	-0.01	0.00	0.17	-0.03	0.03
1B2a	Fugitive Emissions from Oils	CO ₂	11.4	0.1	10	25	26.93	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
1B2a	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
1B2a	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
1B2b	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
1B2b	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
1B2b	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
1B2c	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
1B2c	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
1B2c	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	CO2	C	C	C	C	C	C	C	C	C	C	C
2A2	Mineral Industry - Lime Production	CO2	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	CO2	C	C	C	C	C	C	C	C	C	C	C
2B1	Chemical Industry - Ammonia Production	CO2	C	C	C	C	C	C	C	C	C	C	C
2B2	Chemical Industry - Nitric Acid Production	N2O	C	C	C	C	C	C	C	C	C	C	C
2C1	Metals Production - cast iron And Steel Production	CO2	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	CH4	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	CO2	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	CH4	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	CO2	C	C	C	C	C	C	C	C	C	C	C
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	CH4	2657.2	1466.9	7	25	25.96	7.09	0.01	0.04	1.35	0.09	1.83
3A2	Intestinal Fermentation - Sheep	CH4	0.0	0.0	7	25	25.96	0.00	0.00	0.00	0.00	0.00	0.00
3A3	Intestinal Fermentation - Pigs	CH4	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	CH4	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	CH4	247.2	92.1	7	30	30.81	0.04	0.00	0.00	0.10	0.00	0.01

	A	B	C	D	E	F	G	H	I	J	K	L	M
3B1	Manure Management - Horned Cattle	N ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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 ₂ O	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
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 ₂ O	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

	A	B	C	D	E	F	G	H	I	J	K	L	M
5D1	Household Wastewater Waters Processing	CH4	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	N2O	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	CH4	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
			Base year emissions/removals	2022 Year 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						
	IPCC Categories	Gas	Gg CO2 eq.	Gg CO2 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		

	A	B	C	D	E		F		G		H	I	J		K
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	0.0 0	0.0 0	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	0.0 0	0.0 0	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	0.0 0	0.0 0	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	0.0 0	0.0 0	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	0.0 5	0.0 5	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Biomass	CO2	0.0	2.4	5	5	20	20	21	21	0.00		0.0 0	0.0 0	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	0.0 1	0.0 1	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	0.0 3	0.0 3	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	0.0 0	0.0 0	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Biomass	CH4	0.0	0.0	5	5	50	50	50	50	0.00		0.0 0	0.0 0	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	0.0 0	0.0 0	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	0.0 0	0.0 0	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	0.0 0	0.0 0	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Biomass	N2O	0.0	0.0	5	5	100	100	100	100	0.00		0.0 0	0.0 0	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	0.0 0	0.0 0	Approach 1
1A2	Fuel Burning - recycling Industry And Construction - Air Fuel	N2O	17.8	0.3	5	5	100	100	100	100	0.00	-99	0.0 0	0.0 0	Approach 1
1A3 a	Fuel combustion - Transport - Civil aviation	CO2	0.0	1.5	5	5	4	4	6	6	0.00		0.0 0	0.0 0	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	0.1 5	0.1 5	Approach 1
1A3 b	Fuel Burning - Transport - Road Transport - Air Fuel	CO2	0.0	383.4	2	2	4	4	4	4	0.00		0.0 0	0.0 0	Approach 1
1A3 b	Fuel Burning - Transport - Road Transport	CH4	36.4	47.4	5	5	50	50	50	50	0.00	30	0.0 1	0.0 1	Approach 1
1A3 b	Fuel Burning - Transport - Road Transport	N2O	53.9	47.6	5	5	100	100	100	100	0.00	-12	0.0 3	0.0 3	Approach 1
1A3 c	Fuel Combustion - Transport - Railway - Liquid Fuel	CO2	84.3	4.0	5	5	3	3	6	6	0.00	-95	0.0 0	0.0 0	Approach 1
1A3 c	Fuel Combustion - Transport - Railways - Solid Fuel	CO2	43.2	0.0	5	5	3	3	6	6	0.00	-100	0.0 0	0.0 0	Approach 1
1A3 c	Fuel Combustion - Transport - Railway - Liquid Fuel	CH4	0.2	0.0	5	5	50	50	50	50	0.00	-96	0.0 0	0.0 0	Approach 1
1A3 c	Fuel Combustion - Transport - Railways - Solid Fuel	CH4	0.0	0.0	5	5	50	50	50	50	0.00	-100	0.0 0	0.0 0	Approach 1
1A3 c	Fuel Combustion - Transport - Railway - Liquid Fuel	N2O	0.2	0.4	5	5	100	100	100	100	0.00	135	0.0 0	0.0 0	Approach 1
1A3 c	Fuel Combustion - Transport - Railways - Solid Fuel	N2O	0.2	0.0	5	5	100	100	100	100	0.00	-100	0.0 0	0.0 0	Approach 1

	A	B	C	D	E		F		G		H	I	J		K
1A3d	Fuel Combustion - Transport - Domestic Watercraft Navigation	CO2	0.0	4.2	5	5	3	3	6	6	0.00		0.0	0.0	Approach 1
1A3d	Fuel Combustion - Transport - Domestic Watercraft Navigation	CH4	0.0	0.0	5	5	50	50	50	50	0.00		0.0	0.0	Approach 1
1A3d	Fuel Combustion - Transport - Domestic Watercraft Navigation	N2O	0.0	0.0	5	5	100	100	100	100	0.00		0.0	0.0	Approach 1
1A3e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	CO2	38.4	9.4	5	5	3	3	6	6	0.00	-76	0.0	0.0	Approach 1
1A3e	Fuel Combustion - Transport - Other Transport - Air Fuel	CO2	57.6	649.4	5	5	3	3	6	6	0.00	1026	0.0	0.0	Approach 1
1A3e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	CH4	0.1	0.0	5	5	50	50	50	50	0.00	-82	0.0	0.0	Approach 1
1A3e	Fuel Combustion - Transport - Other Transport - Air Fuel	CH4	0.0	0.3	5	5	50	50	50	50	0.00	723	0.0	0.0	Approach 1
1A3e	Fuel Combustion - Transport - Other Transport - Liquid Fuel	N2O	3.9	0.0	5	5	100	100	100	100	0.00	-99	0.0	0.0	Approach 1
1A3e	Fuel Combustion - Transport - Other Transport - Air Fuel	N2O	0.0	0.3	5	5	100	100	100	100	0.00	723	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Solid Fuel	CO2	85.9	0.0	5	5	5	5	7	7	0.00	-100	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	CO2	626.9	0.2	3	3	3	3	4	4	0.00	-100	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Gas Fuel	CO2	228.2	518.2	2	2	2	2	3	3	0.00	127	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Biomass	CO2	0.0	0.0	20	20	15	15	25	25	0.00		0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Solid Fuel	CH4	0.2	0.0	5	5	50	50	50	50	0.00	-100	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	CH4	2.8	0.0	5	5	50	50	50	50	0.00	-100	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Gas Fuel	CH4	0.6	1.3	5	5	50	50	50	50	0.00	127	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Biomass	CH4	129.6	7.3	5	5	50	50	50	50	0.00	-94	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Solid Fuel	N2O	0.3	0.0	5	5	100	100	100	100	0.00	-100	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Liquid Fuel	N2O	1.6	0.0	5	5	100	100	100	100	0.00	-100	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Gas Fuel	N2O	0.1	0.2	5	5	100	100	100	100	0.00	121	0.0	0.0	Approach 1
1A4a	Fuel Combustion - Commercial / Institutional - Biomass	N2O	16.4	9.2	5	5	100	100	100	100	0.00	-44	0.0	0.0	Approach 1
1A4b	Fuel Burning - Household - Solid Fuel	CO2	273.8	0.4	5	5	7	7	9	9	0.00	-100	0.0	0.0	Approach 1
1A4b	Fuel Burning - Household - Liquid Fuel	CO2	762.1	14.8	5	5	5	5	7	7	0.00	-98	0.0	0.0	Approach 1
1A4b	Fuel Combustion - Domestic - Gas Fuel	CO2	2786.7	2646.0	3	3	3	3	4	4	0.01	-5	0.1	0.1	Approach 1
1A4b	Fuel Burning - Household - Solid Fuel	CH4	6.1	0.0	5	5	50	50	50	50	0.00	-100	0.0	0.0	Approach 1
1A4b	Fuel Burning - Household - Liquid Fuel	CH4	1.0	0.0	5	5	50	50	50	50	0.00	-97	0.0	0.0	Approach 1
1A4b	Fuel Combustion - Domestic - Gas Fuel	CH4	6.6	6.6	5	5	50	50	50	50	0.00	1	0.0	0.0	Approach 1

	A	B	C	D	E		F		G		H	I	J		K
1A4 b	Fuel Combustion - Household - Biomass	CH4	0.4	0.4	5	5	50	50	50	50	0.00	22	0.0 0	0.0 0	Approach 1
1A4 b	Fuel Burning - Household - Solid Fuel	N2O	0.3	0.0	5	5	100	100	100	100	0.00	-100	0.0 0	0.0 0	Approach 1
1A4 b	Fuel Burning - Household - Liquid Fuel	N2O	0.4	0.0	5	5	100	100	100	100	0.00	-99	0.0 0	0.0 0	Approach 1
1A4 b	Fuel Combustion - Domestic - Gas Fuel	N2O	1.2	1.2	5	5	100	100	100	100	0.00	0	0.0 0	0.0 0	Approach 1
1A4 b	Fuel Combustion - Household - Biomass	N2O	1.2	0.1	5	5	100	100	100	100	0.00	-95	0.0 0	0.0 0	Approach 1
1A4 c	Fuel Burning - Stationary - Solid Fuel	CO2	56.8	4.5	3	3	7	7	8	8	0.00	-92	0.0 0	0.0 0	Approach 1
1A4 c	Fuel Combustion - Stationary - Liquid Fuel	CO2	391.0	29.1	5	5	5	5	7	7	0.00	-93	0.0 0	0.0 0	Approach 1
1A4 c	Fuel Combustion - stationary - gas Fuel	CO2	70.5	20.6	3	3	3	3	4	4	0.00	-71	0.0 0	0.0 0	Approach 1
1A4 c	Fuel Combustion - Stationary - Biomass	CO2	0.0	0.0	20	20	50	50	54	54	0.00		0.0 0	0.0 0	Approach 1
1A4 c	Fuel Burning - Stationary - Solid Fuel	CH4	5.0	0.4	5	5	50	50	50	50	0.00	-93	0.0 0	0.0 0	Approach 1
1A4 c	Fuel Combustion - Stationary - Liquid Fuel	CH4	1.5	65.3	5	5	50	50	50	50	0.00	4285	0.0 1	0.0 1	Approach 1
1A4 c	Fuel Combustion - stationary - gas Fuel	CH4	0.2	0.1	5	5	50	50	50	50	0.00	-71	0.0 0	0.0 0	Approach 1
1A4 c	Fuel Combustion - Stationary - Biomass	CH4	0.0	0.0	5	5	50	50	50	50	0.00		0.0 0	0.0 0	Approach 1
1A4 c	Fuel Burning - Stationary - Solid Fuel	N2O	0.2	0.0	5	5	100	100	100	100	0.00	-93	0.0 0	0.0 0	Approach 1
1A4 c	Fuel Combustion - Stationary - Liquid Fuel	N2O	0.8	2.4	5	5	100	100	100	100	0.00	186	0.0 0	0.0 0	Approach 1
1A4 c	Fuel Combustion - stationary - gas Fuel	N2O	0.0	0.0	5	5	100	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	100	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	100	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	100	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

	A	B	C	D	E		F		G		H	I	J		K
1B2 b	Fugitive Emissions Natural From the air	N2O	0.0	0.0	5	5	100	100	100	100	0.00	-100	0.0 0	0.0 0	Approach 1
1B2c	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
1B2c	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
1B2c	Fugitive Emissions From ventilation And Torchlight From burning	N2O	0.0	0.0	5	5	100	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
2F4	Use of substitute products for ozone-depleting substances - aerosols	HFC s	0.0	0.5	20	20	20	20	28	28	0.00		0.0 0	0.0 0	Approach 1
2G	Other Product Manufacture and Use	SF6	0.0	1.1	2	2	3	3	4	4	0.00		0.0 0	0.0 0	Approach 1
3A1	Intestinal Fermentation - Corn Cattle	CH4	2657.2	1466.9	7	7	25	25	26	26	0.09	-45	1.8 3	1.8 3	Approach 1
3A2	Intestinal Fermentation - Sheep	CH4	0.0	0.0	7	7	25	25	26	26	0.00		0.0 0	0.0 0	Approach 1
3A3	Intestinal Fermentation - Pigs	CH4	0.0	0.0	7	7	25	25	26	26	0.00		0.0 0	0.0 0	Approach 1
3A4	Intestinal Fermentation - Other Cattle	CH4	323.1	182.6	7	7	25	25	26	26	0.00	-44	0.0 3	0.0 3	Approach 1
3B1	Manure Management - Horned Cattle	CH4	247.2	92.1	7	7	30	30	31	31	0.00	-63	0.0 1	0.0 1	Approach 1
3B1	Manure Management - Horned Cattle	N2O	63.1	32.7	7	7	30	30	31	31	0.00	-48	0.0 0	0.0 0	Approach 1
3B2	Manure Management - Sheep	CH4	0.0	0.0	7	7	30	30	31	31	0.00		0.0 0	0.0 0	Approach 1
3B3	Manure Management - Pigs	CH4	0.0	0.0	7	7	30	30	31	31	0.00		0.0 0	0.0 0	Approach 1
3B4	Manure Management - Other Cattle	CH4	96.0	26.0	7	7	30	30	31	31	0.00	-73	0.0 0	0.0 0	Approach 1
3B4	Manure Management - Other Cattle	N2O	47.4	15.6	7	7	30	30	31	31	0.00	-67	0.0 0	0.0 0	Approach 1

	A	B	C	D	E		F		G		H	I	J		K
3B5	Manure Management - Indirect N2O Emissions	N2O	70.2	37.1	7	7	30	30	31	31	0.00	-47	0.0 0	0.0 0	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	0.1 5	0.1 5	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	0.0 3	0.0 3	Approach 1
3F	Savannah Established Burning	CH4	2.2	2.2	10	10	50	50	51	51	0.00	0	0.0 0	0.0 0	Approach 1
3F	Savannah Established Burning	N2O	0.5	0.5	10	10	50	50	51	51	0.00	0	0.0 0	0.0 0	Approach 1
3H	Urea Consumption	CO2	0.0	4.0	3	3	20	20	20	20	0.00		0.0 0	0.0 0	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	6.1 0	6.1 0	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	0.0 0	0.0 0	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	0.0 0	0.0 0	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		0.0 0	0.0 0	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	0.0 7	0.0 7	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		0.0 0	0.0 0	Approach 1
4C	Preserved Pastures - important Supplies To be determined	CO2	438.9	765.2	7	7	25	25	26	26	0.02	74	0.5 1	0.5 1	Approach 1
4C	Lands Changed Pastures - important Supplies To be determined	CO2	0.0	0.0	0	0	0	0	0	0	0.00		0.0 0	0.0 0	Approach 1
4D	Preserved Wetland Lands	CH4	15.8	26.1	10	10	50	50	51	51	0.00	65	0.0 0	0.0 0	Approach 1
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	100	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)			

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)
Sharing of the inventory control report with the sectoral experts by the team 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			

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 to the coordinator			
Improved handover of 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			

Annex V. Any additional information, as applicable, including detailed methodological descriptions of source or sink categories and the national emission balance

Estimation of HFCs

Tier 1 Refrigeration Georgia - HFC-32

HFC-32

Current Year 2022

Use in current year - 2022 (tonnes)
 Production of HFC-32: 25
 Imports in current Year: 25
 Exports in current year: 25
 Total new agent to domestic market: 25

Tier 1 Defaults
 Assumed Equipment Lifetime (years): 10
 Emission Factor from installed base: 125
 % 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

Year	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	5	11	5	5	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	5	11	5	5	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	0	1	1	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	0	0	0	0	1	2	8	19	7	29
Release of agent from retired equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	7	18	47	20	87
Bank	-	-	-	-	-	0.02	0.14	0.76	1.75	2.73	2.79	2.71	3.06	3.89	8.14	18.51	21.88	23.95	41.04	55.25	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

Use in current year - 2022 (tonnes)
 Production of HFC-125: 67
 Imports in current Year: 67
 Exports in current year: 67
 Total new agent to domestic market: 67

Tier 1 Defaults
 Assumed Equipment Lifetime (years): 10
 Emission Factor from installed base: 125
 % 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

Year	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	0	1	2	2	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	8	19	7	29
Release of agent from retired equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	7	18	47	20	87
Bank	-	-	-	-	-	0.11	0.45	1.52	3.37	5.54	5.29	5.10	7.38	9.69	30.63	40.82	43.54	44.89	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

Use in current year - 2022 (tonnes)
 Production of HFC-134a: 157
 Imports in current Year: 157
 Exports in current year: 157
 Total new agent to domestic market: 157

Tier 1 Defaults
 Assumed Equipment Lifetime (years): 10
 Emission Factor from installed base: 125
 % 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

Year	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	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	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	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	0	0	0	0	1	1	3	8	16	7	29			
Release of agent from retired equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	3	9	1	7	18	47	20	87
Bank	-	-	-	-	-	0.56	2.37	7.51	11.91	22.28	22.89	26.34	39.30	65.21	134.86	153.21	200.81	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	50.84	58.18	56.55	63.86	73.89	89.41	118.82	98.27	159.77				

Tier 1 Refrigeration
Georgia - HFC-143a

HFC-143a

Current Year 2022

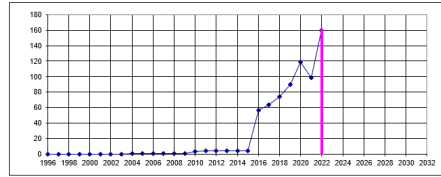
Date Used Here

Use in current year - 2022 (tonnes)
Production of HFC-143a 43
Imports in current year 0
Exports in current year 0

Total new agent to domestic market 49
Year of introduction of HFC-143a 2007
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%

Summary
Country: Georgia
Agent: HFC-143a
Year: 2022
Emission: 159.8 tonnes
In Bank: 487.8 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	1	1	2	0	0	3	2	19	4	4	3	5	4	86	88	109	121	133	145	49	
Total New Agent in Domestic Equipment	0	0	0	0	0	0	1	1	2	0	0	3	2	19	4	4	3	5	4	86	88	109	121	133	145	49	
Agent in Retired Equipment	0	0	0	0	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	15	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	0	2	7	18	47	20	87	
Bank	-	-	-	-	-	0.10	0.35	0.62	1.73	3.03	2.68	2.54	4.76	6.33	24.40	24.96	24.98	24.01	24.47	23.96	370.38	409.13	448.42	475.11	477.53	524.92	487.89
Emission	-	-	-	-	-	0.02	0.05	0.12	0.28	0.46	0.40	0.38	0.71	0.95	3.66	3.81	3.91	3.93	4.31	4.51	50.52	63.86	73.89	89.41	116.82	98.27	159.77

LULUCF

Figure V-1. Decision Framework for Land Category GHG Inventory Calculations

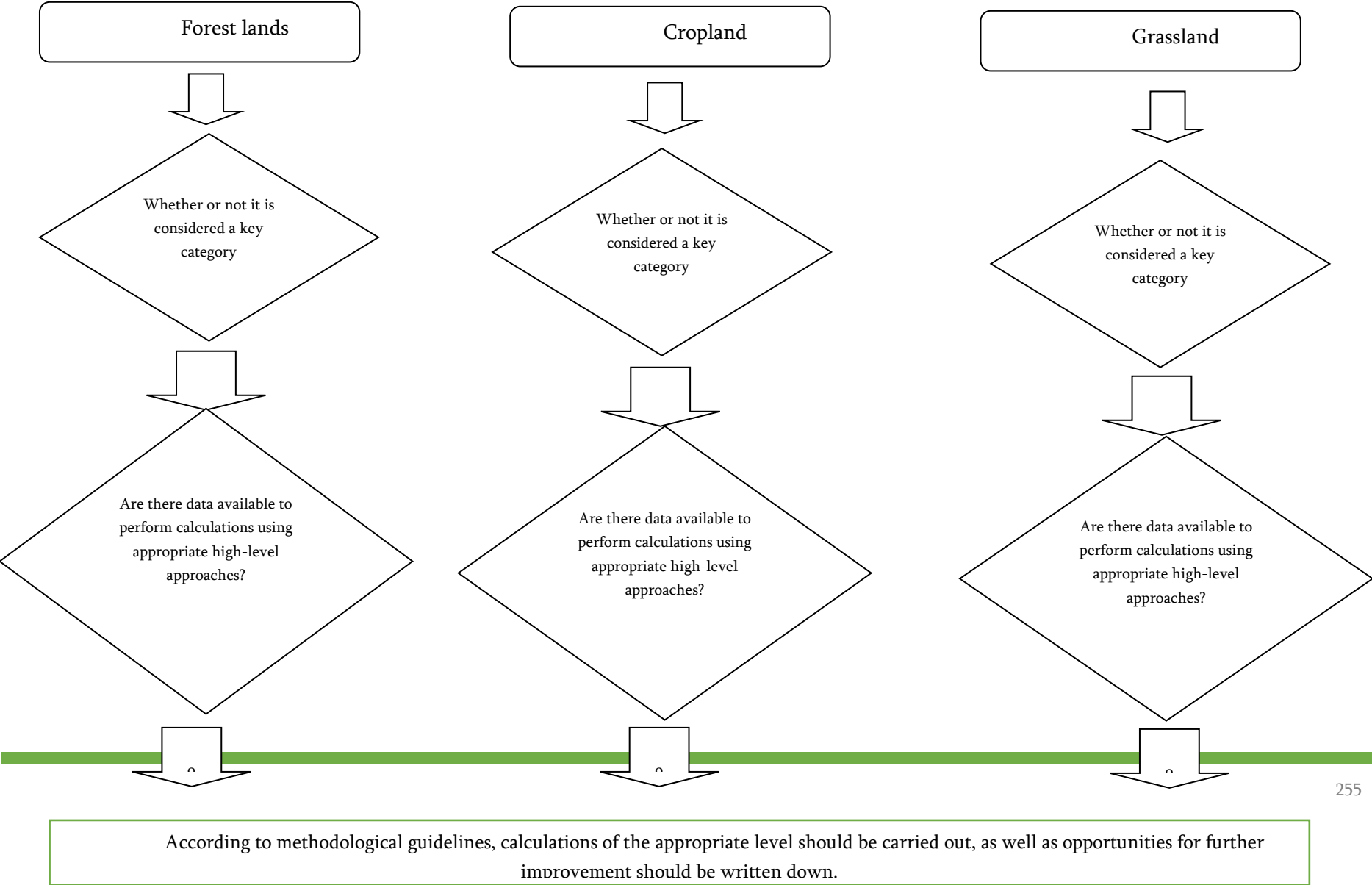


Figure V-2. Calculation of the percentage distribution of firewood and roundwood, conifers and deciduous trees in forest clearings

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	2.1
2		Guria (443 ha of Pontus forest reserve)	85.4	82.1	
3		Imereti	280.2	269.0	
4		Racha-Lechkhumi and Lower Svaneti (protected)	267.9	254.5	
5	Eastern Georgia	Shida Kartli (protected)	101.1	90.9	1.7
6		Mtskheta-Mtianeti (12,510 ha of forested area transferred to the Agency for Protected Areas)	181.9	169.2	
7		Kakheti	283.6	263.7	
8		Kvemo Kartli (natural monuments)	145.1	132.0	
9		Samtskhe-Javakheti (Borjomi-Kharag National Park)	122.2	117.3	

Figure V-4. Calculation of the weighted average BCEFI coefficient.

	Main forest-forming species	Timber stock, m ³ /ha	Average annual m ³ of wood increment (net annual increment) converted into average annual aboveground biomass increment (BCEFI _i)
1	Beech (<i>Fagus orientalis</i>)	300.10	0.48
2	Hornbeam (<i>Carpinus caucasica</i>)	185.90	0.60
3	Oriental spruce (<i>Picea orientalis</i>)	346.40	0.60
4	Caucasian Fir (<i>Abies nordmanniana</i>)	517.20	0.60
5	Chestnut (<i>Castanea satina</i>)	219.80	0.48
6	Alder (<i>Alnus barbata</i>)	136.20	0.60
7	Oak (<i>Quercus iberica</i>)	147.80	0.60
8	Caucasian Pine (<i>Pinus hamata</i>)	271.80	0.69

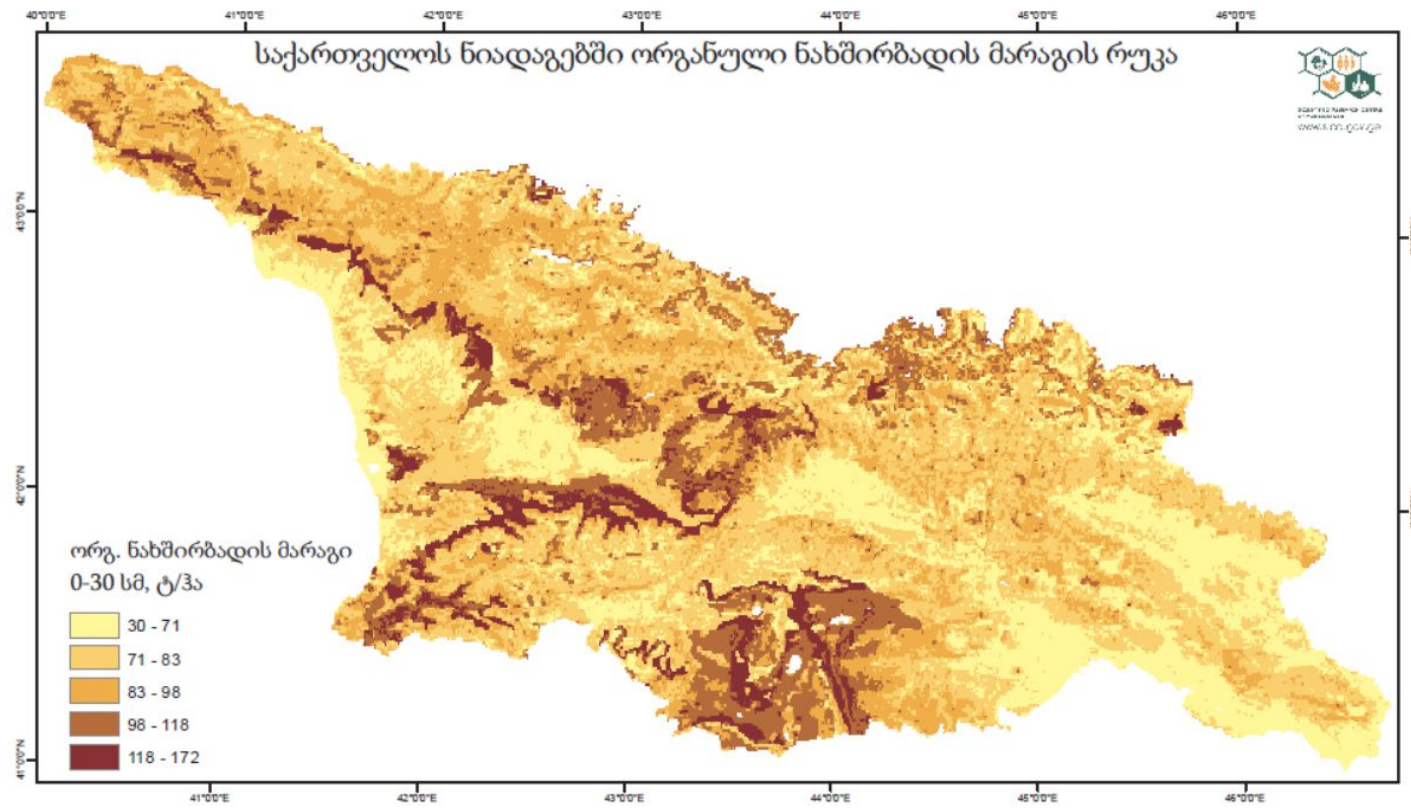
Figure V-5. Calculation of the weighted average BCEFR ratio

	Main forest-forming species	Timber stock, m ³ /ha	Biomass conversion factor (BCEFR _R) of the volume of woody biomass produced (m ³)
1	Beech (<i>Fagus orientalis</i>)	300.10	0.89
2	Hornbeam (<i>Carpinus caucasica</i>)	185.90	1.17
3	Oriental spruce (<i>Picea orientalis</i>)	346.40	0.77
4	Caucasian Fir (<i>Abies nordmanniana</i>)	517.20	0.77
5	Chestnut (<i>Castanea satina</i>)	219.80	0.89
6	Alder (<i>Alnus barbata</i>)	136.20	1.17
7	Oak (<i>Quercus iberica</i>)	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 (<i>Fagus orientalis</i>)	300.10	0.58	174.06	0.24
2	Hornbeam (<i>Carpinus caucasica</i>)	185.90	0.74	137.57	0.23
3	Oriental spruce (<i>Picea orientalis</i>)	346.40	0.44	152.42	0.20
4	Caucasian Fir (<i>Abies nordmanniana</i>)	517.20	0.41	212.05	0.20
5	Chestnut (<i>Castanea satina</i>)	219.80	0.54	118.69	0.23
6	Alder (<i>Alnus barbata</i>)	136.20	0.40	54.48	0.46
7	Oak (<i>Quercus iberica</i>)	147.80	0.66	97.55	0.30
8	Caucasian Pine (<i>Pinus hamata</i>)	271.80	0.42	114.16	0.29
9	Caucasian Lime (<i>Tilia begonifolia</i>)	236.70	0.47	111.25	0.23
10	oriental hornbeam (<i>carpinus orientalis</i>)	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	81.2	0.1	81.1
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			
Western Georgia				
Adjara	4.8	81.1	15.0	77.8
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			
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.