GEORGIA'S LONG-TERM LOW EMISSION DEVELOPMENT STRATEGY

2023

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ACRONYMS AND ABBREVIATIONS

AA	EU-Georgia Association Agreement
ADB	Asian Development Bank
AFOLU	Agriculture, Forestry and Other Land Use
A/R	Afforestation and Reforestation
BDW	Biodegradable Waste
BOD	Biological Oxygen Demand
BP	British Petroleum
BUR	Biennial Update Report (to the UNFCCC)
CS/CAP	Climate Change Strategy/Climate Change Action Plan
CSAP	Climate Change Strategy and Action Plan
CC	Climate Change
CCC	Climate Change Council of Georgia
CENN	Caucasus Environmental NGO Network
CFS	Climate Finance Strategy
CHP	Combine Heat and Power
CIF	Climate Investment Fund
CIS	Commonwealth of Independent States
CNF	Caucasus Nature Fund
CO2	Carbon Dioxide
CoM	Covenant of Mayors
COP	Conference of the Parties (UNFCCC)
D&CWW	Domestic and Commercial Waster Water
DHW	Domestic Hot Water
DSO	Distribution System Operators
EBRD	European Bank for Reconstruction and Development
EC	Energy Community
ECAC	European Civil Aviation Conference
EC LEDS	Enhancing Capacity for Low-Emission Development Strategy
EE	Energy Efficiency
EIEC	Environmental Information and Education Center
EPBD	Energy Performance of Buildings Directive

EPS	Expanded Polystyrene
ER	Emission Reduction
EU	European Union
EXPS	Extruded Polystyrene
F-Gases	Fluorinated Gases
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
FM	Forest Management
FOD	First Order Decay
GCAA	Georgian Civil Aviation Agency
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GEF	Global Environment Facility
GFA	Gross Floor Area
Gg	Gigagram
GHG	Greenhouse Gas Emissions
GHGI	Greenhouse Gas Inventory
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit/German Agency for International Cooperation
GNERC	Georgia National Energy and Water Supply Regulatory Commission
GoG	Government of Georgia
GOGC	Georgian Oil and Gas Corporation
GR	Georgian Railway
GSE	Georgian State Electrosystem
HFCs	Hydrofluorocarbons
HPP	Hydro Power Plant
HVAC	Heating, Ventilation and Air conditioning
ICAO	International Civil Aviation Organization
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPCC GLs	IPCC Guidelines
IPPU	Industrial Processes and Product Use

IWW	Industrial Waste Water
JCIA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
KhW	Kilowatt-hour
Ktoe	Thousand Tons of Oil Equivalent
LEDS	Low Emission Development Strategy
LTA	Land Transport Agency
LT LEDS	Long-Term Low Emission Development Strategy (UNFCCC)
LTS	Long-Term Strategy (Energy Community)
LULUCF	Land Use, Land Use Change and Forestry
MCF	Methane Correction Factors
MCC	Millennium Challenge Corporation
MESD/ MoESD	Ministry of Economy and Sustainable Development of Georgia
MEPA / MoEPA	Ministry of Environmental Protection and Agriculture of Georgia
MoF	Ministry of Finance of Georgia
MRDI	Ministry of Regional Development and Infrastructure of Georgia
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
MTI	Maritime Transport Agency
MWh	Megawatt Hours
N	Nitrogen
NBG	National Bank of Georgia
NC	National Communication to the UNFCCC
NCEP	National Energy and Climate Plan
NCP	National Climate Platform
NCW	National Consultation Workshop
NDC	Nationally Determined Contribution
NEA	LEPL National Environment Agency
NEEAP	National Energy Efficiency Action Plan
NGO	Non-governmental Organization
NIR	National Inventory Report
N2O	Nitrous Oxide
NREAP	National Renewable Energy Action Plan

NSMGP	North-South Main Gas Pipeline
ODS	Ozone Depleting Substances
PA	Paris Agreement
PAM (P&M)	Policies and Measures
PFCs	Perfluorocarbons
PJ	Petajoule (energy unit)
PU	Product Use
PV	Photovoltaic
QA	Quality Assurance
QC	Quality Control
RE	Renewable Energy
RECC	Regional Environmental Centre for the Caucasus
SCADA	Supervisory Control and Data Acquisition
SCCF	Special Climate Change Fund
SDGs	Sustainable Development Goals
SE(C)AP	Sustainable Energy (and Climate) Action Plan
SF6	Sulphur Hexafluoride
SME	Small and Medium-sized Enterprises
STEM	Science, Technology, Engineering and Math
SWDL	Solid Waste Disposal on Land
SWMC	Solid Waste Management Company
TT	Technology Transfer
TPPs	Thermal Power Plants
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
WAM (or WaM)	With Additional Measures (scenario)
WEM (or WeM)	With Existing Measures (scenario)
WOM (or WoM)	Without Measures (or Baseline) (scenario)
WW	Waste Water
WMSAP	Waste Management Strategy and Action Plan

PREAMBLE

The Long-Term Low Emission Development Strategy (hereafter the LT LEDS or LTS)[1] is developed by the Government of Georgia as a framework document for Georgia's long-term vision of low emission development in accordance with the provision of the Paris Agreement. In December 2015, the Paris Agreement marked a milestone in the global process and started a new era for the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) to tackle climate change according to their commitments reflected in corresponding Nationally Determined Contributions (NDCs). The Paris Agreement also asks Parties to develop long-term low emission development strategies with a mid-century view. Alongside the obligations of the Convention and the Paris Agreement, the development of a long-term low emission development strategy is required by the EU-Georgia Association Agreement (EU-Georgia AA) and fulfills the obligation taken by the country as a result of joining the Energy Community.

INTRODUCTION

This LT LEDS defines a range of estimated national greenhouse gas (GHG) emissions and removals and sets a vision for 2050 based on the projections of GHG emissions and removals from the GHG emitter and sink sectors aggregated into the total national emissions. This vision is considered a GHG reduction goal by mid-century. It may become a subject of further review and update as suggested by changing international circumstances, commitments and opportunities. Georgia's LT LEDS aims to shape and formulate the vision and principles for the low-emission development of the country by 2050. The LT LEDS is fully compliant with the United Nations Framework Convention on Climate Change together with its Paris Agreement, the EU-Georgia Association Agreement, the Energy Community, the UN 2030 Agenda (Sustainable Development Goals) and other commitments (see Annex 2. Connection of the LT LED to other policy and legal documents).

The Strategy derives from Georgia's international obligations. Georgia has been a Party to the United Nations Framework Convention on Climate Change (UNFCCC) since 1994 and has fulfilled its commitments under the Convention. So far, Georgia has submitted four National Communications, six National GHG Inventories and two Biennial Update Reports (BUR) and has prepared six expert reviewers for the UNFCCC's periodic review processes for its various reporting requirements. In 2015, Georgia signed the Paris Agreement and submitted its Intended Nationally Determined Contribution (INDC). In 2021, Georgia submitted an updated Nationally Determined Contribution (NDC) and developed its *Climate Change Strategy* for 2030 and *Action Plan for 2021- 2023 (CSAP)*[2] along with the detailed target indicators and measures for seven sectors of the economy.

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1 The United Nations Framework Convention on Climate Change gives preference to the "LT LEDS" abbreviation while the glossary of the Energy Community Union typically uses "LTS." Both abbreviations refer to one and the same document.

2 Resolution of the Government of Georgia No. 167 dated April 8, 2021 on the Approval of the Updated Nationally Determined Contributions (NDC), 2030 Climate Strategy and the 2021-2023 Action Plan. https://matsne.gov.ge/ka/document/view/5147380?publication=0

This LT LEDS has been drafted by the Government of Georgia as a framework document for the long-term vision of low-emission development of Georgia in accordance with the Paris Agreement.

The Paris Agreement, adopted at COP21 in December 2015, stipulates its objective to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels and for this purpose achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases (worldwide carbon neutrality) in the second half of this century.

With respect to the Paris Agreement Georgia has formulated its long-term vision and reflected it in the LT LEDS that will serve as a framework for combating climate change. The Strategy is followed by the ten-year low-emission development strategies (LEDS) which will be elaborated along with updating the NDC and developing its corresponding short-term action plans. The LT LEDS will also serve as a framework for the sectorial policy planning documents prepared in a parallel process and linked to climate change.

The document also addresses the SDGs and the conditions for a green and fair energy transition. Georgia intends to go "green" by 2050 by switching to energy-efficient technologies and renewables. Technological transformation and modernization are key to economic development and decarbonization through increasing efficiency, minimizing losses and utilizing low-emission technologies. Georgia plans to combine low-emission development and economic growth by introducing innovations that will reduce GHG emissions at the same time. Georgia aims to achieve the goal of climate neutrality by 2050 - through a rapid and fundamental technological transformation.

The elaboration of the document is also envisaged by the Regulation on the Governance of the Energy Union and Climate Action (the Governance Regulation)[3] which is a part of Annex I of the Treaty Establishing the Energy Community. With its decision on November 2021, the EU Council of Ministers approved the Clean Energy Package, including the Governance Regulation. It is a binding legal document for all member states of the Energy Community, including Georgia. It sets specific legal requirements for submitting an LT LEDS document and several other key obligations.

It should be noted that Georgia, as a contracting party to the Treaty Establishing the Energy Community, is now harmonizing and enforcing the EU legislation (Acquis Communautaire) in accordance with the Energy Community Treaty and the Protocol of the Accession of Georgia to the Energy Community Treaty. As a result of the consultations with the Energy Community, the European Commission and the Government of Georgia, there was a new GHG reduction target set for Georgia by 2030 which envisages the reduction of greenhouse gases by 47% as compared to the level of 1990 (including land use, land use change and the forestry sector [LULUCF]). By the decision of the Council of Ministers of the Energy Community, dated December 15, 2022, this target was integrated into the Governance Regulation. This updated commitment will be reflected by Georgia in the updated NDC in 2025. Additionally, the Recommendation of the Energy Community on the Preparation for the Development

3 Regulation (EU) 2018/1999 of the European Parliament and of the Council of December 11, 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council, Decision 2021/13/MC-EnC passed by the Council of Ministers on November 30, 2021.

of Integrated National Energy and Climate Plans by the Contracting Parties of the Energy Community and the General Policy Guidelines on the 2030 Targets for the Contracting Parties of the Energy Community were represented as the only recommendatory and non-binding framework concerning the development of NECP and LTS before adopting the Governance Regulation mentioned above.

The preparation of the document at the national level is based on several normative acts, including the Law of Georgia on Energy and Water Supply. In particular, Sub-paragraph A of Paragraph 2 of Article 7 of the Law of Georgia on Energy and Water Supply stipulates that the state shall elaborate a strategy for a long-term period. Noteworthy here are the Resolution of the Parliament of Georgia on the Main Directions of the State Policy in the Energy Sector of Georgia, the Law of Georgia on Promoting the Generation and Consumption of Energy from Renewable Sources, the Law of Georgia on Energy Efficiency, the Law of Georgia on Energy Labelling and the Law of Georgia on Energy Efficiency of Buildings.

The Paris Agreement requires each party to "prepare, communicate and maintain successive nationally determined contributions that it intends to achieve (UNFCCC Paris Agreement, Article 4, Paragraph 2). The NDC is an obligation after 2020 which reflects climate-related commitments for reducing GHG emissions at the national level, among them reducing or limiting the emissions from the economy and implementing mitigation measures to this end. The NDC is a document that reflects the country's targeted climate index for every five years which the country presents to the international community based on which the UNFCCC conducts a global stocktaking every five years.

The LT LEDS was developed in accordance with Resolution No. 629 of December 20, 2019 of the Government of Georgia on the Approval of the Rules for the Development, Monitoring and Evaluation of Policy Documents.

The elaboration of LT LEDS began in September 2020. The document has been prepared in close coordination with the parallel preparation processes of other relevant policy documents. The methodology and approach for the document were elaborated and presented at the Inception Workshop and followed by the Inception Report. Furthermore, data collection and policy analysis have been conducted for each sector and proper drivers have been selected which were used to elaborate Baseline Scenarios (pessimistic and optimistic). Based on the existing policy documents, including the CS2030/CAP 2021-2023, mitigation measures have been identified for both WEM and WAM packages. Finally, six scenarios (pessimistic and optimistic WOM, WEM, and WAM) have been elaborated which show the tentative range of GHG emissions up to 2050. The results of the scenarios have been presented to wider stakeholders at the National Consultation Workshop for their comments and suggestions. The aforementioned methodology and the detailed analysis of the scenarios in the sectors can be found in Appendix 1.

By analyzing the projected emission trends for each scenario, the possibility of climate neutrality has been additionally discussed and the areas for additional mitigation potential have been identified. Further, additional calculations revealed the conditions (extent of additional efforts) sufficient for achieving climate neutrality by 2050 (See Annex 4.).

A large group of stakeholders was involved in drafting the Strategy, including representatives from public, sectoral, scientific and civil organizations and experts from the sectors relevant to the Strategy theme. As part of this engagement, various events were held such as interviews, consultations, a national consultation meeting, discussions with stakeholders and comments were solicited vis-à-vis the LT LEDS.

As for the annexes:

- Annex 1 describes the LEDS drafting methodology and projections - it provides the models applied, their description, assumptions and parameters, and national GHG emission projections by 2050;
- Annex 2 explains the Strategy's linkage to other policy and legislative documents;
- Annex 3 describes energy efficiency measures;
- Annex 4 presents the potential measures of the LT LEDS with scheduled and additional actions;
- Annex 5 is attached as a separate document to the LT LEDS and includes the summary report of public consultations.

1 SITUATION ANALYSIS

The analysis of the current situation entailing the need for the elaboration of a long-term low emission development strategy is based on the overview of the climate change impacts in the country; among them, the GHG emissions trend, the analysis of GHG emissions in individual sectors and the discussion of emission sources in these sectors. Each sector-specific section of this section contains detailed information about the sector, including its description, the current situation and historical GHG emissions.

According to the Special Report on Global Warming of 1.5°C, adopted by the IPCC Session in October 2018, climate-related risks to health, livelihoods, food security, water supply, human security and economic growth are projected to increase with global warming of 1.5°C and a further increase to 2°C. In limiting global warming to 1.5°C, anthropogenic CO_2 emissions are expected to reach net zero around 2050. Furthermore, it is suggested that emission pathways limiting global warming to 1.5°C would require rapid and far-reaching transitions in energy, land use, urban, infrastructure, and industrial systems. These transitions are said to be unprecedented in terms of scale but not necessarily in terms of speed. The international community considers the findings of the IPCC Special Report on Global Warming of 1.5°C and shares the necessity of strengthening international responses to the threat of climate change. The urgent need for action was reemphasized in the 6th IPCC Assessment Report published in 2021.[4]

1.1 Overview of CC Impacts in Georgia

Climate change impacts are becoming more and more tangible in Georgia, increasing the current risks for all systems: economic, environmental and human.

According to the study conducted by the EU and the United Nations Development Program (UNDP) in 2020, more than 91% of Georgia's population believes that climate change is a real process that poses a danger to life on Earth. Among the adverse impacts of climate change, people are most concerned about global warming and its impacts such as drought (96.11%), natural disasters (92.84%), melting of glaciers and ice layers in the oceans (91.83%).

According to Georgia's latest (4th) National Communication to the UNFCCC (2021),[5] climate change processes have significantly intensified in the country with a wide range of adverse impacts. Some climate parameters demonstrate significant changes between two 30-year periods of observation (1956-1985 and 1986-2015).

Climate change and its harmful impact on ecosystems and the economy pose a serious threat to the sustainable development of Georgia. Due to its geographical location, complex terrain and diversity of climatic zones, the country is characterized by a wide range of harmful effects of climate change: a) rising level of the Black Sea and subsequent damage to the coastline, b) increased frequency and

4 Sixth Assessment Report. IPCC. https://www.ipcc.ch/assessment-report/ar6/

5 Georgia's 4th National Communication to the UNFCCC, 2021. https://www.ge.undp.org/content/georgia/ka/home/library/environment_energy/unfccc-fourth-national-communication.html

intensity of floods, flashfloods, landslides and mudflows; c) increased droughts, accelerating the process of desertification of semi-deserts in east Georgia; d) more intense and frequent heatwaves which affect human health and the economy and increase pressure on the energy system, e) rising temperatures, extreme temperatures, changes in precipitation regimes, the reduction of water resources, infections and diseases, forest fires that reduce forest cover and its productivity and the melting of glaciers which contributes to heavy flashfloods and results in the loss of water resources and f) shifting of seasons, soil erosion, frequent extreme weather events and reduced access to water which seriously reduces agricultural productivity. Due to climate change, the risks of environmental impacts on human health are increasing as well as diseases tending to spread over a larger geographical area. Three main peculiar events of climate change affect human health in Georgia in particular: heat waves, natural disasters and a changed infectious background. Most likely, the impact will become broader and more intense in the future in the wake of global warming which will place an additional burden on the well-being of society.

AVERAGE TEMPERATURE

During 1986-2015, the average annual air temperature increased throughout almost the entire country by 0.25–0.58°C. The average increase calculated on the regional level is 0.47°C as compared to the 1956-1985 period.

PRECIPITATION

Between 1986 and 2015, the annual precipitation increased in the western part of the country as compared to 1956-1985 and decreased in some eastern regions. The upward trends in the average annual precipitation were observed in almost all locations in western Georgia with the most dramatic increase of 60-75 mm/10-yr and the largest difference of up to 15% between the two 30-year periods. The growth trend apparently results from the increased incidence of heavy rainfalls. In contrast to western Georgia, precipitation has reduced by 15% in most parts of eastern Georgia over the last 30 years, most likely resulting from increased dry periods without rainfall.

HUMIDITY

The relative humidity has increased throughout the country with changes ranging between -1% and 5%. Increased humidity is most pronounced in the winter months in western Georgia which seems to be due to an increase in extremely humid days (10-12 days per year) while the decreasing trends are observed to be most intensive in summer and early autumn.

WIND SPEED

The average wind speed decreases throughout almost the entire country in all seasons by 1-2 m/sec in the second period as compared to the first period. The number of high wind days (≥ 15 m/s) has decreased in the western and increased in the eastern regions of Georgia, especially in the Mtkvari/Kura River Gorge where the number of high wind days has increased significantly. The frequency of extremely high wind days (≥ 25 m/s) has significantly decreased in some regions while steadily increasing in others.

1.2 Overview of the Current Situation in GHG Emissions

Climate change and its negative consequences are related to the fact that GHG emissions are gradually increasing in Georgia which is reflected in national GHG inventories periodically prepared and submitted to the UNFCCC. The increase in emissions since 1995 is evident practically from all sectors. Thus, according to the latest National GHGI (2019), the total GHG emissions excluding LULUCF have increased from 12,696 (1995) to 17,766 Gg CO2e (2017). Factors contributing to the growing trend of GHG emissions include not only **economic growth** but also **inefficient and outdated technologies, energy loss, insignificant (small-scale) mitigation measures, etc**. This may threaten the commitment taken by Georgia under the PA which envisages the GHG emission reduction with respect to the base year (1990) by 35% unconditionally and by 50-57% in the case of international support in the current decade (2020-2030).

Table 1.2.1. gives national and sectoral GHG emissions between 1990-2017. Two versions are considered: GHG emissions excluding and including land use, land use change and the forestry (LULUCF) sector. Since the 1990s, GHG emissions from all sectors, excluding the waste sector, have significantly reduced as compared to 1990 levels. In 2017, GHG emissions from the energy sector constituted about 28% of the 1990 level, about 50% from the IPPU sector and about 66% from the agricultural sector. Removal of GHG emissions also reduced by 22% in 2017 as compared to the 1990 level.

TABLE 1.2.1 National GHG Emissions in 1990-2017s

Sector	Energy	IPPU	Agriculture	Waste	LULUCF	Total (excluding LULUCF)	Total (including LULUCF)
1990	36,698	3,879	4,101	1,135	-6,353	45,813	39,460
1995	8,319	447	2,805	1,125	-6,273	12,696	6,423
2000	5,612	725	3,317	1,269	-5,031	10,923	5,892
2005	5,396	957	3,461	1,354	-4,163	11,168	7,006
2010	7,707	1,443	3,055	1,483	-4,537	13,688	9,151
2011	9,743	1,794	2,981	1,509	-4,864	16,027	11,163
2012	10,294	1,872	3,223	1,538	-4,750	16,927	12,178
2013	8,949	1,892	3,582	1,542	-4,834	15,964	11,130
2014	9,642	2,035	3,633	1,551	-4,609	16,861	12,252
2015	10,849	2,058	3,745	1,562	-4,617	18,214	13,597
2016	11,355	1,822	3,798	1,559	-4,797	18,534	13,738
2017	10,726	1,990	3,488	1,562	-4,924	17,766	12,842

Table 1.2.2. gives the share of sectoral GHG emissions in national emissions from 1990-2017. According to this table, the dominant sector is the energy sector. Its share constituted about 90% in 1990. Last year's share of this sector varies from 60-65%.

TABLE 1.2.2 Share of Sectoral GHG Emissions in National Emissions in 1990-2017

Sector	Energy	IPPU	Agriculture	Waste	LULUCF	Total (excluding LULUCF)	Total (including LULUCF
1990	80.1%	8.5%	9.0%	2.5%	-13.9%	100%	86.1%
1995	65.6%	3.5%	22.1%	8.9%	-49.4%	100%	50.6%
2000	51.4%	6.6%	30.4%	11.6%	-46.1%	100%	53.9%
2005	48.4%	8.4%	31.0%	12.1%	-37.3%	100%	62.7%
2010	56.5%	10.3%	22.4%	10.9%	-33.2%	100%	66.8%
2011	61.0%	10.9%	18.7%	9.4%	-30.4%	100%	69.6%
2012	60.9%	10.9%	19.1%	9.1%	-28.1%	100%	71.9%
2013	56.2%	11.6%	22.5%	9.7%	-30.4%	100%	69.6%
2014	58.9%	12.6%	18.6%	9.9%	-29.3%	100%	70.7%
2015	61.7%	11.7%	17.5%	9.1%	-27.0%	100%	73.0%
2016	64.5%	10.2%	16.2%	9.1%	-28.1%	100%	71.9%
2017	62.4%	11.6%	16.4%	9.5%	-30.1%	100%	69.9%

A separate problem is the **barriers to accessing, mobilizing and increasing financial capital** which prevent the implementation of climate-friendly actions and measures. The barriers hinder the process of green investment. These barriers are influenced by the country's level of development, economic conditions, capital market development and other national and country-specific circumstances. Barriers to mobilizing climate-related financial resources in Georgia are presented in Table 1.2.3.

TABLE 1.2.3 General Barriers to the Access to and Mobilization of Climate Finances in Georgia

Barrier	Short Description
Limited resources	Due to the risks associated with climate-friendly activities, they require high-risk capital. Early-stage investments (such as venture capital) are very important because they provide the bridge between the research and development of technology and scaling up.
Perceptions of high risks	Risks that apply to climate-friendly investments are often perceived by investors in vastly different ways. This results in a wide variation in pricing and capital availability.
Lack of transparent data	A lack of consistent, transparent and available data that report the technical performance, energy production and environmental impact of climate projects limits the ability of potential investors to evaluate the past performance of similar projects. This often results in higher risk premiums.
Policy uncertainty	Further dissuading long-term investment in climate-friendly activities is the uncertainty associated with policies around climate change.
Short-term investments	Many investment decisions are focused on near-term risks and returns.

Deal size preferences	Usually, large financial donor institutions deal with large-scale projects. Consequently, small implementing entities find it difficult to raise financial capital for climate-friendly projects such as solar photovoltaic panels, electric vehicles, efficient buildings, energy-saving household appliances and measures for improving energy efficiency (for detailed information, please see Annex 3. Energy efficiency measures), etc.
Timing of Climate Risk Impacts	Many professionals making investment decisions do not view climate change as a significant short-term risk that requires the adjustment of investment and credit considerations.

SOURCE: Climate Finance Strategy 2018-2023, Hewlett Foundation

1.3 Energy Consumption

Table 1.3.1. provides GHG emissions from energy sectors (fuel combustion), estimated applying energy balances of Georgia (2013-2019).[6]

TABLE 1.3.1 GHG Emissions in Gg CO2-eq from Energy Sectors (Fuel Combustion)

Year	Sub-sector						Total
	Energy Industries	Industry	Transport	Commercial/ Institutional	Residential	Agriculture	
2013	1,019	1,515	2,908	267	1,167	32	6,907
2014	1,128	1,419	3,489	462	1,265	25	7,789
2015	1,320	1,400	3,875	408	1,466	38	8,507
2016	1,119	1,308	4,345	412	1,642	68	8,895
2017	1,113	1,450	3,918	417	1,818	68	8,783
2018	1,040	1,496	4,035	405	1,772	54	8,801
2019	1,459	1,577	3,901	459	2,008	52	9,456

According to Table 1.3.2. the transport sector's share exceeds 40% and the share of the agriculture sector is insignificant.

6 Georgia's Energy Balance (2013-2019).

TABLE 1.3.2 Share of Sub-sectors in Energy Sector Emissions

Year	ქვესექტორი					
	Energy Industries	Industry	Transport	Commercial	Residential	Agriculture
2013	14.8%	21.9%	42.1%	3.9%	16.9%	0.5%
2014	14.5%	18.2%	44.8%	5.9%	16.2%	0.3%
2015	15.5%	16.5%	45.6%	4.8%	17.2%	0.4%
2016	12.6%	14.7%	48.9%	4.6%	18.5%	0.8%
2017	12.7%	16.5%	44.6%	4.8%	20.7%	0.8%
2018	11.8%	17.0%	45.8%	4.6%	20.1%	0.6%
2019	15.4%	16.7%	41.3%	4.9%	21.2%	0.6%

The GHG emissions by sub-sectors are shown in Figure 1.3.1 and the contribution of fossil fuels to energy sector emissions is shown in Figure 1.3.2.

FIGURE 1.3.1 GHG Emissions by Sub-sectors in 2013-2019

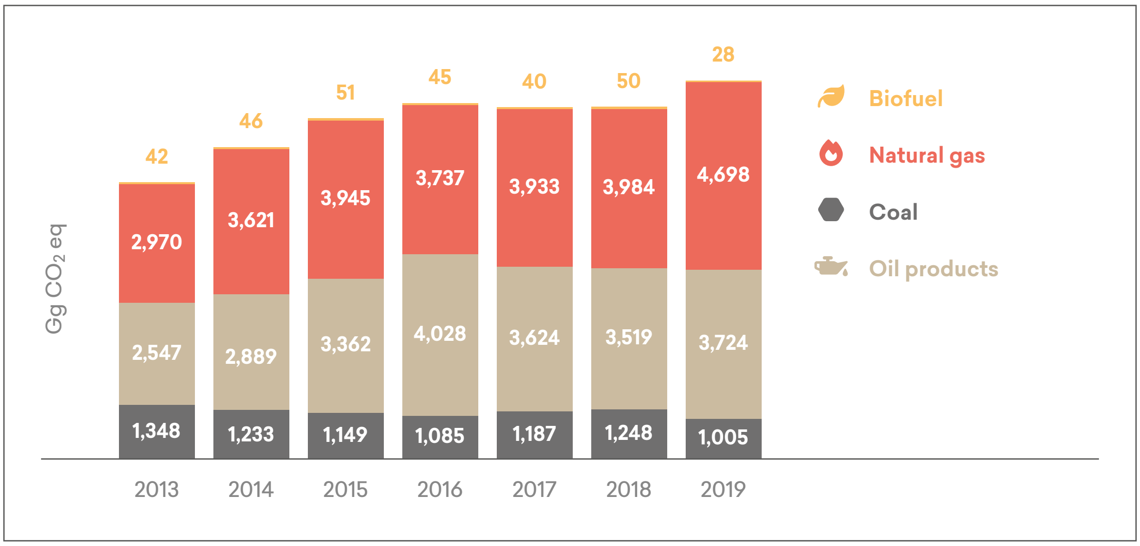
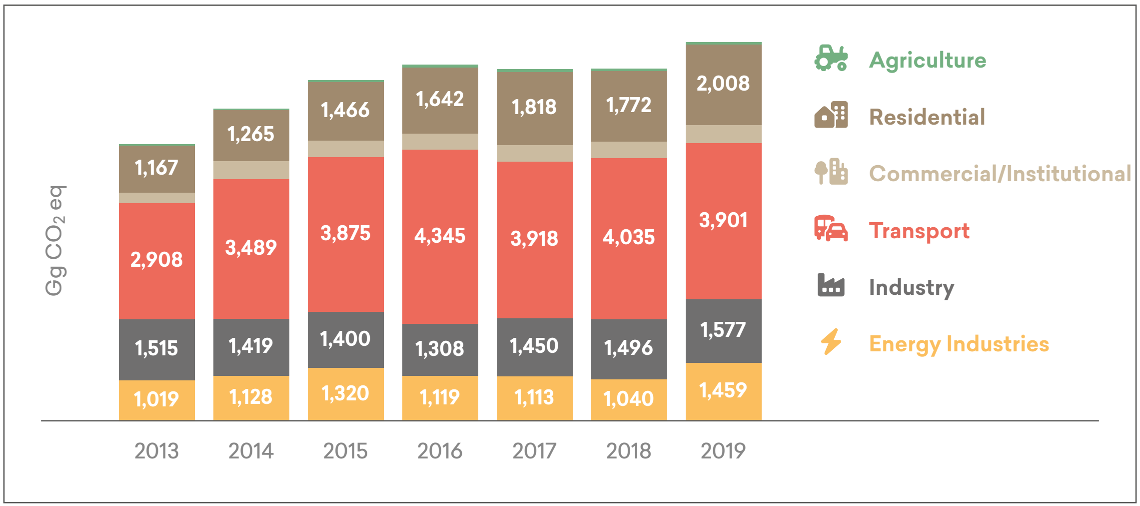


FIGURE 1.3.2 GHG Emissions by Fuel Type in 2013-2019



The contribution of natural gas and oil products in energy sector emissions are comparable, the share of coal decreased between 2013 and 2019 and the share of biomass remained insignificant (Table 1.3.3.)

TABLE 1.3.3 Share of Fossil Fuels in GHG Emissions

Year	Fuel				Total
	Coal	Natural gas	Oil products	Biomass	
2013	19.5%	43.0%	36.9%	0.6%	100%
2014	15.8%	46.5%	37.1%	0.6%	100%
2015	13.5%	46.4%	39.5%	0.6%	100%
2016	12.2%	42.0%	45.3%	0.5%	100%
2017	13.5%	44.8%	41.3%	0.5%	100%
2018	14.2%	45.3%	40.0%	0.6%	100%
2019	10.6%	49.7%	39.4%	0.3%	100%

In recent years, the energy consumption of Georgia has permanently increased. The main energy consumers are buildings (residential and commercial sectors), transport and industry.

TABLE 1.3.4 Energy Consumption (in TJ) by Sectors in 2013-2019

Year	Sub-sector					Other	Non-energy use	Total
	Industry	Transport	Commercial/Institutional	Residential	Agriculture			
2013	30,777	46,780	14,700	48,537	576	5,779	9,286	**147,149**
2014	31,661	52,554	17,944	49,501	506	5,899	9,378	**167,443**
2015	32,592	57,497	16,868	50,276	783	6,470	10,054	**164,486**
2016	31,291	63,810	18,142	52,990	1,234	6,937	9,650	**184,054**
2017	35,044	57,886	18,965	55,948	1,294	7,207	10,189	**186,533**
2018	36,398	56,603	21,558	51,385	1,123	6,918	10,827	**184,812**
2019	34,446	58,785	22,422	54,456	1,120	7,416	13,614	**192,259**

TABLE 1.3.5 Consumption of Energy (in TJ) Generated from Sources

Year	Coal	Natural gas	Oil products	Geothermal	Biomass	Electricity	Total
2013	13,194	48,401	41,462	567	20,143	32,669	**156,435**
2014	12,159	55,989	43,973	623	19,470	35,228	**167,443**
2015	11,362	59,888	50,261	692	16,675	35,663	**174,540**
2016	10,469	58,890	59,982	769	16,192	37,752	**184,054**
2017	11,569	64,303	54,311	786	15,214	40,351	**186,532**
2018	12,308	64,330	53,064	799	11,336	42,974	**184,811**
2019	10,104	69,905	57,748	810	10,270	43,414	**192,249**

Natural gas and oil products consumed in Georgia are imported. In recent years coal imports have significantly increased due to decreased coal production (Table 1.3.6.). In the future, the use of coal for energy means will no longer be considered.

TABLE 1.3.6 Share of Imported Fossil Fuel in Energy Consumption

Year	Total			
	Coal	Crude oil	Oil products	Natural gas
2013	46.8%	0.0%	100.0%	99.7%
2014	58.2%	0.0%	100.0%	99.5%
2015	54.3%	0.0%	99.1%	99.5%
2016	53.9%	39.2%	100.0%	99.7%
2017	62.7%	64.0%	100.0%	99.6%
2018	81.5%	0.0%	100.0%	99.6%
2019	97.4%	6.7%	100.0%	99.6%

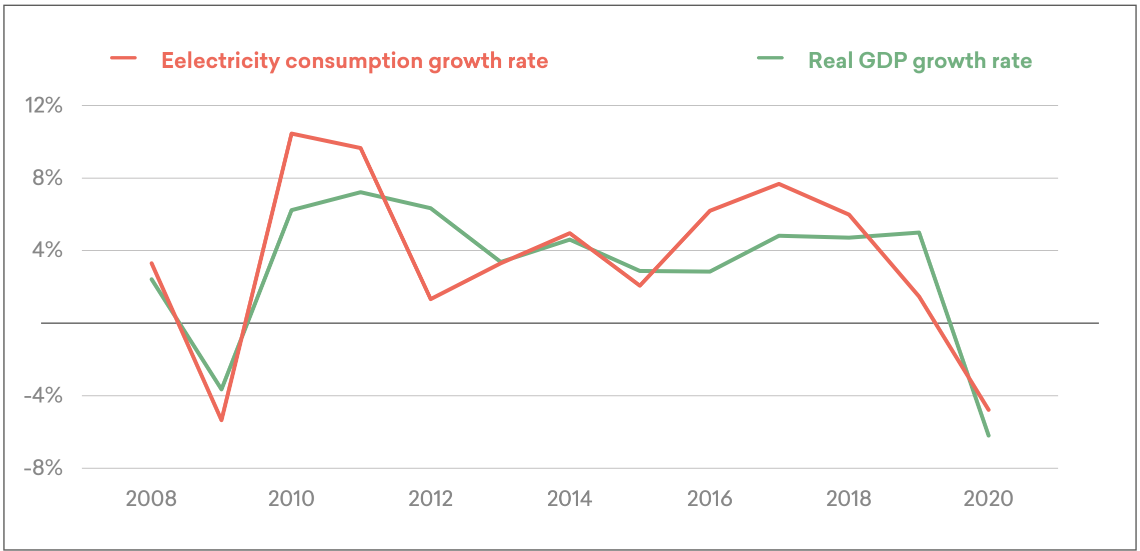
Between 2008-2020, electricity consumption has permanently increased except for two years: 2009 (after the 2008 Russian-Georgian war) and 2020 (due to the COVID-19 pandemic).

TABLE 1.3.7 Electricity Consumption in 2008-2020

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Million kWh	8,074	7,642	8,441	9,257	9,379	9,690	10,170	10,382	11,027	11,875	12,584	12,768	12,157

The nature of electricity consumption and the change in the GDP have been consistent for years. The year 2016 was an exception when the sharp increase in consumption led to a large-scale "cryptocurrency" production. Georgia's GDP grew on average by 3.8% between 2008-2018. Electricity consumption also increased by 4.2% on average between 2008-2018.

FIGURE 1.3.3 GDP and Electricity Growth Rates in 2008-2020



Electricity demand during the autumn-winter period cannot be met by the capacity of HPPs and TPPs which requires the import of electricity. From May to July, excess water resources allow electricity demand to be met and the export of residual electricity.

The power transmission and distribution network is one of the most important infrastructures in the country whose development ensures a safe, uninterrupted and reliable supply for consumers. The capacity of transboundary transmission lines in the Georgian electricity system allows for the import and export of electricity to and from neighboring countries.

One of the most important functions of transmission and distribution system operators is the loss of energy in the transmission and distribution networks and its reasonable reduction. From 2010–2018, losses in the transmission network were 1.74–2.21%. Losses in the network of the major distribution network operators (JSC Telasi and JSC Energo-Pro Georgia) generally tend to decrease.

ENERGY SUPPLY

In energy supply, natural gas is the dominant source (40-45%) followed by oil products (24-26%). The share of biofuel reduced from 11.5% in 2013 to 14.8% in 2019 due to the gasification of regions and the restriction of illegal logging.

TABLE 1.3.8 Energy Supply (in PJ) in 2013-2019

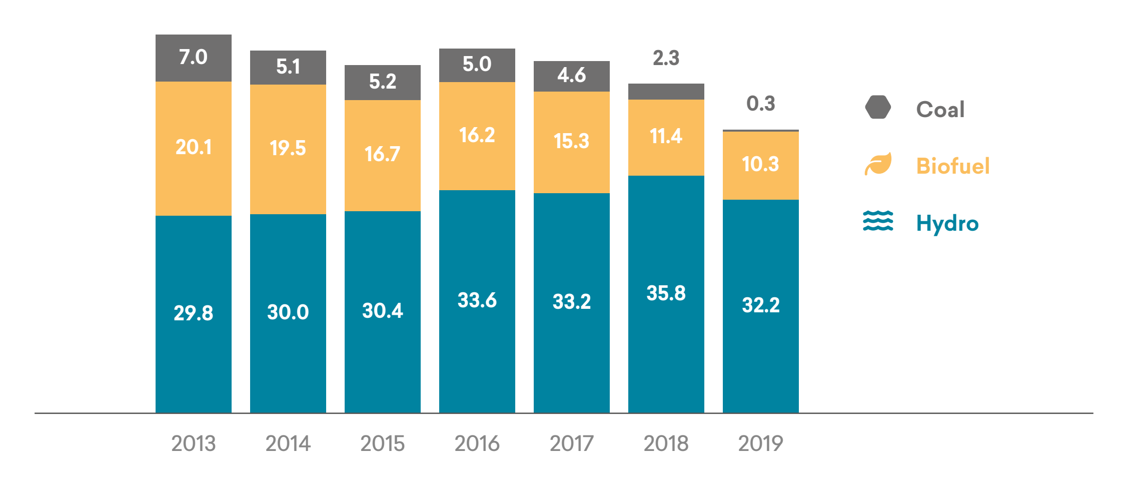
Source\Year	2013	2014	2015	2016	2017	2018	2019
Coal	13.2	12.2	11.4	11	12.2	12.7	10.1
Crude oil	0.00	0.00	0.6	3	3.8	1.0	1.6
Oil products	41.5	44.0	49.8	57	47.8	52.2	56.2
Natural gas	69.1	78.9	86.9	82	86.0	85.6	97.0
Hydro	29.8	30.0	30.4	34	33.2	35.8	32.2
Geothermal and solar	0.6	0.7	0.8	1	1.2	1.2	1.2
Biofuel	20.1	19.5	16.7	16	15.2	11.3	10.3
Electricity	0.1	0.9	0.1	0	2.9	3.3	5.0
Total	174.4	186.1	196.7	203.0	202.3	203.1	213.6

According to the energy balances of Georgia for 2013-2019, only part of the energy was supplied by domestic resources (Table 1.3.9.). Their share permanently decreased from year to year. In 2019, the energy supply from domestic resources constituted only about 21.6%. Consumption of firewood tends to decrease. The share of produced energy from coal, oil and natural gas constituted about 5% in 2019.

In energy supply, renewables are the dominant source. Their share varied from year to year within 84.5%-92.4% due to the construction of new HPPs. The share of hydro increased (but shows fluctuations due to the seasonal variation of water discharge).

Firewood consumption tends to decrease due to the gasification of households and businesses and the restriction of illegal logging.

FIGURE 1.3.4 Domestic Sources Contributing to Energy Supply, in PJ



Domestic energy production consists mainly of hydropower and bioenergy.

TABLE 1.3.9 Energy Supply by Domestic Sources (in PJ) and Their Share in Total Energy Supply in 2013-2019[7]

	Year	2013	2014	2015	2016	2017	2018	2019
Energy supply, PJ	PJ	174.4	186.1	196.7	203.0	202.3	203.1	213.6
Production from domestic resources	PJ	59.8	57.4	55.2	57.7	56.2	52.7	46.0
	Share	34.3%	30.9%	28.1%	28.4%	27.8%	25.9%	21.6%
Renewables	PJ	50.6	50.2	47.9	50.7	49.9	48.7	43.9
	Share	84.5%	87.4%	86.8%	88.0%	88.9%	92.4%	95.4%
Hydro	PJ	29.8	30.0	30.4	33.6	33.2	35.8	32.2
	Share	49.8%	52.2%	55.1%	58.3%	59.0%	68.0%	69.8%
Wind	PJ	-	-	-	0.03	0.3	0.3	0.3
	Share	-	-	-	0.1%	0.6%	0.6%	0.7%
Geothermal and solar	PJ	0.6	0.7	0.8	0.9	1.2	1.2	1.2
	Share	1.1%	1.2%	1.4%	1.5%	2.1%	2.2%	2.6%
Biofuel	PJ	20.1	19.5	16.7	16.2	15.3	11.4	10.3
	Share	33.7%	33.9%	30.3%	28.2%	27.2%	21.6%	22.3%
Fossil fuels	PJ	9.3	7.3	7.3	6.9	6.2	4.0	2.1
	Share	15.5%	12.6%	13.2%	12.0%	11.1%	7.6%	4.6%
Coal	PJ	7.0	5.1	5.2	5.0	4.6	2.3	0.3
	Share	11.8%	8.9%	9.4%	8.7%	8.1%	4.4%	0.6%

7 Georgia's Energy Balance (2013-2019).

Crude oil	PJ	2.0	1.8	1.7	1.6	1.4	1.3	1.5
	Share	3.4%	3.2%	3.1%	2.8%	2.4%	2.4%	3.2%
Natural gas	PJ	0.2	0.4	0.4	0.2	0.3	0.4	0.3
	Share	0.3%	0.6%	0.7%	0.4%	0.5%	0.7%	0.8%

ENERGY RESOURCES

Georgia is a rich country in renewable energy resources, especially **hydro**. The net hydroelectric resources capacity of main rivers constitutes approximately 140 billion kWh. The technically achievable potential is estimated to constitute 50–60 billion kWh through different estimations. Only about 20-22% of this potential is used in Georgia.

Georgia has an important **wind** energy potential, estimated to generate about 8-10 TWh of electricity annually. Some of the most suitable areas for constructing wind power stations with an annual generation potential of about 4 TWh have been identified.

There are areas on the territory of Georgia where it is expedient and economically favorable to use **solar** radiation as an energy source. Due to the country's geographical location, the emanation of solar radiation is relatively high. In most regions of the country, there are 250-280 sunny days per year which is approximately 6,000-6,780 hours per year. Solar energy potential varies from 1,250-1,800 kWh/m^2 depending on the region. The maximum radiation is in the high mountain zone in the central part of the Greater Caucasus.

The forecasted stocks of **geothermal** waters in Georgia equal 200-250 million m^3 annually. Geothermal water temperature ranges from 30 to 110^0 C. There are well bores with a water temperature of 85^0 C. The comparatively low temperature of geothermal waters does not allow for generating electricity. Despite this, the utilization of this resource for providing hot water to settlements is of paramount importance in terms of saving expensive energy sources to be imported as well as reducing greenhouse gas emissions.

Biomass potential – According to the research, entitled World Experience for Georgia, Biomass Potential,[8] one can conclude that the highest potential energy from biomass waste is coming from forestry. It amounts to 40 PJ or more than 11 Terawatt hours (TWh) which exceeds Georgia's current annual electric energy consumption. But this 40 PJ energy comes from different sources: 31.3 PJ is already accumulated wood energy value and 8.7 PJ is annual potential. It also must be mentioned that wood biomass, particularly sawdust, is more concentrated and commercially interesting than other types of agricultural biomass.

The maximum **oil** output of 3.2-3.3 million tons was observed in 1980-1983 in Georgia. Since that period, oil production has been dramatically decreasing and the annual production has varied between 30.2-47.9 thousand tons in recent years. On the one hand, this is because new fields are for some reason not being discovered and, on the other hand, the production rate at the already existing fields is reduced due to general developments. During the last 10-15 years, foreign oil companies started

8 Research – Assessment of Wood and Agricultural Residue Biomass Energy Potential in Georgia. Prepared by World Experience for Georgia - WEG.

operating in Georgia after concluding purchase and sale agreements with the government. Although these companies have already done significant exploration on their licensed territories, new fields have not yet been discovered despite promising geological examinations.

In 2019, Georgia exploited 9.6 million m³ of **natural gas** which is 6% less than in 2018. In 2019, gas consumption in Georgia amounted to 2.7 billion m³ with local extraction comprising 0.35% of total consumption.

Georgian **coal** reserves are estimated at 200 million to 500 million tons and natural resources at 700 million tons. In 2018, 138 thousand tons of coal were produced in Georgia. Domestic coal satisfies only a negligible share of domestic consumption. Production and consumption have decreased rapidly in recent years. Coal consumption fluctuated considerably between 2008 and 2018. In 2008, 70 thousand tons of oil equivalent (Ktoe) of coal were consumed whereas consumption was 300 Ktoe in 2018.

ENERGY GENERATION AND TRANSITION

No combined heat and power (CHP) plants and heat plants exist in Georgia. Only electricity generation from thermal power plants and small-scale petroleum refining belong to this sub-sector.

HPPs

As of 2020, 98 hydropower plants (HPPs) are operating in the country, including seven large regulated HPPs, 19 seasonal HPPs and 72 small HPPs. At present, there are six thermal power plants in Georgia. The table below shows the characteristics of the 10 top hydropower plants (by capacity) and thermal power plants.

TABLE 1.3.10 Characteristics of Top HPPs in Georgia

No	HPP	River	Reservoir	Capacity, MW	Type of Regulation	Commissioning Year
1	Enguri HPP	Enguri	Jvari	1,300	regulatory	1978
2	Vardnili HPP	Enguri		220	regulatory	1971
3	Vartsikhe HHP	Rioni		184	seasonal	1976-1977
4	Shuakhevi HPP	Ajaristskali		179	seasonal	2017
5	Zhinvali HPP	Aragvi	Zhinvali	130	regulatory	1984
6	Lajanuri HPP	Lajanuri	Lajanuri	114	seasonal	1960
7	Khrami 1	Khrami	Tsalka	113	regulatory	1947
8	Khrami 2	Khrami	Tsalka	110	regulatory	1963
9	Dariali	Tergi		108	seasonal	2016
10	Paravani HPP	Paravani		87	seasonal	2014

TPPs

TABLE 1.3.11 Georgia's Thermal Power Plants as of 2020

N	TPP	Technology / Fuel	Installed capacity, MW
1	Mtkvari	Conventional / Natural gas	300
2	Tbilsresi	Conventional / Natural gas	270
3	Gardabani 1	Combined cycle / Natural gas	230
4	Gardabani 2	Combined cycle / Natural gas	230
5	GPower	Air turbine / Natural gas	110
6	Tkibuli	Conventional / Coal	13.2

Wind Power

There is only one wind power plant in Georgia located in the Shida Kartli region of Georgia. In 2020 the 20.7 MW power plant generated 90 GWh of electricity, about 0.8% of the total electricity generated. At present, a Memorandum of Understanding has been signed for the construction of 18 wind farms with a total installed capacity of 1,160 MW and an annual output of 4,480 GWh.

Solar Power

In terms of solar power usage in Georgia, there are mainly two technologies used for heat and electricity: the solar collector, which is relatively widespread in Georgia and used for water heating, and solar photovoltaic generators, which are slowly being introduced in the country and used for electricity production. As of 2022, the Ministry of Economy and Sustainable Development of Georgia has signed six Memorandums of Understanding on the construction of solar farms with an installed capacity of 93 MW and an annual output of 132 GWh.

ELECTRICITY GENERATION

During the last few years (excluding 2020), more than 75% of the electricity generated in Georgia has come from HPPs. The rest is generated by thermal power plants (TPPs).

TABLE 1.3.12 Electricity Generated by Power Plants in TWh in 2013-2020

Year	Total	Hydro Power Plants								Thermal Power Plants		Wind Farm	
		Total		Regulatory		Seasonal		Small					
		TWh	%	TWh	%	TWh	%	TWh	%	TWh	%	TWh	%
2013	10.06	8.27	82.2	5.39	53.5	2.56	25.4	0.33	3.3	1.79	17.8		
2014	10.37	8.33	80.4	5.16	49.7	2.68	25.9	0.49	4.7	2.04	19.6		
2015	10.83	8.45	78.0	5.12	47.3	2.82	26	0.52	4.8	2.38	22		
2016	11.57	9.33	80.6	5.41	46.7	3.24	28	0.68	5.9	2.24	19.3	0.01	0.1
2017	11.53	9.21	79.9	5.35	46.4	3.26	28.3	0.60	5.2	2.23	19.4	0.09	0.8
2018	12.15	9.95	81.9	5.80	47.8	3.46	28.4	0.69	5.7	2.12	17.4	0.08	0.7
2019	11.86	8.93	75.3	4.97	41.9	3.31	27.9	0.66	5.5	2.84	24	0.08	0.7
2020	11.16	8.25	73.9	4.08	36.6	3.54	31.7	0.63	5.7	2.82	25.3	0.09	0.8

FIGURE 1.3.5 Electricity Generated by Power Plants in TWh in 2013-2020

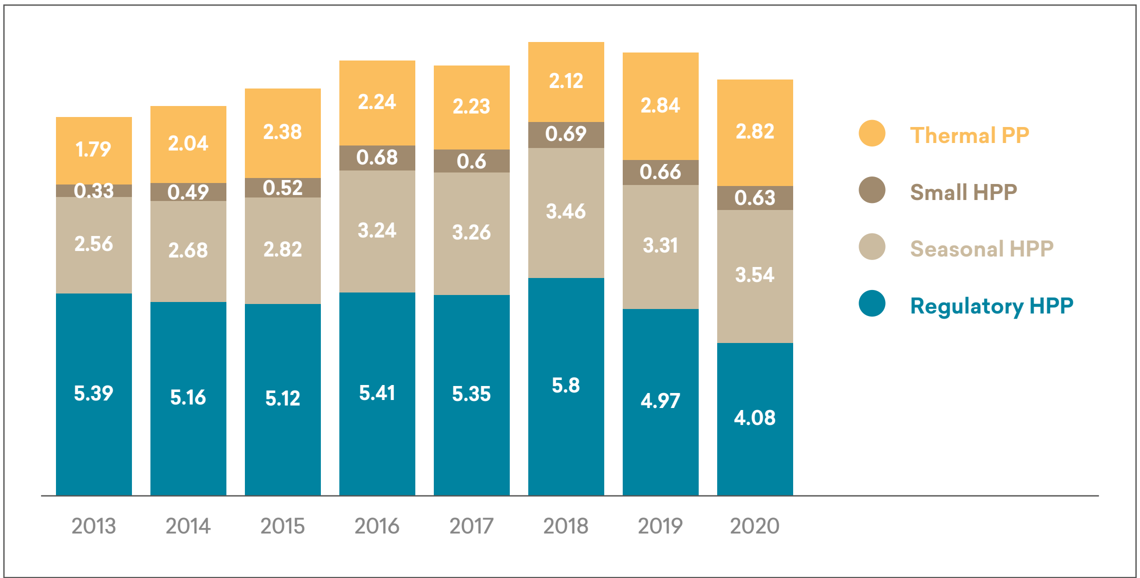
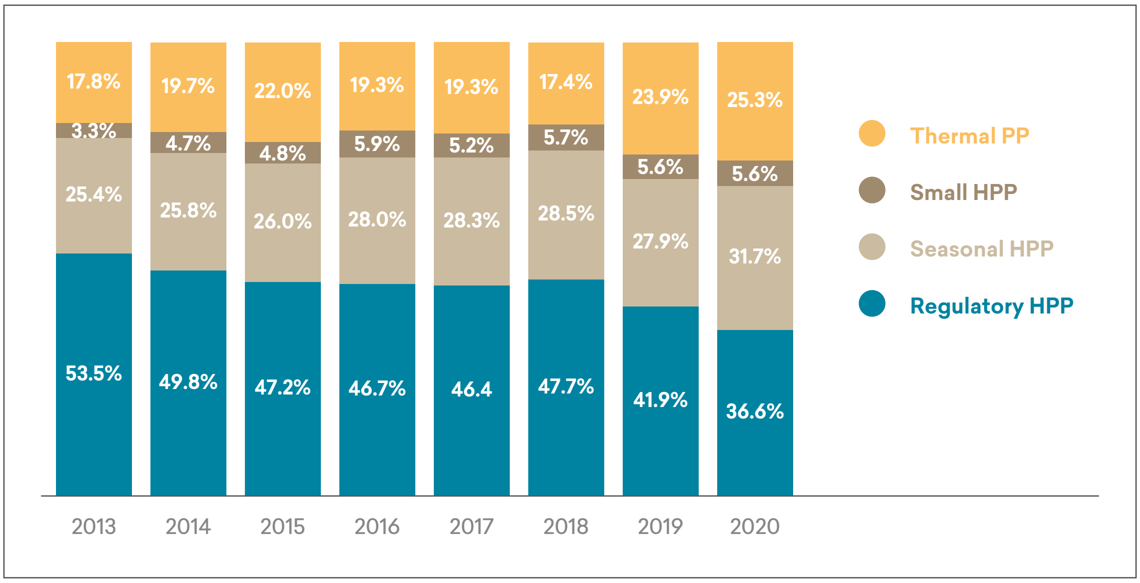


FIGURE 1.3.6 Share of Power Plants in Total Electricity Generation in 2013-2020



1.4 Fugitive Emissions

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories[9] defines fugitive emissions as: "Intentional or unintentional release of greenhouse gases may occur during the extraction, processing and delivery of fossil fuels to the point of final use."

In Georgia, fugitive emissions occur during the geological processes of coal formation and from oil and natural gas activities (production, transmission and distribution).

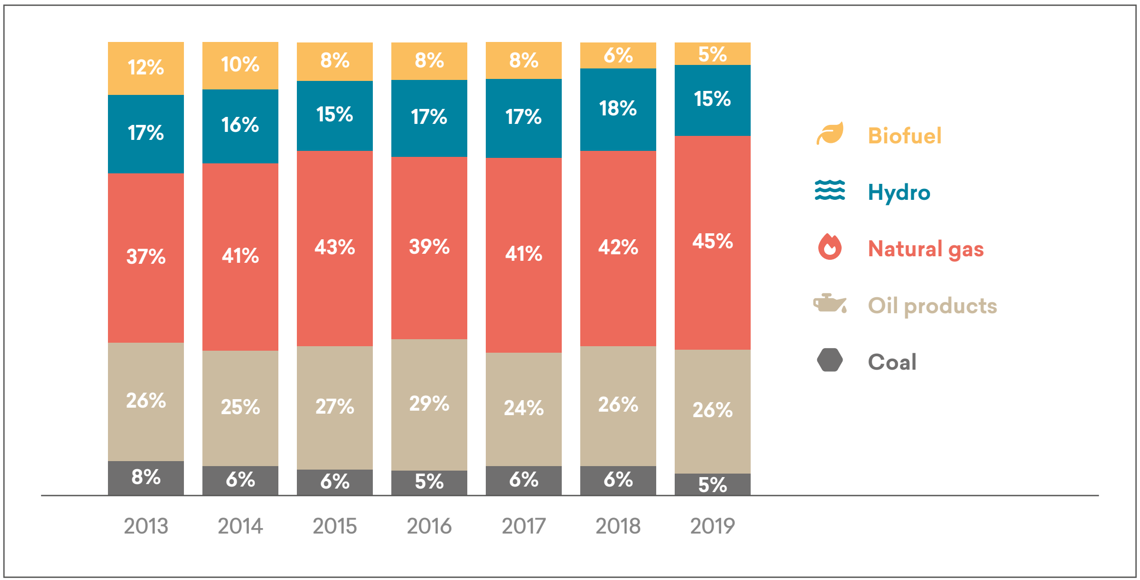
Fugitive emissions from solid fuel (coal) and oil and natural gas operations were a key source during 2008-2017.[10] Their share in the national GHG emissions varied from 14% (2012) to 6.1% (2017). In general, fugitive emissions are difficult to quantify with a high degree of accuracy - there remains substantial uncertainty in the values available.

According to Georgia's 2013-2019 Energy Balances, natural gas and oil products are dominant energy sources. Georgia does not have significant oil and gas reserves. The import mainly balances the country's demand for natural gas. Local gas production is small and its share in total consumption is less than 0.5%. More than 98% of consumed oil products are imported into Georgia.

9 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

10 National GHG Inventory Report of Georgia (1990-2017). https://unfccc.int/documents/271342

FIGURE 1.4.1 Shares of Sources in Energy Consumption of Georgia in 2013-2019



In 2013-2019, crude oil production varied between 30.2-47.9 thousand tons. Petroleum refining started in 2015. In some years, imported crude oil also was refined.

TABLE 1.4.1 Crude Oil Production and Refining in 2013-2019 in Thousand Tons

Process / Year	2013	2014	2015	2016	2017	2018	2019
Crude Oil Production	47.9	42.6	40.2	38.6	32.0	30.2	35.1
Petroleum Refining			14.5	63.5	25.0	23.7	37.6

FUGITIVE EMISSIONS FROM COAL MINING

Fugitive emissions from coal mining in 2014-2017 are given in Table 1.4.2. Coal mining has stopped from 2018. Methane emissions from the abandoned underground mines are insignificant (annually, about 2 kg CO_2-eq).

TABLE 1.4.2 Fugitive Emissions from Coal Mining in Gg CO_2-eq

Year/Source	Mining	Post-mining Seam Gas Emissions	Total
2014	115.2	18.2	133.4
2015	117.7	18.6	136.3
2016	114.1	18.1	132.1
2017	103.2	16.4	119.4
Average	112.6	17.8	130.3

FUGITIVE EMISSIONS FROM NATURAL GAS OPERATIONS

According to the Energy Balances of Georgia,[11] natural gas losses in the natural gas distribution system varied between 3.23–6.02%. On average, losses constituted 4.6%. This significantly exceeds normative losses (1.2%) set by the Georgian National Energy and Water Supply Regulatory Commission (GNERC).

Figure 1.4.2. and Table 4.2.3. show domestic natural gas supply, distribution losses and fugitive emissions in 2013-2019.

FIGURE 1.4.2 Natural Gas Supply in Million m³ and Losses in Percent

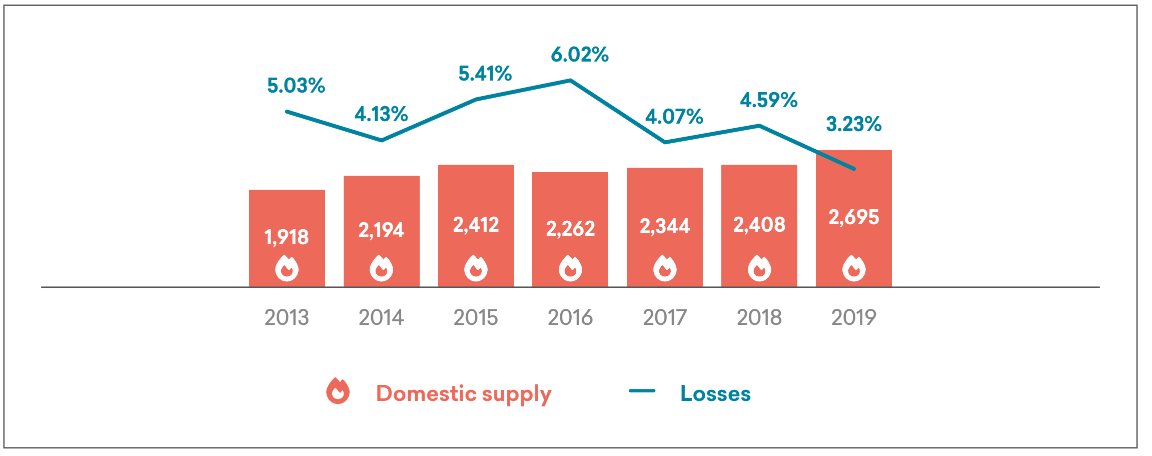


TABLE 1.4.3 Domestic Supply and Losses of Natural Gas and Fugitive Emissions in 2013-2019

Year	Domestic supply, Mm³	Losses			ϱ	Fugitive emissions	
		Percent	Mm³	CH_4, Mm³	kg/m³	Gg CH_4	Gg CO_2-eq
2013	1,918	5.03%	96.5	91.7	0.67	61.4	1,289.9
2014	2,194	4.13%	90.5	86.0	0.67	57.6	1,209.7
2015	2,412	5.41%	130.5	124.0	0.67	83.1	1,744.3
2016	2,262	6.02%	136.2	129.4	0.67	86.7	1,820.5
2017	2,344	4.07%	95.5	90.7	0.67	60.8	1,276.5
2018	2,408	4.59%	110.5	105.0	0.67	70.3	1,477.0
2019	2,695	3.23%	87.0	82.7	0.67	55.4	1,162.9
Average	4.60%						

GNERC reports have been used as transmission loss data sources.[12]

11 Energy Balance of Georgia - National Statistical Service of Georgia. https://www.geostat.ge/en/modules/categories/328/energy-balance-of-georgia

12 Georgian National Energy and Water Supply Regulatory Commission. Report on Activities. https://gnerc.org/en/commission/commission-reports/tsliuri-angarishebi

TABLE 1.4.4 Natural Gas Transmission Losses and Fugitive Emissions in 2016-2019

Year	Transmission, Mm^3			Losses		CH_4	ϱ	CH_4	Fugitive emissions
	SCP	NSMPG	Total	Percent	Mm^3	Mm^3	Kg/m^3	Gg	Gg CO_2-eq
2016	7,145	1867	9,012	0.6	54.1	51.4	0.67	34	723
2017	8,200	1,988	10,188	0.82	83.5	79.4	0.67	53	1,117
2018	9000	1,978	10,978	0.7	76.8	73.0	0.67	49	1,027
2019	10,414	2,326	12,740	0.7	89.2	84.7	0.67	57	1,192

FUGITIVE EMISSIONS FROM OIL SYSTEMS

Fugitive emissions from oil systems in 2014-2017 are given in Table 1.4.5. (Source: Fourth National Communication of Georgia to the UNFCCC). Due to the absence of the country's long-term vision for sector development, the average value of 2014-2017 (37.8 Gg CO_2-eq) is used for 2030-2050. Mitigation measures are not considered.

TABLE 1.4.5 Fugitive Emissions from Oil Systems in Gg CO_2-eq

Year\ Source	Oil venting	Oil flaring	Oil production and upgrading	Oil transport	Total
2014	1.0	2.6	32.7	5.3	41.5
2015	0.9	2.4	30.8	5.3	39.4
2016	0.9	2.3	29.5	5.2	37.9
2017	0.7	1.9	24.5	5.1	32.2
Average					**37.8**

COAL MINING

Georgian coal reserves are estimated at 300 million to 500 million tons and the overall natural coal resources at 700 million tons, all hard coal. In 2018, 138 thousand tons of coal were produced in Georgia. Domestic coal satisfies only a negligible share of domestic consumption, although production and consumption have decreased rapidly in recent years. Coal consumption fluctuated considerably between 2008 and 2018. In 2008, 70 thousand tons of oil equivalent (Ktoe) of coal were consumed whereas consumption was 300 Ktoe in 2018. Coal mining was well developed in Georgia during the Soviet period but production decreased after 1991 and began to rise again only in 2009 when the mines were privatized. Coal production has been suspended since 2018 because of accidents in which several miners were killed or injured. According to preliminary reports, a methane explosion in one of the shaft's tunnels allegedly caused the deformation of the walls. Rehabilitation and further development of the local coal industry will depend on the demand for coal for power generation. There are no incentive programs for coal. Georgia does not produce coalbed methane from virgin coal seams because of the high cost.

Due to the absence of the country's long-term vision concerning coal mining sector development, the average value of 2014-2017 (130 Gg CO_2-eq) is used for 2030-2050.

NATURAL GAS SYSTEMS

Natural gas extraction in Georgia started in the 1970s with associated petroleum gas extracted from the Samgori-Patardzeuli field. During the peak period of oil extraction (1980-1983), the annual extraction of such gas reached 300 million m^3. The so-called free gas was extracted in 1983 when the Rustavi gas field was discovered. Later free and associated gas extraction continued in the Ninotsminda area which is still ongoing. In total, 2.8 billion m^3 of gas has been extracted in Georgia, most of which comes from the Soviet period.

The share of natural gas in the total supply of energy resources in total energy supply is about 40%. Gas is the most widely consumed primary energy source in Georgia.

The natural gas sector is one of the most dynamically developing segments of the country. Local gas production is rather low; therefore, the demand for natural gas in Georgia is mainly balanced by imports. Today, gas import is provided from two foreign sources based on several independent contracts. Natural gas import is carried out based on agreements between the parties, followed by the wholesale supply of natural gas to distribution companies. The distribution companies, on their part, supply natural gas to the so-called social sector and commercial consumers.

The Georgian National Energy and Water Supply Regulatory Commission (GNERC) defines natural gas distribution activity as the receipt of natural gas from one or more points of delivery, the operation of a distribution network and the supply of natural gas to consumers within the limits of a specific distribution network at the request of suppliers. The GNERC grants the license for natural gas distribution.

In 2019, 10 suppliers traded in wholesale natural gas on the Georgian market where the three largest suppliers took up 94%, indicating a high market concentration. Under circumstances when the natural gas market at the import level is characterized by a high concentration, the development of competition in trading at the wholesale level is impossible without taking special measures. Searching for alternative sources of natural gas is important in the long-term perspective (including access to liquefied natural gas) which can be implemented in the case of relevant amendments being made to legislation and the interests of suppliers. In addition, it is very important to promote local production, including biogas, and support its integration into the network.

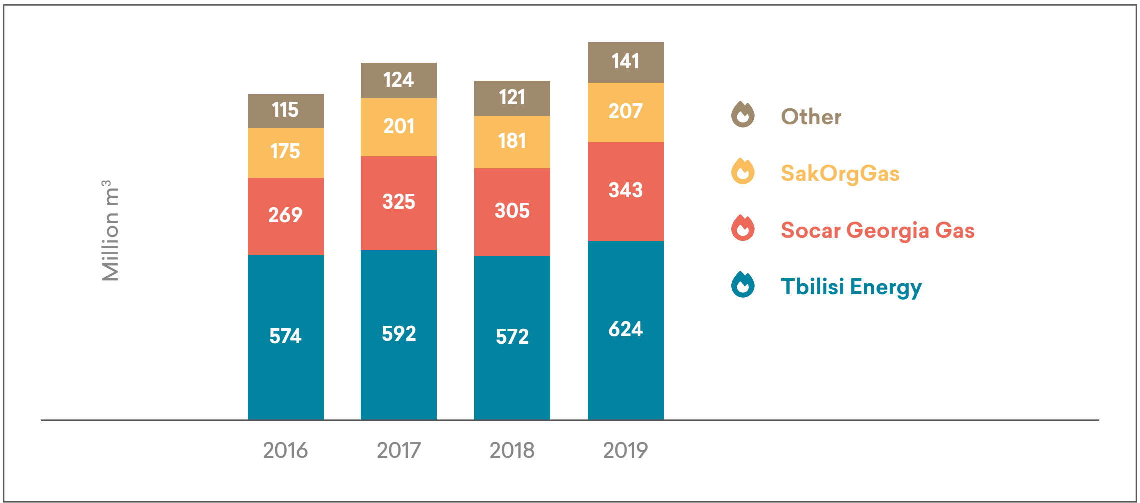
The price of natural gas is significantly conditioned by the level of competition in the market, including at the wholesale level. Upon determining the average price at the wholesale level, the average weighted price of natural gas sold by each supplier in this market segment is considered. The separation of the social and the commercial segments is also important in the case of price determination.

Georgia purchases so-called social gas at a preferential price from the South Caucasus Pipeline which is used for supplying the residential sector and Thermal Power Plants with natural gas. Therefore, the retail and the wholesale prices of natural gas are significantly low in this segment as compared to the commercial segment. Estimating the social gas price at the wholesale level is possible through the natural gas price envisaged upon determining the consumption tariff by the GNERC which varies from 0.25 to 0.30 GEL/m^3 (about 0.08-0.1 USD/m^3), taking into account subsidies at various levels of government. As for the commercial segment, the average price of natural gas at this level of trading in 2019 accounted for 0.59 GEL/m^3 (about 0.2 USD/m^3).

The main source of fugitive emissions is natural gas activities. By December 2019, 25 natural gas distribution licensees were operating in Georgia of which three were large licensees (*Tbilisi Energy, Socar Georgia Gas* and *SakOrgGas*) that distributed 89% of the total natural gas.

The main function of *Tbilisi Energy* is the safe and continuous gas supply to the capital of Georgia, Tbilisi. The main directions of *SOCAR Georgia Gas* activity comprise import into the Georgian market and the sale of natural gas as well as the construction and the rehabilitation of gas pipelines. *SOCAR Georgia Gas* and *SakOrgGas* serve the population (residential sector) and small and medium-sized businesses in the regions of Georgia.

FIGURE 1.4.3 Share of Distribution Licensees in Total Distributed Natural Gas (Mm³)



Two natural gas pipelines pass through the territory of Georgia - the South Caucasus Pipeline (SCP) and the North-South Main Gas Pipeline (NSMGP). The SCP, also known as the Baku-Tbilisi-Erzurum Gas Pipeline, transports gas from Azerbaijan's giant Shah Deniz field to Turkey's eastern border via Georgia. The SCP was launched in 2006. A total of 45,432 million m³ of gas was transported via the SCP in 2016-2020 as cited by the APA-Economics reports by the State Statistics Committee of Azerbaijan.[13] The highest figure (12,268 million m³) in the reporting period was recorded in 2020 and the lowest (7,145 million m³) - in 2016. The NSMGP was built in the 1970s. The pipeline stretches from Georgia-Russia to the Georgia-Armenia border (221 km), supplying the Georgian and the Armenian markets with natural gas.

Distribution

Distribution losses in 2030-2050 are assumed to be 4.6% (average losses in 2013-2019). Natural gas supply corresponds to the demand of economy sectors (energy industry, IPPU, transport, agriculture, commercial/institutional and residential sectors).

13 https://apa.az/en/azerbaijan_energy_and_industry/Gas-transportation-via-South-Caucasus-pipeline-increased-by-72percent-over-the-past-five-years-341111

TABLE 1.4.6 Projected Natural Gas Distribution Losses and Fugitive Emissions (WoM scenario)

Year	Distribution	Losses		CH_4	ϱ	CH_4	Fugitive emissions
	Mm³	Percent	Mm³	Mm³	kg/m³	Gg	Gg CO_2-eq
2030	2,815	4.60%	129.5	123.0	0.67	82.4	1,731
2040	3,830	4.60%	176.2	167.4	0.67	112.1	2,355
2050	6,618	4.60%	304.4	289.2	0.67	193.8	4,069

Transmission

Based on the expert judgment here, it is assumed that the SCP will ensure the transmission of 18 billion m³ of gas by 2030, 25 billion m³ by 2040 and 40 billion m³ by 2050; transmission from the NSMGP will remain at the 2019 level – about 2,300 Mm³/year and NG losses are the same as in 2019. Table 1.4.7. summarizes the projected natural gas transmission losses and fugitive emissions.

TABLE 1.4.7 Projected Natural Gas Transmission Losses and Fugitive Emissions

Year	Transmission, Mm³			Losses		CH_4	ϱ	CH_4	Fugitive emissions
	SCP	NSMPG	Total	%	Mm³	Mm³	Kg/m³	Gg	Gg CO_2-eq
2030	18,000	2,442	20,442	0.700	143.1	135.9	0.67	91.1	1,913
2040	25000	2,491	27,491	0.700	192.4	182.8	0.67	122.5	2,572
2050	40,000	2,596	42,596	0.700	298.2	283.3	0.67	189.8	3,986

OIL SYSTEMS

In the second half of the 19th century, industrial oil production was initiated at low-depth wells in the Kakheti region with up to 2,000 tons of annual production. Oil extraction operations were conducted without prior geological investigations of the oil fields and the primitive methods applied were unsuccessful in developing the fields to the full extent.

Regular investigations to estimate Georgia's oil and gas resources and drilling operations to discover reservoirs and oil production were launched in the 1920s.

During 1930-1960, oil production operations were conducted at seven small fields with annual production ranging between 22-25 thousand tons. The period between 1970-1985 is the most remarkable and successful stage in the oil production history of Georgia when several prolific oil fields were discovered, considerably increasing oil production after they became operational.

The highest annual oil output of 3.2-3.3 million tons was recorded in 1980-1983. It was followed by a dramatic fall during 2013-2019, mostly because new fields had not yet been discovered and the production rate at the already existing fields was reduced due to natural developments.

In recent years, foreign oil companies started operating in Georgia after concluding purchase and sale agreements with the government. Although these companies have already done significant exploration on their licensed territories, new fields have not yet been discovered despite promising geological examinations.

Due to the absence of a long-term vision concerning sector development, the average value of 2014-2017 (37.8 Gg CO_2-eq) is used for 2030-2050 in the case of the baseline scenario.

1.5 Building Sector

GHG emissions by sub-category under the buildings sector are provided in Table 1.5.1. (according to the National GHG Inventory Report of Georgia). The residential sector is the dominant sub-category under IPCC category 1A4 with 73% emissions in 2017 while GHG emissions from commercial and agricultural sub-sectors amounted to 16% and 11%, respectively.

TABLE 1.5.1 GHG Emissions (Gg CO_2-eq) in the Buildings Sector

Year	1A4a - Commercial	1A4b - Residential	1A4c – Agriculture/Forestry/ Fishing	Total 1A4
1990	1090	3812	524	5,427
1995	126	675	275	1,076
2000	181	1064	182	1,427
2005	124	680	280	1,084
2010	226	1,184	307	1,717
2011	373	1,281	330	1,984
2012	562	1,210	74	1,846
2013	270	1,278	32	1,579
2014	466	1,367	25	1,859
2015	413	1,542	38	1,993
2016	415	1,722	69	2,206
2017	419	1,895	293	2,608

Within the energy sector, buildings represented above 25% of the emissions (4.9% in commercial/institutional and 21.2% in residential) in 2019 as illustrated in the following table.

TABLE 1.5.2 Shares of End-use Sectors in Energy Sector Emissions

Year	End-use Sector					
	Energy Industry	Industry	Transport	Commercial/ Institutional	Residential	Agriculture
2013	14.8%	21.9%	42.1%	3.9%	16.9%	0.5%
2014	14.5%	18.2%	44.8%	5.9%	16.2%	0.3%
2015	15.5%	16.5%	45.6%	4.8%	17.2%	0.4%
2016	12.6%	14.7%	48.9%	4.6%	18.5%	0.8%
2017	12.7%	16.5%	44.6%	4.8%	20.7%	0.8%
2018	11.8%	17.0%	45.8%	4.6%	20.1%	0.6%
2019	15.4%	16.7%	41.3%	4.9%	21.2%	0.6%

There are various types of buildings conditioning their energy demand and use. The typology of the existing Georgian building stock is as follows:

Historical - Buildings developed before 1921 have the following features – with the excess thermal mass of the bearing and non-bearing structures: thick walls of stones or bricks which accumulate heat or cold during one daily peak and release it during the other.

Early Soviet period (1921-1937) - Most buildings were designed individually without any unified style. The main environmental features are building basements, bricks used for load-bearing walls and the envelope (mainly 38 cm), timber beams and flooring, timber-bearing structures for low-rise developments, timber/glass conservatories, attics, sloped roofs, single timber glazing, enclosed or open type staircases and a mainly low-rise concept is applied.

Stalin period (1937-1956) - The main environmental features are: design and construction according to regulations, building basements, bricks used for load-bearing walls and the envelope (minimum 38 cm, in some cases 50 cm), reinforced concrete floor/ceiling slabs, reinforced concrete framed conservatories, attics, sloped roofs, single timber glazing or double timber glazing in colder areas, enclosed staircases, average and the high-rise building development concept is applied.

So-called Khrushchev period of typical buildings development (1956-1969) - Standard 38 cm of brick or block outer wall buildings.

Developed socialism period (1969-1990) - The main feature of this period is the same as the Khrushchev period with the difference that the ceiling height increased from 2.40-2.50 m to 2.7-2.80 m.

Post-Soviet (current) - Prevailing environmental features: 20 or 30-cm thickness building envelope, mainly cavity blocks made of thermal conductive concrete, double glazed PVC doors/windows, no attic, no conservatory and horizontal roofing.

Homes/residential buildings (all periods) - Home buildings are the major type of building in rural areas and old parts of towns and cities of Georgia. The vast majority of them is constructed in the Soviet era, after WW2. Several dominant types of homes can be separated with the following structures and features: timber, brick/block, stone and mixed/complex types.

The table below shows the typical energy performance of the above types of buildings and their approximate share in the Georgian building stock (dwellings).

TABLE 1.5.3 Types of Houses (2)

Type	Performance	Stock volume	Energy demand	Percentage in the building stock
Multistoried buildings	kWh/m²/year	m²	kWh/year	%
Old (including up to 1921)	90-150 (average consumption 110)	3,811,128	666,947,370	11.7
Early Soviet period: 1921-1937	150-250 (average consumption 200)			
Stalin period: 1937-1956	150-200 (average consumption 175)			
So-called Khrushchev period (1956-1969)	230-260 (average consumption 250)	24,984,060	6,495,855,652	76.7
Developed socialism period: 1969-1990	250-300 (average consumption 275)			
Current (post-Soviet) period	320-350 (average consumption 340)	3,778,554	1,265,815,618	11.6
Sub-Total/Average	259	32,573,742	8,428,618,640	100
Traditional House	kWh/ m²/ year	m²	kWh/year	%
Timber	Weighted average consumption 365	74,116,450	27,075,402,928	
Brick				
Stone				
Other or Complex type				
Sub-Total	415	74,116,450	27,075,402,928	100
GRAND TOTAL/AVERAGE	333	106,690,192	35,504,021,568	-

Note: the share of the traditional houses (homes) from the total stock is 69.5%.

The baseline average energy performance of the buildings (kWh/m2) is based on the GIZ-supported research, entitled Energy Efficiency in Construction,[14] considering the minimum required comfort level in each type of building. According to the provided share of heating areas by types of buildings based on the Report of Energy Consumption in Households (2017) developed by the National Statistics Office of Georgia, the annual average specific energy consumption and identified heating area final annual energy demand was determined for each type of building (in total 35,504,021,568 kWh/year).

Along with the common drivers used for projections for all sectors, the following sector-specific data have been used for building sector scenarios:

14 Brigit T. Mayer, Khatuna Sichinava, Holger Reif and Nani Meparishvili, "Energy Efficiency in Construction – In Georgia," 2017, Private Sector Development and Technical Vocational Education and Training in the South Caucasus Project, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Bonn and Eschborn, Germany, www.giz.de.

Number of persons per household - Table 1.5.4. estimates below show the statistical data (from statistical yearbooks) on incomes per household and incomes per person and calculated from the number of persons per household with average annual change. This parameter was used as a driver for projections for 2050.

TABLE 1.5.4 Estimated Person per Household Parameter

Year	Income per household in GEL	Income per person in GEL	Persons per household
2009	518.8	141.5	3.67
2018	1,005	284.7	3.53
Average 10-year change			-0.42%

Building replacement - Average life cycle of buildings is 50-100 years. Replacement rate of the building stock: 1-2% (average – 1.5 %).

The retrofit of buildings is presented in the graphs below.

FIGURE 1.5.1 Percentage of Retrofitted Residential Buildings

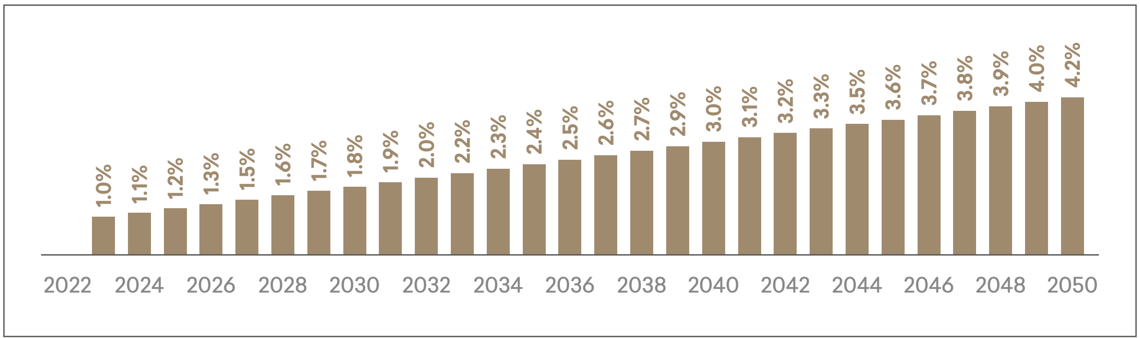


FIGURE 1.5.2 Cumulative % of Retrofitted Residential Buildings

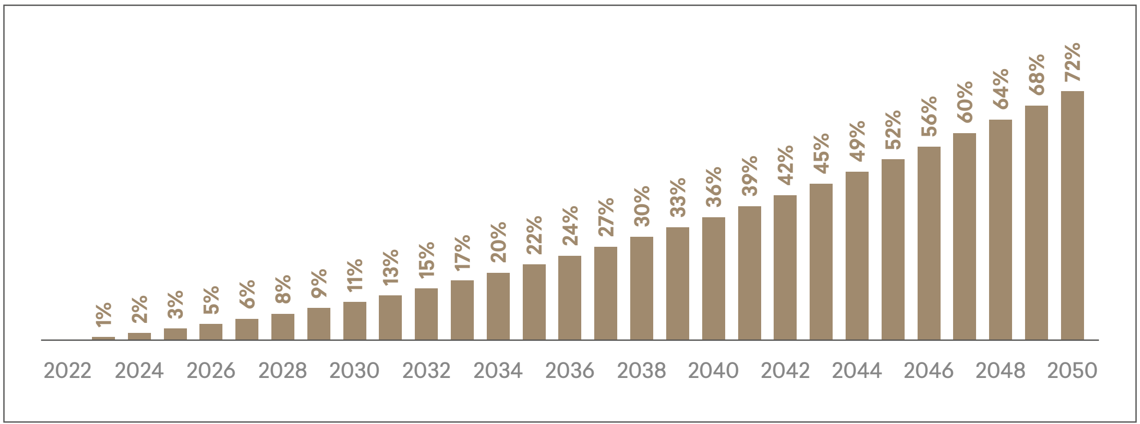
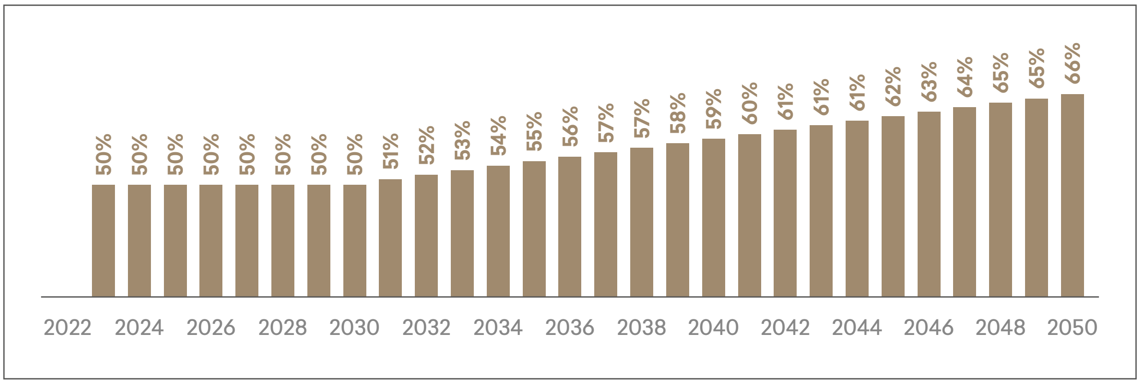


FIGURE 1.5.3 Efficiency in Retrofitted Buildings



Existing Building Stock and New Developments

The number of new buildings is taken from the webpage of the National Statistics Office of Georgia.[15]

Existing Building Stock (Heated Area)

The verified total area of public schools is 3.8 million m^2. Total building area per capita: assumed 10 m^2 x 3.8 million = 38,000,000 m^2. From this – the assumption is that 2.5 million people live in buildings (blocks of flats) and 1.3 million in traditional houses (homes). The ratio between the per capita area is assumed as 2/1 building dwellers vs. homeowners. Therefore, the Gross Floor Area (GFA) of buildings is 18.6 million m^2 and the Gross Floor Area (GFA) for Traditional Houses/Homes is 19.4 million m^2. The GFA of public buildings is assumed at 15% of dwellings, for a total of 5.7 million m^2. From that, 3.8 million m^2 are school buildings and the rest – 1.9 million m^2 – are other buildings (including municipal and central, privately owned non-residential buildings).

1.6 Transport Sector

Georgia's climate-friendly economic development is directly linked to the efficient operation of the transport sector. Georgia is located at the crossroads of Europe and Asia and its economic growth largely depends on the effective use of its transit function. Since the 1990s, Georgia's role in the transport corridor between Europe, the Caucasus and Asia has increased significantly. This reinforces the interest in the country's sustainable development which primarily involves the creation of a quality transit infrastructure in the country.

Georgia's transport system comprises five modes - road, rail, sea, air and pipelines. All provinces, cities, towns and neighboring countries are connected directly or indirectly by at least one of these modes. To improve these connections, rules and regulations on the supply of transport infrastructure and services have been revised since 2005, the institutions have been restructured and the authority for modernizing the transport system has been delegated to respective agencies. This has helped draw private capital into aviation (airports and airlines), maritime services (ports and shipping), road transport (all freight and intercity passenger) and pipelines (oil and gas from Azerbaijan and Kazakhstan).

15 https://www.geostat.ge/en/modules/categories/621/information-about-permissions-granted-for-construction-and-completed-objects

GHG emissions from the transport sector and by transport modes are given in Table 1.6.1. For 1990-2017, data are sourced from the National Inventory Report.[16] For 2018-2019, GHG emissions are estimated by applying the Energy Balance of Georgia.[17] According to the table below, the share of GHG emissions from road transport exceeds 90% of total GHG emissions from the transport sector and exceeds 99%, excluding pipelines.

TABLE 1.6.1 GHG Emissions from the Transport Sector (in Gg CO2-eq) and Share of Transport Modes

Year	Total	Road transport						Civil aviation		Railways		National navigation		Pipelines	
		CO_2 ჯამ		CO_2		CH_4 და N_2O									
		Total	Share	CO_2	Share	CO_2 eq	Share	CO_2	Share	CO_2	Share	CO_2	Share	CO_2	Share
1990	3,901	3,678	94.3%	NE	-	43.58	1.12%	NE	-	101	2.59%	78	2.00%	NE	-
1995	863	844	97.8%	NE	-	0.89	0.10%	NE	-	NE	-	18	2.09%	NE	-
2000	965	945	97.9%	NE	-	0.04	0.00%	NE	-	NE	-	20	2.07%	NE	-
2005	1,571	1,537	97.8%	NE	-	0	0.00%	NE	-	NE	-	34	2.16%	NE	-
2010	2,630	2,390	90.9%	NE	-	0.02	0.00%	NE	-	190	7.22%	50	1.90%	NE	-
2015	4,208	3,965	94.2%	3,855	91.6%	110	2.60%	2	0.05%	18	0.43%	2	0.05%	221	5.3%
2016	4,500	4,239	94.2%	4,125	91.7%	114	2.54%	3	0.08%	34	0.75%	2	0.05%	222	4.9%
2017	4,472	4,240	94.8%	4,128	92.3%	112	2.50%	2	0.04%	34	0.77%	6	0.14%	190	4.3%
2018	4,153	3,875	93.3%	3,772	90.8%	103	2.48%	1	0.02%	34	0.83%	2	0.05%	240	5.8%
2019	3,995	3,669	91.8%	3,571	89.4%	97	2.44%	2	0.05%	32	0.80%	1	0.03%	292	7.3%

CO_2 EMISSIONS FROM PIPELINES

Natural gas is transported via compressor stations passing through pipelines. The stations consume approximately 3-5% of the transported gas. The optimal operation of the compressors is important. During the last (2011-2019) years, CO_2 emissions from natural gas pipelines constitute, on average, 219 Gg CO_2.

TABLE 1.6.2 CO_2 Emissions from Pipelines in 2011-2019

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
CO_2 emissions, Gg CO_2	190	215	204	191	227	224	190	240	292	219

16 National GHG Inventory Report of Georgia (1990-2017). https://unfccc.int/sites/default/files/resource/NIR%20%20Eng%2030.03.pdf

17 https://www.geostat.ge/en/modules/categories/328/energy-balance-of-georgia

During 2021-2050, the natural gas consumption in pipelines will depend on the amount of transported gas. CO_2 emissions from pipelines by 2050 will be projected based on the envisioned amount of natural gas transport by 2050.

GHG emissions from road transport by fuel in 2013-2017 are given in Table 1.6.3.

TABLE 1.6.3 GHG Emissions from Road Transport by Fuel in 2013-2017

Year	CO_2					CH_4 and N_2O CO_2 eq	Total in CO_2 eq
	Natural gas	Gasoline	Diesel oil	LPG	Total		
2013	518	1,147	1,226	6	2,897	84	2,981
2014	695	1,168	1,585	6	3,454	100	3,555
2015	723	1,298	1,834	1	3,856	110	3,965
2016	548	1,724	1,850	2	4,124	114	4,239
2017	498	1,751	1,870	8	4,127	112	4,240

During the last several years, the share of GHG emissions from the transport sector in national GHG emissions has tended to increase, from 8.8% in 2000 to 25.2% in 2017 (Table 1.6.4.).

TABLE 1.6.4 Transport Sector Emissions and Their Share in National GHG Emissions

Year	National GHG, Gg CO_2 eq	Transport	
		GHG, Gg CO_2 eq	Share
1990	45,814	3,901	8.5%
1995	12,696	863	6.8%
2000	10,923	965	8.8%
2005	11,168	1,571	14.1%
2010	13,688	2,630	19.2%
2015	18,214	4,208	23.1%
2016	18,534	4,500	24.3%
2017	17,766	4,472	25.2%

Yearly, the GDP (at constant 2015 prices) and the transport sector's contribution changed insignificantly[18] (Table 1.6.5.).

18 Gross domestic product (GDP) - National Statistical Office of Georgia. https://www.geostat.ge/en/modules/categories/23/gross-domestic-product-gdp

TABLE 1.6.5 GDP at Constant 2015 Prices and Transport Sector Contribution

Economic Activity	2011	2012	2013	2014	2015	2016	2017	2018	2019
GDP at constant 2015 prices, billion GEL	25.4	27.0	28.0	29.2	30.2	31.1	32.6	34.2	35.9
Transport contribution, billion GEL	1.557	1.698	1.640	1.755	1.850	1.725	1.925	2.012	2.181
Transport contribution	6.1%	6.3%	5.8%	6.0%	6.1%	5.5%	5.9%	5.9%	6.1%

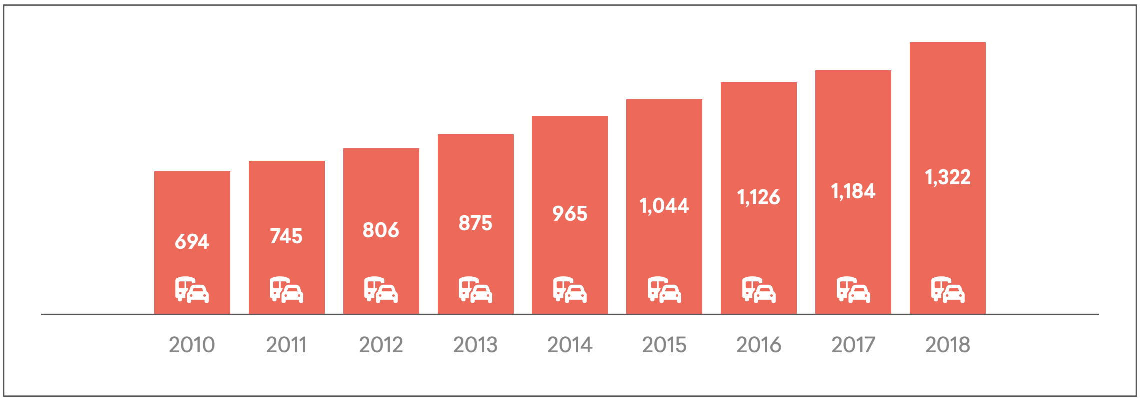
ROAD TRANSPORT

The road network of Georgia consists of 20,000 km of roads divided into three categories: roads of international importance (1,455 km long), roads of national importance (5,446 km) and roads of local importance (14,143 km). Recent years have seen significant investments in road infrastructure (roads of international importance above all), yet further improvements are necessary, especially at the regional and local levels. Passenger railways and secondary and local roads do not meet demands and expectations.

The European Union, the Japan International Cooperation Agency (JICA), the Millennium Challenge Corporation (MCC), the European Bank for Reconstruction and Development (EBRD) and the World Bank (WB) support the development of the road network of Georgia, providing technical assistance for institutional strengthening and private sector development in such areas as project management, traffic safety, personnel development, elaboration of training programs, procurements for road maintenance needs, etc.

The number of vehicles (cars, busses, mini-busses, trucks, trailers) registered in Georgia shows a steady upward trend (Figure 1.6.1.) having increased about two times in 2018 as compared to 2008. Annual freight transport by road is 25 million tons (around 59.9% of total freight traffic) and passenger traffic reaches 260 million people.

FIGURE 1.6.1 Number of Registered Vehicles in 2010-2018



The high volume of international road transport creates a high traffic load. Between 2011 and 2018, the international transportation volume ranged within 30 million tons; in 2018, this figure increased to 31.1 million tons.

Due to low purchasing power, the population and businesses prefer buying cheap used/second-hand motor vehicles, imported mainly from the EU, Japan and the USA. According to the Ministry of Internal Affairs of Georgia, more than 90% of road transport in 2015 was old with low-efficient engines. The situation insignificantly improved in 2019 (Table 1.6.6.).

TABLE 1.6.6 Distribution of Road Transport by Age and Production Date

Year	Age (years)									
	1–3		4–6		7–10		11–20		>20	
	%	Production date	%	Production date	%	Production date	%	Production date	%	Production date
2015	2.2	2012-2015	1.8	2009-2011	8.0	2005-2008	46.5	1995-2004	40.8	1995-მდე
2016	1.9	2013-2016	2.3	2010-2012	7.2	2006-2009	46.4	1996-2005	41.5	1996-მდე
2017	1.8	2014-2017	3.0	2011-2013	6.8	2007-2010	44.4	1997-2006	43.3	1997-მდე
2018	1.9	2015–2018	3.9	2012–2014	6.8	2008–2011	41.8	1998–2007	45.0	1998-მდე
2019	2.2	2016-2019	3.8	2013-2015	7.2	2009-2012	38.4	1999-2008	47.8	1999-მდე

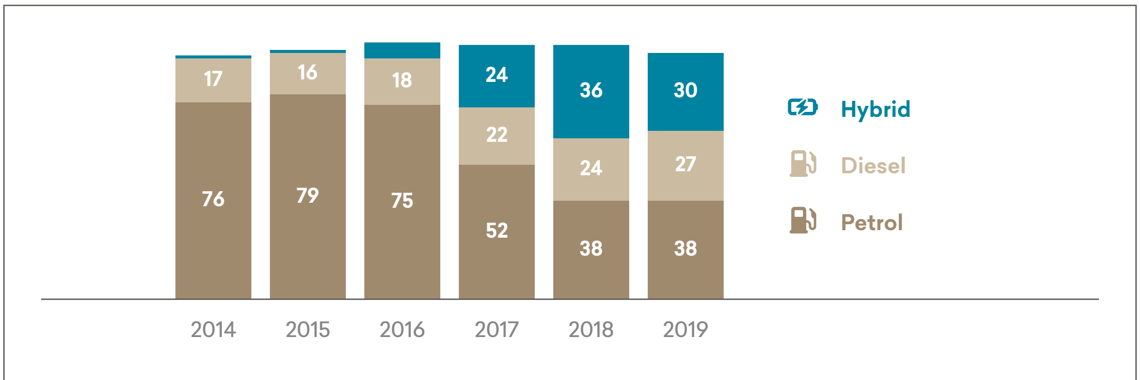
DISTRIBUTION OF IMPORTED PASSENGER CARS BY FUEL

Since 2017, the share of diesel oil-based cars and hybrid cars has increased. The distribution of imported passenger cars by fuel type is given in Table 1.6.7.

TABLE 1.6.7 Distribution of Imported Passenger Cars by Fuel Type (in %)

Fuel	2014	2015	2016	2017	2018	2019
Petrol	76	79	75	52	38	39
Diesel	17	16	18	22	24	27
Natural gas	6	3	1	1	0	1
Hybrid	1	1	6	24	36	32
Electric				1	1	1

FIGURE 1.6.2 Distribution of Imported Passenger Cars by Fuel Type (%)



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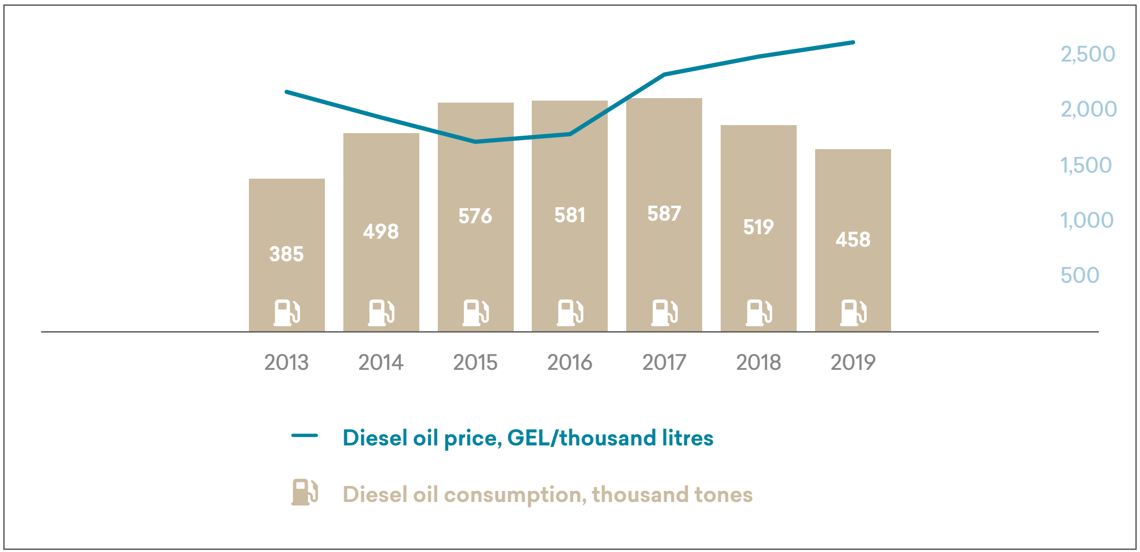
FUEL PRICES

Motor fuel price fluctuations were compared with those of crude oil. Diesel fuel and global oil prices have been changing in the same direction in Georgia between 2014-2018. Motor fuel consumption in Georgia significantly depends on its prices. The dependence of diesel oil consumption on its prices is given in Figure 1.6.3. According to these figures, an increase in fuel prices leads to a reduction in fuel consumption.

FIGURE 1.6.3 Dependence of Diesel Oil Consumption on its Price



1.7 Industry Sector

Low-carbon development possibilities for the industry sector (industry, manufacturing) are related to mitigating sectoral GHG emissions from two major sources: the energy sector and the industrial sector (technology-related emissions). The GHG emissions released from fuel combustion in the sector are counted for the energy sector while all other emissions, synthesized as by-products during the non-energy related activities at the production sites, are allocated to the IPPU sector. In addition, the IPPU sector also comprises the GHG emissions from product use (PU); namely, the use of ozone-depleting substances (ODS).

In 2016, the total GHG emissions (both energy and non-energy related) from the industry sector were estimated at 15% (2738 Gg CO2 eq.) of the total national GHG inventory (MEPA, 2021).

The IPCC 2006 Guidelines, used by Georgia for national GHG inventory reporting, consider energy and non-energy-related GHG emissions from the IPPU sector. The GHG emissions from the industrial (technological) processes relate to the appropriate technological activities (processes) while the energy-related GHG emissions are generated from the energy used for these (industrial) processes.

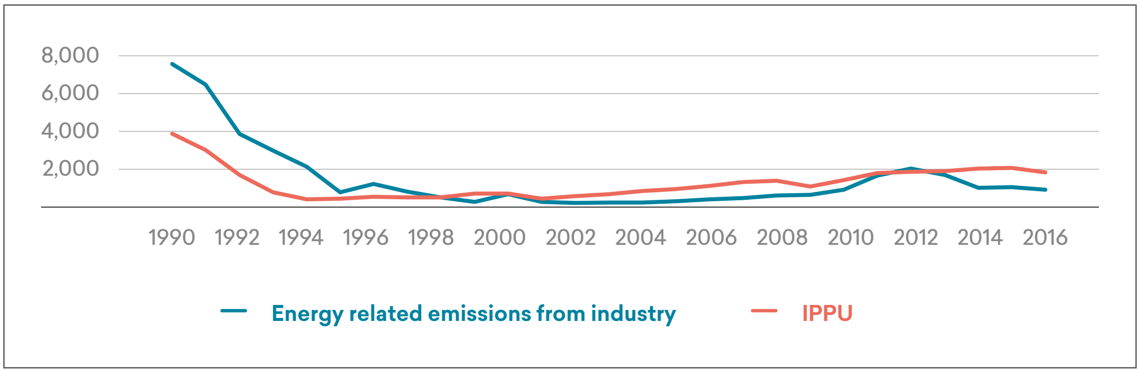
In accordance with Georgia's National GHG Inventory Report, the energy-related emissions from the industry sector are allocated within the energy sector; namely, the category of Manufacturing Industries and Construction (1A2) consisting of the following sub-categories: iron and steel production, chemicals, food products, non-metallic minerals and other. In 2016, the energy-related emissions from the industry sector were about 33% (916 Gg CO2 eq.) of the total industrial sector emissions. For the non-energy related (processual) emissions (IPCC), the following categories of the IPPU sector are taken into consideration: Mineral Products (2A), Chemical Industry (2B), Metal Production (2C), Non-Energy Products from Fuels and Solvent Use (2D), Electronics Industry (2E), Product Uses as Substitutes for ODS (2F) and Other Product Manufacture and Use (2G). According to the 5th National GHG Inventory Report of Georgia to the UNFCCC, no emission is generated in the sub-sector (2E) due to the absence of the electronics industry. Correspondingly, the higher share of the emissions within the sector is from non-energy related industrial processes – 67% (1822 Gg CO2 eq.) of the total industrial sector emissions.

Furthermore, the National GHG Inventory Report states that several categories are not estimated due to their insignificance and limited data processing capacity necessary for GHG emission estimations. These source-categories are Solvent Use (2D3), Foam Blowing Agents (2F2), Fire Protection (2F3), Aerosols (2F4), Solvents (2F5), and SF6 and PFCs from Other Product Uses (2G2).

Hence, the estimations do not consider the share of the emissions related to activities from these source-categories.

The GHG emissions from both energy-related and non-energy-related industrial activities declined between 1990 and 2016. By the end of this period, the emissions from energy-related activities comprised 12% of the emissions for the year 1990. The same value for the non-energy part of the emission (IPPU sector) was 47% since the decline was not as major as in the energy-related emission trend.

FIGURE 1.7.1 GHG Emissions Trends from the Industry Sector from 1990 to 2016 (Gg CO_2-eq)

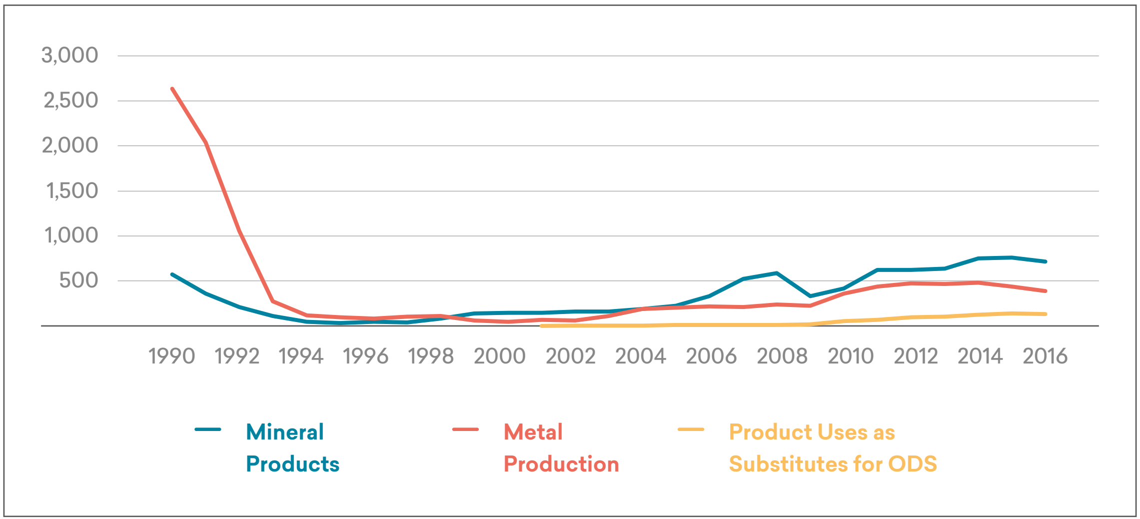


Several key major factors have influenced the GHG emission trends for three decades of estimation such as (1) the political instability at the beginning of the independence period of the country, (2) the economic crisis induced by global market changes, (3) industry market competition within the region and (4) increase of the share of renewables in energy generation causing a lowering of the grid emission factor.

In the IPPU sector itself (non-energy emissions), the sub-sector of mineral production prevailed in 2016, followed by metal production and ODS-substitutes subsectors, respectively, as demonstrated in the figure below.[19]

19 The data are presented with the consideration of confidentiality.

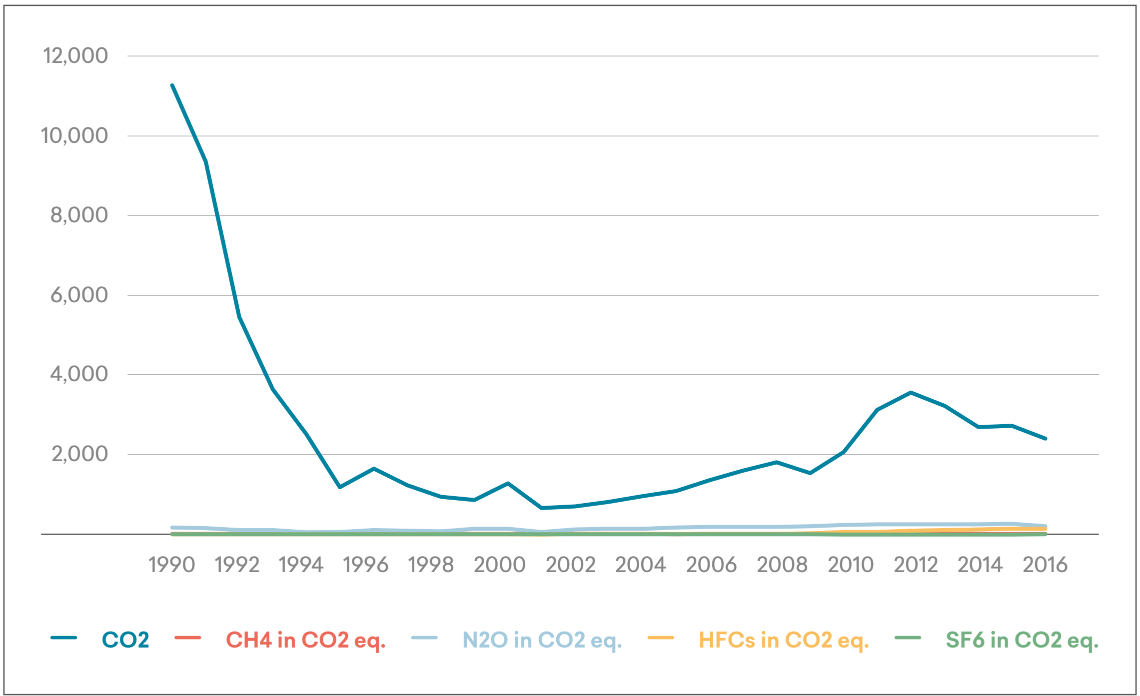
FIGURE 1.7.2 Trend of Non-energy GHG Emissions from the IPPU Sector in 1990-2016 (GgCO2 eq).



In terms of the variety of GHGs, the IPPU is considered one of the most complex sectors. The emissions trends for the period of 1990-2016 by categories and GHGs are presented below.

The types of greenhouse gases estimated under the industry sector are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs) and sulfur hexafluoride (SF6).[20]

FIGURE 1.7.3 GHG Emission Trend by Gases from 1990 to 2016



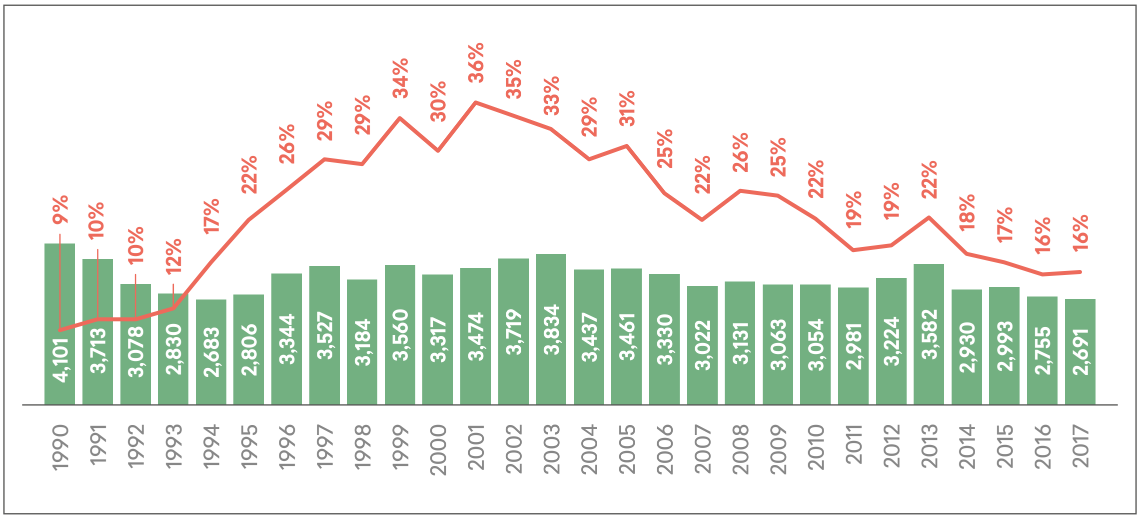
Other greenhouse gas estimated emissions are very low compared to carbon dioxide (CO_2). Nevertheless, accounting for all gases is a matter of completeness and accuracy.

20 The 5th National GHG Inventory Report.

1.8 Agriculture

According to Georgia's National GHG Inventory Report,[21] GHG emissions from the agriculture sector in 1990-2017 varied from 4,101 Gg CO_2eq in 1990 to 2,691 Gg CO_2eq in 2017. Sector share in national GHG emissions varied from 9.0% in 1990 to 36.2% in 2001 and 16% in 2017. Figure 1.8.1. presents GHG emissions from the agriculture sector and their share in national GHG emissions in 1990-2017.

FIGURE 1.8.1 GHG Emissions from the Agriculture Sector in Gg CO2eq and its Share in National GHG Emissions



	1990	1991	1992	1993	1994	1995	1996
GHG National	45,813	36,385	30,118	24,397	15,745	12,696	12,963
GHG Agriculture	4,101	3,713	3,078	2,830	2,683	2,806	3,344
Share of Agriculture	9%	10%	10%	12%	17%	22%	26%

	1997	1998	1999	2000	2001	2002	2003
GHG National	11,993	11,019	10,356	10,923	9,592	10,754	11,616
GHG Agriculture	3,527	3,184	3,560	3,317	3,474	3,719	3,834
Share of Agriculture	29%	29%	34%	30%	36%	35%	33%

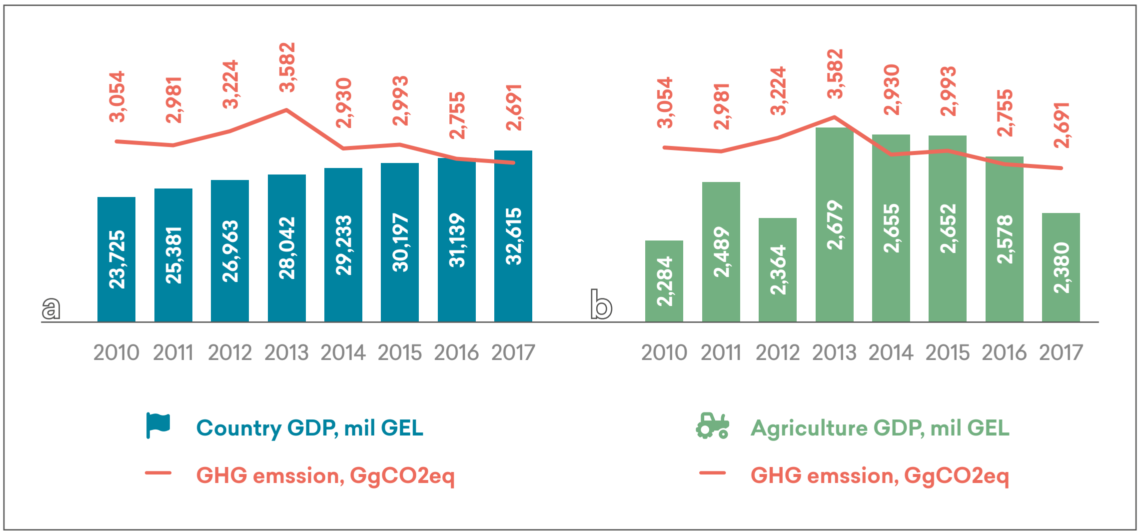
	2004	2005	2006	2007	2008	2009	2010
GHG National	11,707	11,168	13,099	13,624	12,203	12,203	13,688
GHG Agriculture	3,437	3,461	3,330	3,022	3,131	3,063	3,054
Share of Agriculture	29%	31%	25%	22%	26%	25%	22%

21 National Greenhouse Gas Inventory Report of Georgia (1990 2017). https://unfccc.int/sites/default/files/resource/NIR%20%20Eng%2030.03.pdf

	2011	2012	2013	2014	2015	2016	2017
GHG National	16,027	16,927	15,964	16,157	17,461	17,679	16,968
GHG Agriculture	2,981	3,224	3,582	2,930	2,993	2,755	2,691
Share of Agriculture	19%	19%	22%	18%	17%	16%	16%

National and agriculture GHG emissions and the GDP are given in Figure 1.8.2.

FIGURE 1.8.2 National GHG Emissions and GDP (a) and Agriculture GHG Emissions and Agriculture's Share in the GDP (b) (Gross domestic product at constant 2015 prices [basic prices] and Agricultural Value Added at Regular 2015 Prices)



During 2013-2019, energy consumption in the agriculture sector varied within 487-1,290 terajoule (TJ) and the related GHG emissions within 25.3-68.4 gigagram (Gg) CO_2eq.

In 2016, GHG emissions constituted 67.4 Gg CO_2eq. The share of emissions from fuel combustion in the agriculture sub-sector constituted 0.8% of energy sector emissions. In 2016, 600 tons (10 Tj) of coal, 13.9 thousand tons (592 TJ) of diesel oil, 900 tons (42 TJ) of gasoline and 10.5 million m^3 (368 TJ) of natural gas were used. Figures 1.8.3 and 1.8.4 show consumption by fuel type and related GHG emissions in 2016. Diesel fuel is the main source of fuel for agricultural machinery. Natural gas is used for heating farm buildings and in greenhouses. A total of 52.5 million kWh (189 TJ) of electricity was used mainly for water pumping and partly for lighting.

FIGURE 1.8.3 Fuel Combustion by Type in TJ in 2016

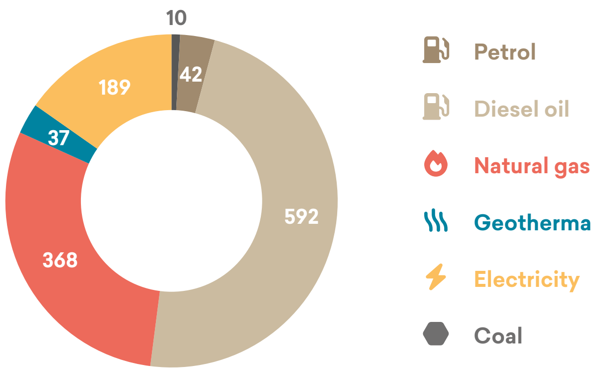


FIGURE 1.8.4 Energy (Fuel Combustion) Related GHG Emissions in 2016 in Gg CO2-eq

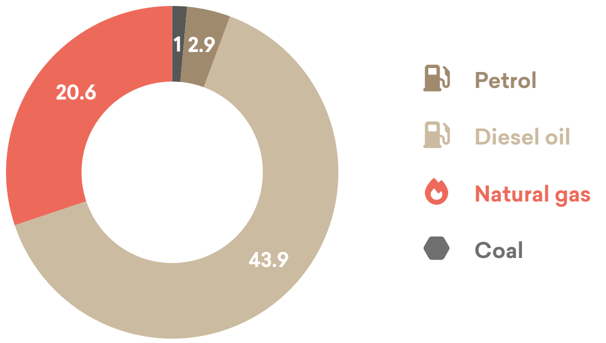


TABLE 1.8.1 Energy Consumption in TJ During 2013-2019

Year	Coal	Gasoline	Diesel	LPG	Natural Gas	Geothermal, solar	Biofuel	Electricity	Total
2013	-	36.2	352.9	-	58.6	-	0.0	125.6	573
2014	-	35.2	205	1	135	21.3	1	110	487
2015	8.4	4.3	383.9	0.1	146.5	33.5	0.0	205.2	782
2016	10.3	41.7	592.1	0.0	367.5	37.0	0.3	189.0	1,238
2017	10.5	70.0	506.9	0.0	437.5	37.8	1.1	226.4	1,290
2018	7.6	87.2	410.7	3.7	283.5	39.4	0.5	285.8	1,118
2019	4.4	68.6	391.9	13.8	307.8	42.6	0.0	291.2	1,120

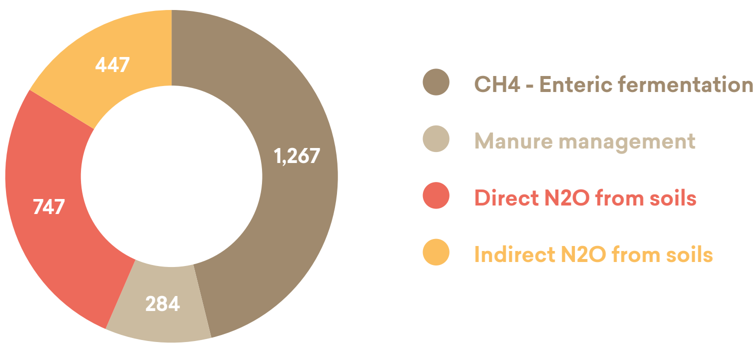
TABLE 1.8.2 CO_2 Emissions by Fuel in Gg CO_2-eq in 2013-2019

Year	Coal	Gasoline	Diesel	LPG	Natural Gas	Total
2013		2.5	26.1	0.0	3.3	31.9
2014		2.4	15.2	0.0	7.6	25.3
2015	0.8	0.3	28.4	0.0	8.2	37.8
2016	1.0	2.9	43.9	0.0	20.6	68.4
2017	1.0	4.9	37.6	0.0	24.5	68.0
2018	0.7	6.0	30.4	0.2	15.9	53.3
2019	0.4	4.8	29.0	0.9	17.3	52.4

As a source of GHG emissions, Georgia's agricultural sector includes three source categories: enteric fermentation, manure management and agricultural soils. According to the IPCC classification, other categories such as rice growing and savanna burning are not typical for Georgia and, therefore, are not considered.

GHG emissions in 2016 constituted 2,755 Gg CO_2eq, about 16% of national GHG emissions. The main source of methane is enteric fermentation while the main sources of Nitrous Oxide are agricultural soils - direct emissions (*synthetic fertilizers, animal waste (organic fertilizers) applied to soils, crop residue decomposition and manure from grazing animals*) and indirect emissions (*nitrogen evaporation and deposition and nitrogen leaching and run-off*). On the right, Figure 1.8.5. gives GHG emissions from the agriculture sector in 2016.

FIGURE 1.8.5 GHG Emissions (Gg CO2-eq) from Major Sources in 2016



According to the 2014 Census of Agriculture, Georgia has 2.55 million hectares of agricultural land which is about 37% of the country's total area. Georgia has favorable climatic and natural conditions conducive to the development of agriculture. Nowadays, however, the agriculture sector is characterized by low productivity. During 2010-2019, the share of agriculture in the GDP fell from 9.6% in 2010 to 7.4% in 2019.

Transparency International Georgia has analyzed the trends in Georgia's agriculture sector in 2012-2019.[22]

A total of 19.8% of all employees work in the agriculture sector (2020) and mostly on their small farms. A total of 73.1% of farms manage up to 1 ha, 25% from 1 ha to 5 ha and only 1.5% manage more than 5 ha. The scarcity of land areas confines the development of large-scale farming and affects the farming scale

Crop area was reduced by 20% in 2018 as compared to 2012. The highest reduction was in maize growing areas. Despite a decline in total crop production, there is a positive trend in almost every annual crop yield (production per ha).

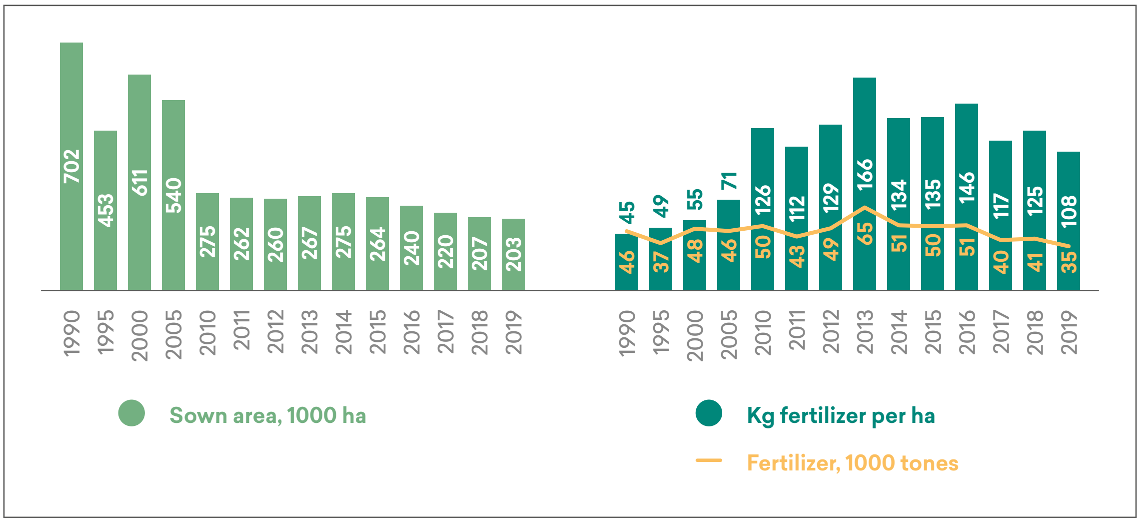
The decline in the quantities of livestock did not have a tangible impact on livestock production. Meat production has an upward trend. Unlike meat, milk production has decreased.

A number of state programs have been implemented in the last 15 years to develop agriculture; however, they have been mostly social rather than aimed at increasing the economic efficiency of the sector.

The main drivers of GHG emissions from the agriculture sector are the number and distribution by breeds of livestock, manure distribution by the manure management system and the amount of applied nitrogen fertilizers (sown area and fertilizer consumption per ha).

The sown area (croplands) drastically fell between 2005 and 2010. In 2019, sown areas constituted only 29% of the 1990 level. Applied nitrogen fertilizers per ha during 2010-2019 varied in the range of 108-166 kg/ha. Figure 1.8.6. gives information on cultivated land occupied by annual and permanent crops and nitrogen (N) fertilizer applied during 1990-2019. The amount of applied N fertilizers and the average amount of N fertilizer added per ha varied significantly from year to year.

FIGURE 1.8.6 Areas of Annual and Permanent Crops and Amount of Nitrogen Fertilizers Applied in 1990-2019

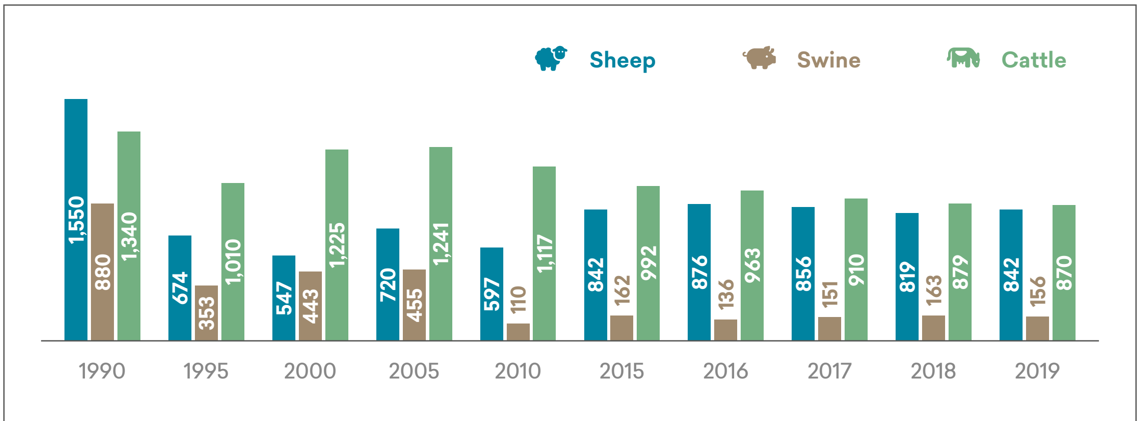


22 Trends in Georgia's Agriculture Sector in 2012-2019, March 12, 2020. https://www.transparency.ge/en/post/trends-georgias-agriculture-sector-2012-2019

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Area under annual crops, 1,000 ha	702	453	611	540	275	262	260	267	275	264	240	220	207	203
Area under permanent crops, 1,000 ha	322	296	259	106	121	121	121	125	106	106	110	121	121	121
Nitrogen fertilizers, 1,000 tons	46	37	48	46	50	43	49	65	51	50	51	40	41	35
Kg nitrogen fertilizers per ha	45	49	55	71	126	112	129	166	134	135	146	117	125	108

The highest number of livestock was recorded in 1990. In 1991-1995, the number of livestock drastically decreased; however, it more or less stabilized in the last years (Figure 1.8.7.). The numbers of livestock since 2014 are based on the Census of Agriculture 2014.

FIGURE 1.8.7 Numbers of Cattle, Sheep and Swine (Thousand Heads) in 1990-2019



Food security is a vital necessity for society and its members. Food independence provides the basis for food security. The share of domestic production in food products supply is low in Georgia; more than 50% of consumed meat and dairy products are imported (Table 1.8.3, a, b.). Moreover, consumption of essential products - meat and dairy - is low. Per capita, meat consumption (average of around 40 kg) is significantly less than in the EU (on average 64 kg per capita in 2016). Dairy product consumption in 2016 constituted 184 kg/capita (in Europe, 288 kg/capita).

TABLE 1.8.3 (A) Per Capita Meat Consumption and Share of Import

Indicator	Beef				Pork				Sheep and Goats			
	2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
kg/capita	7.4	7.6	8.2	8.5	10.8	11.2	11.3	12.1	1.5	2.0	2.7	1.8
Import, %	21	24	24	29	56	59	54	56	15	11	7	12

TABLE 1.8.3 (B) Per Capita Meat Consumption and Share of Import

Indicator	Poultry				Meat in Total			
	2016	2017	2018	2019	2016	2017	2018	2019
kg/capita	21.2	20.1	20.1	20.8	40.8	41.0	42.2	43.2
Import, %	70	70	69	70	55	55	53	56

Part of dairy cattle and swine manure is disposed of in anaerobic lagoons. The use of an anaerobic lagoon is one of the most common practices for storing manure on big farms.

A significant part of the agricultural soil of Georgia is highly degraded, mainly due to soil erosion. As a result, soil productivity, essential to agricultural development, food security and support of the livelihoods of poor populations, is very low in Georgia. For instance, the yield of cereals, which are strategic for the country - wheat and corn (maize) - is 2.5 t/ha, much lower than the average yield in the European Union (5.66 t/ha wheat and 8.8 t/ha maize).

1.9 LULUCF (Land Use, Land Use Change and Forestry) Sector

Forests are one of the most precious resources in Georgia. They have a leading multifunctional role as a natural carbon sink and as renewable natural resources for the country. Due to the difficult terrain and contrasting climatic conditions, the forests of Georgia create a unique ecosystem. Forests (including the forest areas of Abkhazia and South Ossetia) cover about 2.77 million hectares of Georgian land which is 39% of the country's territory. A total of 97-98% of Georgia's forests are of natural origin; their composition, structure, growth, development conditions and other characteristics create a rich biodiversity. About 800 species of trees and shrubs grow in the forests of Georgia. The diversity of dendroflora is expressed in the high number of endemic woody species; 61 species are endemic to Georgia and 43 species are endemic to the Caucasus region that occur in the forests of Georgia.

A total of 98% of forested areas fall on mountain slopes and more than 60% of forests are located on slopes with an inclination above 25 degrees. A total of 24% of forests grow on more than 35 degree slopes where the law prohibits forest use. Only 14% of the forests are located below 750 meters above sea level while almost 60% are located above 1,000 meters above sea level.

The condition of a significant part of the forests is currently unsatisfactory which is reflected in the following: 54% of the forest area is covered with stands of 0.5 and lesser density, there is often an undesirable change of woody species (where relatively low value secondary woody species replace high-value woody species), there are frequent processes of erosion and degradation of soil and stands, the upper forest line of sub-alpine forests is significantly shifting down and fairly large areas are covered with low-density stands with dense evergreen understory and tall grass and almost no natural regeneration of the forest. The number of high-value woody species (chestnut, elm, maple, yew, box tree, etc.) is significantly reduced in the forests due to their use for various purposes. Forest restoration and maintenance measures require a lot of financial resources which hinders the large-scale rehabilitation of degraded forest areas.

LULUCF (Land Use, Land Use Change and Forestry) is a sector developed explicitly by the IPCC for evaluating greenhouse gas emissions and removals caused by various activities in different land categories (such as forestry, agriculture, peat mining, urbanization, etc.), including changes in land categories.

Emissions and removals in the sector are recorded in a total of six land categories (forest land, cropland, grassland, wetlands, settlements and other land use) where, as mentioned above, emissions originate and vary in amount as a result of various activities as well as changes in land categories. Unlike other sectors, the LULUCF sector is a source but also a sink for carbon dioxide emissions. Based on the balance between these two functions, it can be determined whether the LULUCF sector is a carbon emitter or a carbon sink (i.e., removes more than it releases).

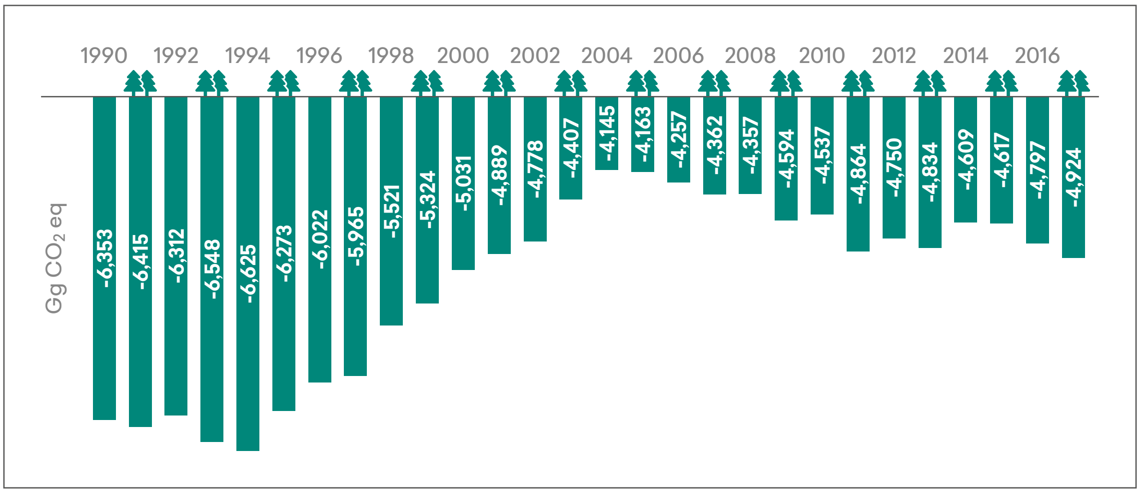
One of the main drivers of GHG emissions in the LULUCF sector is changes in land use categories and areas. Therefore, land use changes are tracked during GHG inventories in the LULUCF sector and a land-use matrix is prepared for those inventories (see Table 1.9.1.).

TABLE 1.9.1 Georgia's Land Use Change Matrix for 2016-2017 (Including Abkhazia and South Ossetia)

Land Use Categories	Area, Thousand ha	
	2016	2017
Forest land	2746.5	2747.1
Cropland	918.1	928.9
Grassland	1996.5	1996.5
Wetlands	835.1	835.1
Settlements	211.2	211.2
Other land use	921.0	909.6
Total (including territorial waters)	7628.4	7628.4

According to the latest GHG inventory (2019), the LULUCF sector represents a carbon reservoir; i.e., as mentioned above, a carbon sink (see Figure 1.9.1.).

FIGURE 1.9.1 Dynamics of Net Removals-Emissions in the LULUCF Sector in 1990-2017



As the above figure shows, the highest removal rate in the sector was recorded in 1994 (-6,625.1 Gg CO_2), followed by an almost yearly declining trend and removals decreased by 35% (-4,145.3 Gg CO_2) by 2004. In the following years, the trend is reversed and there is an increase in removals, although at a relatively low rate. By 2017, removals increased by 16%, reaching -4,923.8 Gg CO_2.

TABLE 1.9.2 LULUCF Sector Removals/Emissions in 2016-2017 (Fourth National Communication)

Year	Forest lands		Croplands				Grasslands		Net emission/removal	
			Perennial crops		Arable lands					
	Thousand ton C	Gg CO_2	Thousand ton C	Gg CO_2	Thousand ton C	Gg CO_2	Thousand ton C	Gg CO_2	Thousand ton C	Gg CO_2
2016	1,532	-5,617	231	-847	339	-1,244	-794	2,912	1,308	-4,797
2017	1,521	-5,578	276	-1,013	339	-1,244	-794	2,912	1,343	-4,924

The 1990-2017 LULUCF sector GHG inventory was conducted in only three sub-sectors - forest lands, croplands and grasslands. These are the main sub-sectors with relatively large-scale removals/emissions. As can be seen from Table 1.9.2., forest lands have the highest removal potential as compared to other LULUCF sub-sectors. The grasslands sub-sector is the only net emitter in the LULUCF sector with annual emissions of 2912 Gg CO_2 in 2016 and 2017.

1.10 Waste Sector

The waste sector remains a significant challenge for Georgia due to problems with inadequate waste management, including a lack of proper regulation for hazardous waste, outdated landfills and the disposal of a substantial part of municipal waste in dumpsites.

Emission sources in the waste sector include non-hazardous waste landfills and wastewater. The sector accounted for approximately 8.79% of national GHG emissions (1,562 GgCO_2e) in 2017. In 2017, emissions from solid waste disposal accounted for 71% of the sector's GHG emissions while emissions from wastewater management represented 29%, split almost evenly between domestic and industrial wastewater management. Waste incineration (of clinical waste) and composting emissions have not yet been recorded in the national inventory, although these activities are carried out throughout the country.

The country has 57 non-hazardous solid waste landfills. A total of 54 of the non-hazardous waste landfills are managed by the Solid Waste Management Company of Georgia (25 are already closed, one is in the process of closure and 28 are still active). The Waste Management Company plans the construction of six new non-hazardous waste landfills for the disposal of regional waste and will close other landfills in parallel.

Around 900,000 tons of municipal waste are generated annually in Georgia of which about 700,000 tons are disposed of in official landfills. The remaining 200,000 tons are disposed of in dumpsites (dumped in ravines and riverbeds) or burnt in open spaces (Government of Georgia, 2016b). Apart from polluting adjacent areas and the environment in general, dumpsites pose a significant threat to human health. According to the National Waste Management Strategy and Action Plan, all existing dumpsites in the country should be closed by the end of 2030 along with the construction of new landfills. The processes have already started at the municipal level. There are no data on the share of the population with access to waste collection services but according to the National Waste Management Strategy and Action Plan, the waste collection rate should be at 100% by 2025 with all municipal waste collected, partially recycled and disposed of in non-hazardous waste landfills.

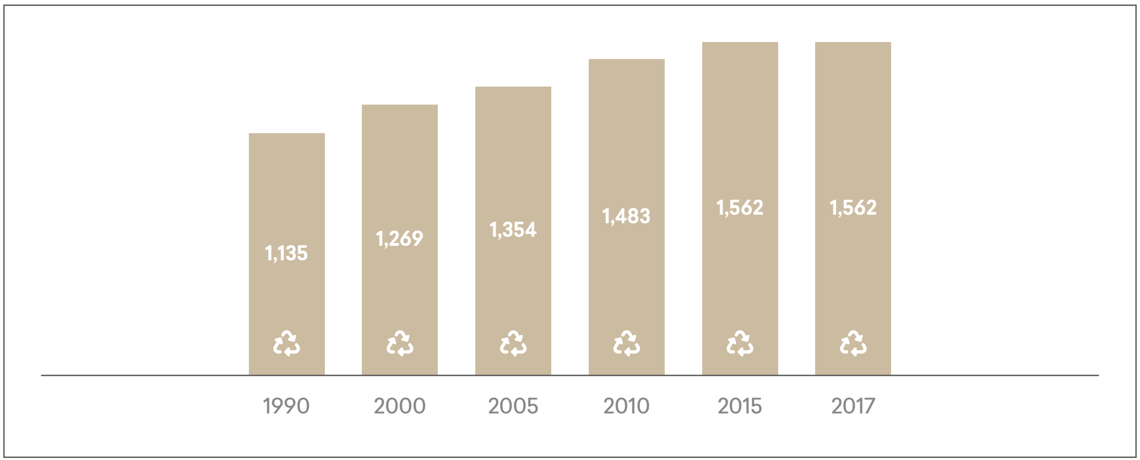
About 80% of the population is connected to sewerage systems. However, these systems were built between 25-40 years ago and are in poor condition. Most plants cannot provide highly efficient sewage treatment and none provide biological treatment since the technical facilities are out of order (MEPA, 2019). It should be noted that according to the data for 2022, the construction of treatment plants has been completed in Telavi, Tskaltubo, Zugdidi, Abastumani, Ureki and Anaklia. In addition, the Poti wastewater treatment plant's construction is at the completion stage. Wastewater treatment plants were constructed in the towns of Gudauri and Marneuli.

Over the years, the waste sector in Georgia has experienced slow but steady growth and this trend is expected to continue in the future. However, adequate waste management has become one of the country's priorities in recent years. In 2016, Georgia adopted the Waste Management National Strategy and its Action Plan in compliance with the Waste Management Code and relevant directives envisaged under the EU-Georgia Association Agreement.

The following source categories are identified by the 2006 IPCC guidelines for the waste sector; namely, Solid Waste Disposal on Land, Biological Treatment of Solid Waste (Thermal Processing of SW and Composting), Incineration and Open Burning of Waste and Wastewater Treatment and Discharge (Domestic and Commercial WW and Industrial WW). Therefore, Georgia only accounts for GHG emissions from Solid Waste Disposal on Land (SWDL) and Wastewater Treatment (WWT). Incineration (except clinical waste) or municipal solid waste's thermal processing does not occur in the country. However, mechanical composting and incineration of clinical waste are already in practice.

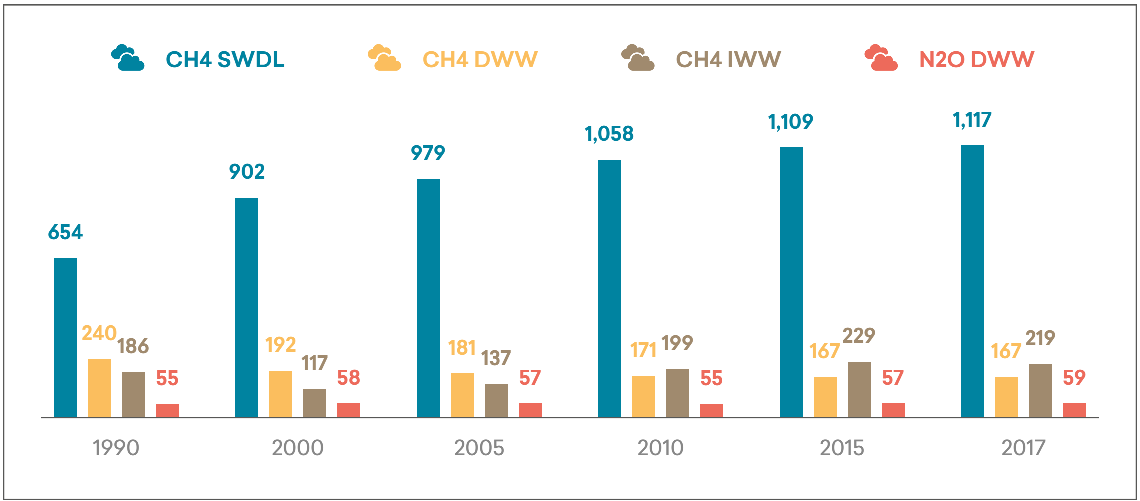
The sector is a considerable emitter of GHGs and the sub-sectors of Solid Waste and Domestic Wastewater keep being among the key categories of the national GHG inventory for years. The sector keeps increasing GHG emissions. According to the latest National GHG Emissions Inventory, embracing 1990-2017, the sector accounted for approximately 8.79% of national GHG emissions (1,562 $GgCO_2e$) in 2017. The emissions from solid waste disposal accounted for 71% of the sector's GHG emissions while emissions from wastewater management represented the remaining 29% of emissions, split almost evenly between domestic and industrial wastewater treatment.

FIGURE 1.10.1 Trend of GHG Emissions from the Waste Sector Over Time (National GHG Inventory Report of Georgia 1990-2017)



Among the sub-sectors, the SWD is the major source of emissions. The distribution of sectoral emissions among the sub-sectors by year is presented below:

FIGURE 1.10.2 Trend of GHG Emissions (Tons) from the Waste Sector with Shares of Sub-sectors (National GHG Inventory Report of Georgia 1990-2017)



It is important to note that Georgia's GHG inventories so far keep reporting only these sub-sectors: SWDL and WWT, while in the long-term perspective, the other sub-sectors, identified by the UNFCCC reporting guidelines and IPCC guidelines for GHG inventories for the waste sector, are to be taken in consideration in the course of the introduction and the implementation of new practices. The CS 2030/CAP 2021-2023 reflects composting emissions in the projections from 2020 as this practice is already in place in Georgia. The LT LEDS will also keep this approach for the projections but the actual data are based on the sector's latest GHG inventory 2019 and BUR 2019 layout.

2 GEORGIA'S LONG-TERM VISION FOR LOW EMISSION DEVELOPMENT

In the updated Nationally Determined Contribution (NDC2021), as well as the Climate Change Strategy 2030 and the Climate Change Action Plan 2021-2023, Georgia has set realistic GHG emission reduction goals for 2030 based on "bottom-up and top-down" calculations made on the ground of specific sectoral policies, measures and technologies. However, in order to plan a long-term climate change policy, a clear vision of "a perfect future model" is required which shows where the policy should be directed and where the efforts should be mobilized to implement it.

For this reason, Georgia proclaims 'climate neutrality' as its goal and aims at achieving it by mid-century.

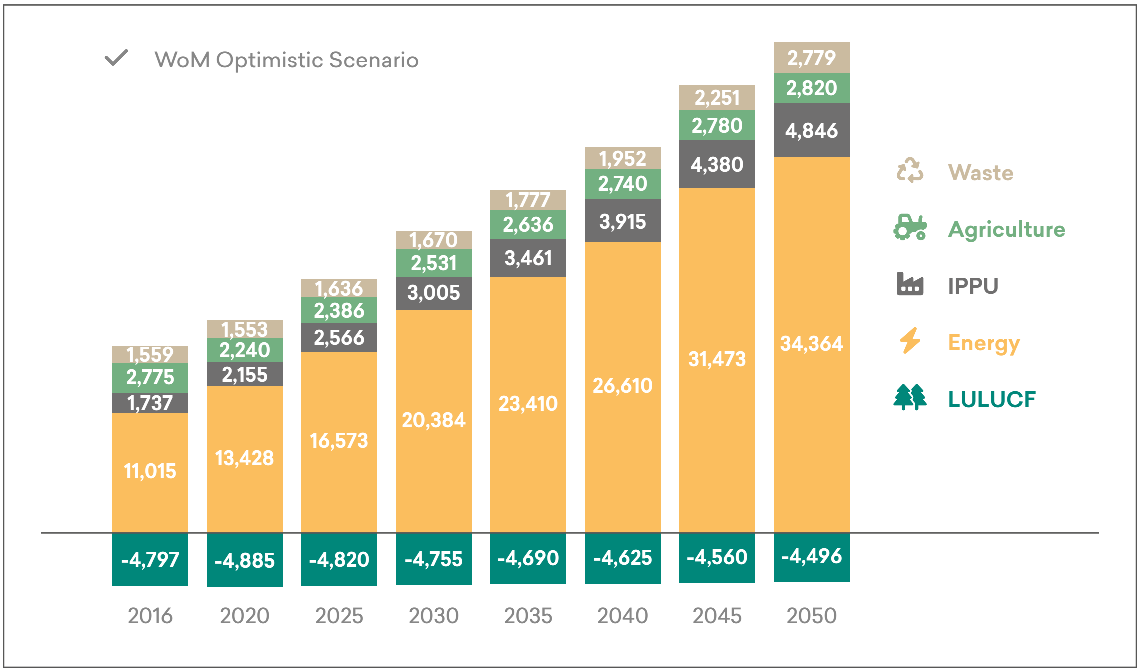
2.1 Projections of National Greenhouse Gas Emissions for 2050

This section describes the range of projected GHG emissions by 2050 between optimistic and pessimistic development scenario trajectories for Georgia for which sector-specific models and methodologies have been used. There is a tentative methodology for collecting data for Monitoring, Reporting and Verification (MRV) proposed for each sector (to see the methodology used, see Annex 1 - Methodology and Projections - Used Models, Description, Assumptions, Parameters. Projected National GHG Emissions by 2050).

Projected national GHG emissions in the case of the baseline scenario (WoM scenario) and the share of sectoral emissions are estimated based on the projected sectoral GHG emissions (provided in Annex 1 in subsequent paragraphs). Results are provided in Figure 2.1.1. and in Tables 2.1.1-2.1.2.

GHG emissions (including LULUCF) by 2050 will reach 40,313 Gg CO_2-eq in the case of the WoM optimistic scenario and 32,499 Gg CO_2-eq in the case of the WoM pessimistic scenario and GHG emissions (excluding LULUCF) by 2050 will reach 44,808 Gg CO_2-eq in the case of the WoM optimistic scenario and 36,995 Gg CO_2-eq in the case of the WoM pessimistic scenario.

FIGURE 2.1.1 Projected GHG Emissions in Gg CO2-eq. WoM Optimistic (a) and WoM Pessimistic (b) Scenarios



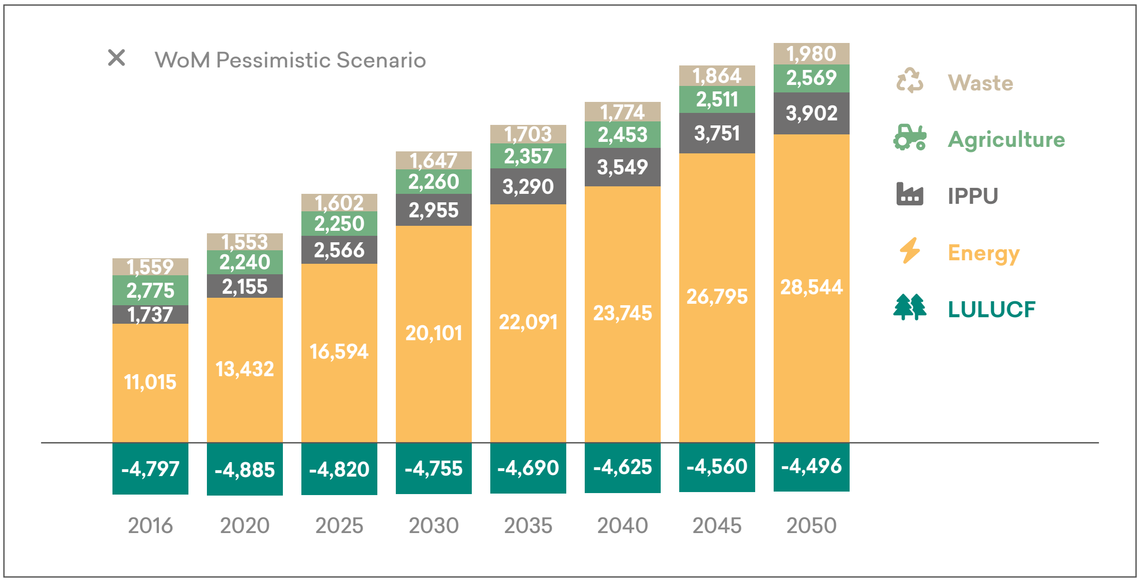


TABLE 2.1.1 Projected National GHG Emissions in Gg CO2-eq. WoM Optimistic Scenario

Sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy	11,015	13,428	16,573	20,384	23,410	26,610	31,473	34,364
IPPU	1,737	2,155	2,566	3,005	3,461	3,915	4,380	4,846
Agriculture	2,775	2,240	2,386	2,531	2,636	2,740	2,780	2,820
Waste	1,559	1,553	1,636	1,670	1,777	1,952	2,251	2,779
Total excluding LULUCF	**17,086**	**19,376**	**23,161**	**27,590**	**31,284**	**35,217**	**40,884**	**44,808**
LULUCF	-4,797	-4,885	-4,820	-4,755	-4,690	-4,625	-4,560	-4,496
Total including LULUCF	**12,289**	**14,491**	**18,341**	**22,835**	**26,594**	**30,592**	**36,324**	**40,313**

TABLE 2.1.2 Projected National GHG Emissions in Gg CO2-eq. WoM Pessimistic Scenario

Sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy	11,015	13,432	16,594	20,101	22,091	23,745	26,795	28,544
IPPU	1,737	2,155	2,566	2,955	3,290	3,549	3,751	3,902
Agriculture	2,775	2,240	2,250	2,260	2,357	2,453	2,511	2,569
Waste	1,559	1,553	1,602	1,647	1,703	1,774	1,864	1,980
Total excluding LULUCF	**17,085**	**19,380**	**23,011**	**26,963**	**29,441**	**31,522**	**34,920**	**36,995**
LULUCF	-4,797	-4,885	-4,820	-4,755	-4,690	-4,625	-4,560	-4,496
Total including LULUCF	**12,289**	**14,495**	**18,192**	**22,208**	**24,751**	**26,897**	**30,360**	**32,499**

TABLE 2.1.3 Share of Sectoral GHG Emissions in National GHG Emissions

Sector	WoM optimistic scenario				WoM pessimistic scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Energy	69%	74%	76%	77%	69%	75%	75%	77%
IPPU	11%	11%	11%	11%	11%	11%	11%	11%
Agriculture	12%	9%	8%	6%	12%	8%	8%	7%
Waste	8%	6%	6%	6%	8%	6%	6%	5%
Total excluding LULUCF	100%	100%	100%	100%	100%	100%	100%	100%
LULUCF	-25%	-17%	-13%	-10%	-25%	-18%	-15%	-12%
Total including LULUCF	75%	83%	87%	90%	75%	82%	85%	88%

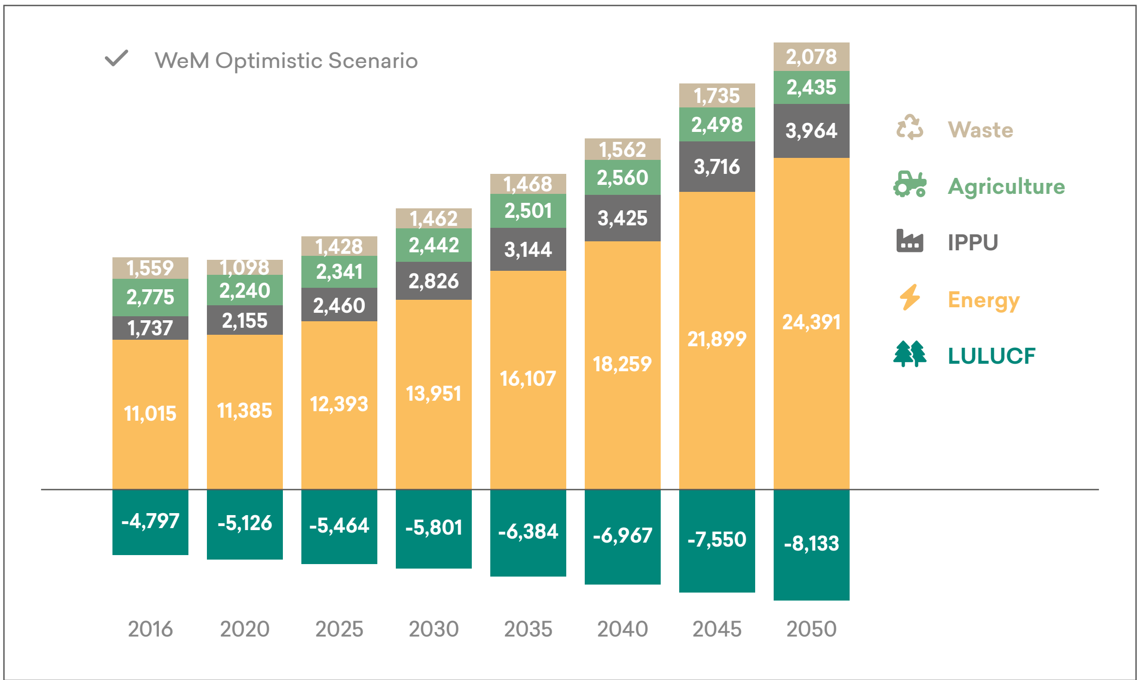
2.2 Protection of GHG Emissions and Strengthening of Absorption for the Year 2050

Projection of national GHG emissions in the case of mitigation (without additional measures [WeM][23] and with additional measures [WaM])[24] scenarios are based on the projected sectoral GHG emissions for mitigation (WeM and WaM) scenarios. (See Annex 1 - Methodology and Projections - Used Models, Description, Assumptions, Parameters. Projected National GHG Emissions by 2050).

WEM SCENARIO WITH EXISTING AND PLANNED MEASURES

Expected GHG emissions (including LULUCF) by 2050 will be 24,736 Gg CO_2-eq in the case of the WeM optimistic scenario and 19,134 Gg CO_2-eq in the case of the WeM pessimistic scenario and GHG emissions (excluding LULUCF) by 2050 will be 32,868 Gg CO_2-eq in the case of the WeM optimistic scenario and 27,267 Gg CO_2-eq in the case of the WeM pessimistic scenario.

FIGURE 2.2.1 Projected GHG Emissions in Gg CO2-eq. WeM Optimistic (a) and WeM Pessimistic (b) Scenarios



23 WEM refers to the scenario with measures planned by the country in accordance with the existing strategies and plans.

24 WAM refers to the scenario with measures that are not planned and represents potential additional measures to increase emission reductions.

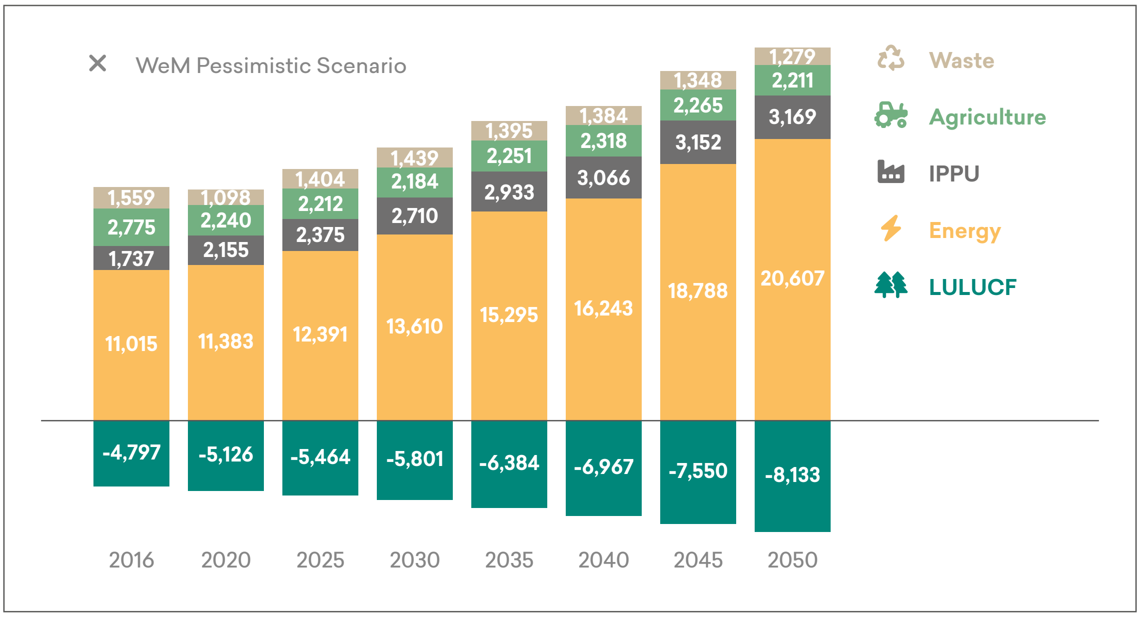


TABLE 2.2.1 Projected National GHG Emissions in Gg CO2-eq. WeM Optimistic Scenario

Sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy	11,015	11,385	12,393	13,951	16,107	18,259	21,899	24,391
IPPU	1,737	2,155	2,460	2,826	3,144	3,425	3,716	3,964
Agriculture	2,775	2,240	2,341	2,442	2,501	2,560	2,498	2,435
Waste	1,559	1,098	1,428	1,462	1,468	1,562	1,735	2,078
Total excluding LULUCF	**17,085**	**16,879**	**18,621**	**20,680**	**23,220**	**25,806**	**29,848**	**32,868**
LULUCF	-4,797	-5,126	-5,464	-5,801	-6,384	-6,967	-7,550	-8,133
Total including LULUCF	**12,289**	**11,752**	**13,157**	**14,879**	**16,835**	**18,839**	**22,298**	**24,736**

TABLE 2.2.2 Projected National GHG Emissions in Gg CO2-eq. WeM Pessimistic Scenario

Sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy	11,015	11,383	12,391	13,610	15,295	16,243	18,788	20,607
IPPU	1,737	2,155	2,375	2,710	2,933	3,066	3,152	3,169
Agriculture	2,775	2,240	2,212	2,184	2,251	2,318	2,265	2,211
Waste	1559	1,098	1,404	1,439	1,395	1,384	1,348	1,279
Total excluding LULUCF	**17,085**	**16,876**	**18,382**	**19,943**	**21,874**	**23,011**	**25,554**	**27,267**
LULUCF	-4,797	-5,126	-5,464	-5,801	-6,384	-6,967	-7,550	-8,133
Total including LULUCF	**12,289**	**11,750**	**12,918**	**14,141**	**15,489**	**16,043**	**18,004**	**19,134**

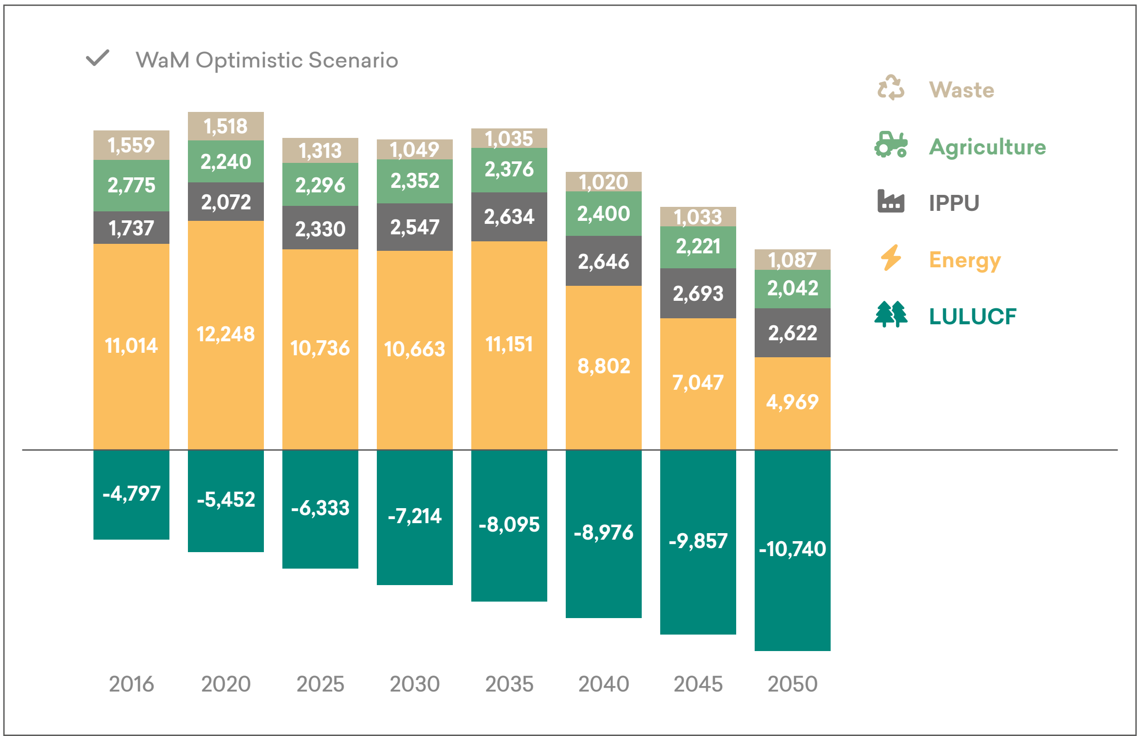
TABLE 2.2.3 Share of Sectoral GHG Emissions in National GHG Emissions

Sector	WeM optimistic scenario				WeM pessimistic scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Energy	67%	67%	71%	74%	67.45%	68.21%	70.56%	75.54%
IPPU	13%	14%	13%	12%	13%	14%	13%	12%
Agriculture	13%	12%	10%	7%	13%	11%	10%	8%
Waste	7%	7%	6%	6%	7%	7%	6%	5%
Total excluding LULUCF	100%	100%	100%	100%	100%	100%	100%	100%
LULUCF	-30%	-28%	-27%	-25%	-30%	-29%	-30%	-29%
Total including LULUCF	70%	72%	73%	75%	70%	71%	70%	71%

WAM SCENARIO

Expected GHG emissions (including LULUCF) by 2050 will be -20 Gg CO_2-eq in the case of the WaM optimistic scenario and -801 Gg CO_2-eq in the case of the WaM pessimistic scenario and GHG emissions (excluding LULUCF) by 2050 will be 10,720 Gg CO_2-eq in the case of the WaM optimistic scenario and 9,939 Gg CO_2-eq in the case of the WaM pessimistic scenario.

FIGURE 2.2.2 Projected GHG Emissions in Gg CO2-eq. WaM Optimistic (a) and WaM Pessimistic (b) Scenarios



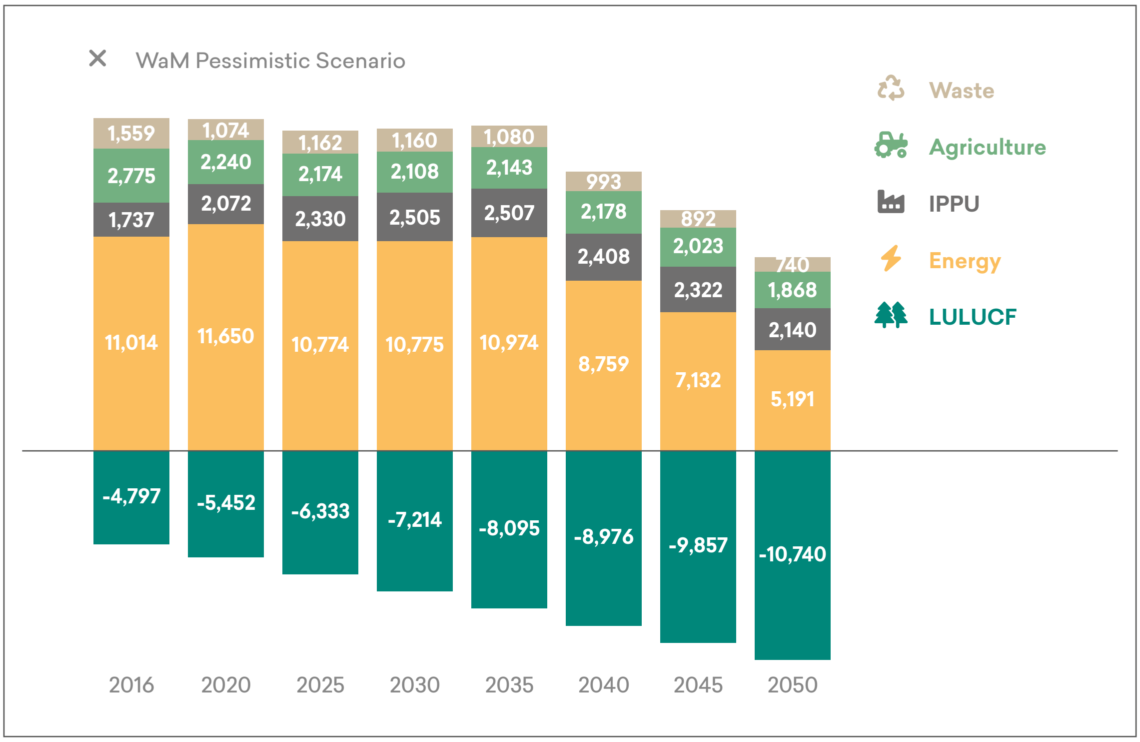


TABLE 2.2.4 Projected National GHG Emissions in Gg CO_2-eq. WaM Optimistic Scenario

Sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy	11,014	12,248	10,736	10,663	11,151	8,802	7,047	4,969
IPPU	1,737	2,072	2,330	2,547	2,634	2,646	2,693	2,622
Agriculture	2,775	2,240	2,296	2,352	2,376	2,400	2,221	2,042
Waste*	1,559	1,518	1,313	1,049	1,035	1,020	1,033	1,087
Total excluding LULUCF	**17,085**	**18,077**	**16,675**	**16,611**	**17,196**	**14,868**	**12,994**	**10,720**
LULUCF	-4,797	-5,452	-6,333	-7,214	-8,095	-8,976	-9,857	-10,740
Total including LULUCF	**12,288**	**12,625**	**10,341**	**9,396**	**9,101**	**5,892**	**3,136**	**-20**

* Additional CH_4 recovery potential has been accounted for.

TABLE 2.2.5 Projected National GHG Emissions in Gg CO_2-eq. WaM Pessimistic Scenario

Sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy	11,014	11,650	10,774	10,775	10,974	8,759	7,132	5,191
IPPU	1,737	2,072	2,330	2,505	2,507	2,408	2,322	2,140
Agriculture	2,775	2,240	2,174	2,108	2,143	2,178	2,023	1,868
Waste	1,559	1,074	1,162	1,160	1,080	993	892	740
Total excluding LULUCF	**17,085**	**17,036**	**16,440**	**16,548**	**16,704**	**14,338**	**12,369**	**9,939**
LULUCF	-4,797	-5,452	-6,333	-7,214	-8,095	-8,976	-9,857	-10,740
Total including LULUCF	**12,288**	**11,583**	**10,107**	**9,334**	**8,609**	**5,362**	**2,511**	**-801**

TABLE 2.2.6 Share of Sectoral GHG Emissions in National GHG Emissions. WaM Optimistic and WaM Pessimistic Scenarios

Sector	WaM optimistic scenario				WaM pessimistic scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Energy	68%	64%	59%	46%	67%	66%	61%	50%
IPPU	12%	15%	18%	25%	12%	15%	17%	21%
Agriculture	12%	14%	16%	19%	13%	13%	15%	18%
Waste	8%	6%	7%	10%	6%	7%	7%	6%
Total excluding LULUCF	100%	100%	100%	100%	100%	100%	100%	100%
LULUCF	-30%	-44%	-61%	-101%	-31%	-44%	-63%	-105%
Total including LULUCF	70%	57%	40%	-1%	69%	56%	37%	-5%

Thus, by 2050, Georgia will be able to become carbon-neutral in the case of both the pessimistic and the optimistic scenarios (see Table 2.2.4. and Table 2.2.5.).

2.3 Vision for 2050

Climate neutrality by mid-century will be the ultimate goal for Georgia's long-term low emissions development. However, it does not seem possible that this can be achieved with the existing measures (WEM scenario). Rather, it can only be reached in the case of scenarios with additional measures (WAM) which demonstrates the crucial importance of the introduction of an innovative policy and new technologies requiring outer (international) technical, technological and financial assistance necessary to realize the goal, especially in the case of the optimistic development path.

Georgia intends to go "green" by 2050 by switching to energy-efficient technologies and renewables. Technological transformation and modernization are the keys to economic development and decarbonization through increasing efficiency, minimizing losses and utilizing low-emission technologies. Georgia plans to combine low-emission development and economic growth by introducing innovations that will reduce GHG emissions at the same time.

3 PRINCIPLES OF LONG-TERM LOW EMISSION DEVELOPMENT

3.1 Promoting the Fight Against Climate Change at All Levels

Implementing climate action, especially in the long-term, is hard work and requires considerable technical, human and financial resources. Reasonable management at the national level and the wide involvement of the public and businesses are necessary to achieve the desired goal.

As climate change is a cross-cutting area for the entire economy and life of the country, climate policy and planning involve various sectors of the economy as well as various aspects of life. Consequently, integrating climate dimensions in national and sectoral development policies is essential for successfully realizing any climate action.

The LT LED Strategy sets tentative ranges and targets for 2050, between pessimistic and optimistic development paths, for each climate-relevant sector to reduce its GHG emissions by mid-century. It also identifies corresponding sets of mitigation actions. Obviously, these activities are envisaged to be implemented in the corresponding economic sector and, thus, should be reflected in the respective strategy and action plan. Therefore, vertical and horizontal coordination of the sectoral and national policies is necessary to ensure their implementation's success.

To resolve the problem of CC interaction with economic sectors, Georgia established a national inter-ministerial body, the *Climate Change Council*, to consolidate CC-related activities across the sectoral ministries as well as to consider, approve and recommend adopting each climate-related policy document and perform the overall supervision of its implementation. Additionally, the country is working on a climate change framework law that will regulate climate change issues at the legislative level.

However, along with official governmental structures, the involvement of independent technical experts, scientists and relevant qualified NGOs in elaborating, updating, monitoring, evaluating and implementing the activities is essential for success. Georgia is rich in qualified human resources and a wide set of sector-specialized NGOs that will be actively involved in all developments. Implementing climate action is impossible without proper public awareness and behavioral changes concerning energy and food consumption, water and other resources use, energy saving and efficiency. Climate introduction in school and higher education, the preparation of climate-specialized journalists and the integration of CC themes in media programs, informational meetings and other events will also be intensified through transformational policy determined under this framing strategy to enable society to pace the changes smoothly.

On the one hand, business involvement in climate change mitigation activities has a key role in investing in the activities and, on the other hand, in tuning the businesses to changeable conditions and taking profit from newly emerged opportunities related to technological reforms and the green economy.

Reasonable and virtuous management balanced between greening and growth, with vertical coordination and horizontal cooperation, and the involvement of a wide range of public and business stakeholders will contribute to promoting climate action at all levels. It will ensure the successful implementation of the long-term goal set in the Strategy.

3.2 Reflecting the Gender Perspective

Georgia has made significant progress by taking international obligations, ratifying conventions[25,26] and adopting anti-discrimination legislation and numerous policies at the national level in support of the protection and promotion of human rights and the elimination of violence against women. Gender equality is constitutionally ensured and protected in Georgia and substantial gender equality is supported instead of formal gender equality. In particular, in accordance with Article 11 of the Constitution, the state takes special measures to eliminate inequality and ensure the essential equality of men and women, including the effective involvement of women and men in non-traditional professional fields, education and employment at the decision-making level. Georgia's legislation addresses challenges related to gender roles. It ensures the empowerment of women and girls in all areas, including in terms of access to professional activities, both at the national and local levels. Formally, women are not limited in their choice of profession or occupation and they can be free to enter the areas where they feel more comfortable. However, gender stereotypes remain deeply rooted, leading to many challenges that inhibit the achievement of gender equality and empowering women and girls.

According to the WB Country Gender Assessment in Georgia (Georgia Country Gender Assessment, Poverty and Equity Global Practice, World Bank Group, 2016), women are mainly represented in humanitarian, education and healthcare sectors, significantly limiting them to economic activities with lower earnings. Around 16.5% of female workers are employed in agriculture and almost one-quarter of female workers are employed in health and education services (as compared to 4% of men, LFS 2018). In contrast, the representation of women in industrial activities and science is relatively low. Women are generally excluded from industrial activities and science. In 2018, only 6% of female workers were concentrated in industrial activities. Only 14% of graduates were women in Science, Technology, Engineering and Math (STEM) programs in tertiary education. This reality can affect the representation of men and women in energy, industry and transport – those with a substantial role in GHG emissions. According to the indicators of the National Statistics Office of Georgia (GeoStat), 14% of employed men worked in the industrial field in 2020 while only 7.8% of women were involved in the same industry. Further, 22.4% of men and 16.5% of women were in agriculture while 12% of men and 0.6% of women were in construction work. A total of 10% of men and only 1% of women were in the transport sector. There is a salary difference in certain professions and differences in actual pay are observed in almost all areas. The wage gap appears in almost every field of occupation, including industry, transport and agriculture.[27]

Natural science is the area where relatively more women are equally represented in Georgia and environment ecology is among the most popular fields among Georgian women. However, the number of

25 The Optional Protocol to the Convention on the Elimination of all Forms of Discrimination against Women (OP-CEDAW). LEPL Legislative Herald of Georgia. (n.d.). Accessed on April 18, 2023. https://matsne.gov.ge/ka/document/view/3860268?publication=0+https%3A%2F%2Fgeorgia.unwomen.org%2Fsites%2Fdefault%2Ffiles%2FField+Office+Georgia%2FAttachments%2FPublications%2F2018%2Fconvention+on+elimination+of+violence.pdf

26 The Council of Europe Convention on Preventing and Combating Violence Against Women and Domestic Violence. LEPL Legislative Herald of Georgia. (n.d.). Accessed on April 18, 2023. https://matsne.gov.ge/ka/document/view/3789678?publication=0

27 Country Gender Equality Profile - UN Women, Georgia. (n.d.). (2021). Accessed on April 18, 2023. https://georgia.unwomen.org/sites/default/files/202204/Country%20Gender%20Equality%20Profile%20GEO.

women in decision-making positions in this field is relatively low as compared to men. Nevertheless, the gender aspect perspective is very important to consider in CC policy, including an analysis of environmental factors and assessing the impact of changes on the population's quality of life. Especially from the point of adaptation, women, girls and groups with special needs are particularly affected by the challenges related to climate change. Considering the gender perspective is also relevant in terms of climate change mitigation; thus, gender aspects should be taken into account in the development and implementation of strategic documents and their action plans, in the short and long-term planning processes, in the LED Strategy and in the entire process of its operation.

The Strategy should adequately reflect the gender aspect in its implementation process. This implies:

- Equal access for women to the economy and the social transformation process of low-emission development to mid-century;
- Effective participation of women in LED planning, monitoring and updating;
- Significant involvement of women in technology needs assessment and introduction processes, including and especially the preparation of the enabling environment, capacity building and services;
- Adequate use of women's expertise and capacities in consulting services in practically all economic, environmental and CC fields and sectors at local as well as national levels;
- Equal and effective access of women to mitigation activities in all sectors according to their expertise and preferences.

Considering the high professional expertise and technical capacities of women living in Georgia and to achieve substantive equality, particularly in the environment, CC and relevant areas, the LT LEDS will ensure the promotion of women's professional development and proper integration into the entire course of the LEDS operation according to the principles of equity, appropriateness and qualification.

3.3 Policy of Introduction and Scaling Up Climate Technologies in Georgia

POLICY OF INTRODUCTION AND SCALING UP CLIMATE TECHNOLOGIES IN GEORGIA

One of the priority challenges of Georgia's climate change policy is related to the urgent need for technological transformation. Existing technologies are outdated and, therefore, inefficient in almost all sectors of the economy. At the same time, they are not designed to reduce greenhouse gases and/or mitigate climate change hazards. Therefore, technological transformation is critical for the country, both to meet international and national commitments regarding combating climate change and addressing its negative consequences as well as for ensuring the country's sustainable economic and social development. Since climate change affects more or less all sectors of the economy, it is impossible to mitigate and slow down this process without the technological modernization of economic sectors. Taking this into account, Georgia's LT LEDS considers that the technological transformation of the economic sectors and the country, in general, creates the basis for low-emissions development.

Innovative technologies in general, and among them climate technologies as well as the technical and economic potential of their introduction and upscaling in the country, are the main drivers of the economy which determine the effectiveness of sustainable development and the sustainability of the country's growth rate. Therefore, research and innovation in this direction are strategically important for introducing and developing climate technologies.

Georgia has been actively involved in the international processes of the introduction and the upscaling of climate technologies since 1998. Accordingly, the results achieved in international negotiations on climate technologies were reflected at the national level and this direction is discussed in detail in all of the national communications.

With GEF funding in 2000-2002 and 2010-2012, a needs assessment for climate technologies was conducted in Georgia. The first assessment process (2000-2002) was mainly focused on assessing the needs of climate technologies for the energy and industry sectors. The second climate technology needs assessment process (2010-2012) was more extensive and its scope covered more sectors, assessing the needs for GHG reduction and adaptation technologies as well as the barriers to their implementation and expansion which resulted in shaping the specific project proposals.

The third stage of the Technology Needs Assessment was carried out in Georgia in 2022-2023. This process differs from the previous two in that a financial source is already available for developing countries (Green Climate Fund - a financial mechanism of the UNFCCC). Countries can apply for this mechanism and are encouraged to submit their project proposals prioritizing climate technologies and requesting funding for introducing innovative technologies.

Despite being active in international processes, Georgia unfortunately still lags behind the desired level of technological development. Currently, it is less likely that the country would be able to overcome technological barriers independently with only its own resources. International assistance will be required to address this problem and the transformations planned at the national level. It is important that the country actively and effectively use financial mechanisms and technical assistance created within the framework of the UNFCCC for the introduction of climate technologies. The process of climate technology transfer under the UNFCCC is not easy. It is a multifaceted activity and includes political, legislative, proprietary, financial and technical determinants. Therefore, in most cases, implementing the scenario for introducing climate technologies requires more time, knowledge and finances than developing the economy with the existing/current scenario.

The LT LEDS considers the process of climate technology transfer by 2050 in two stages.

The first stage (by 2030-2035) is a preparatory-pilot phase when the modern climate technologies necessary for the development of priority sectors are selected based on the existing strategies and plans. These will be the priority technologies that are needed for meeting the commitments taken under the climate change frameworks.

At this stage, it is important to pilot those sectors and technologies as fast and effectively as possible which were prioritized in the TNA, NECP and CAP and are ready for piloting the project (feasibility studies are completed and specific projects are prepared on this basis).

The second stage (2035-2050) – here, the pilot of innovative climate technologies continues and successful climate technologies effectively contribute to the transformation of the economy.

This stage should support the rollout of technologies piloted during the first phase by analyzing and reducing the barriers identified in the pilot projects. In addition, new sectors and technologies will be piloted as well.

4 SECTORIAL PRIORITIES

The sectoral priorities of the Strategy include the sectors of the economy - sources of GHG emissions classified according to the IPCC recommendations and the UNFCCC reporting guidelines which are in full compliance with the template provided for in Annex 4 of the Governance Regulation. These sectors are energy, industrial processes, product use (IPPU), agriculture, land use, land-use change and forestry (LULUCF) and waste. The energy sector considers GHG emissions from fuel combustion which includes the power industry (electricity generation and transmission), energy consumption from stationary sources (buildings) and mobile sources (transportation) and fugitive emissions from fuels.

4.1 Energy Sector

CURRENT POLICY

National and international experience has shown the primary importance of energy policy in achieving sustainable energy development and climate change mitigation goals. Energy is the main pillar of the economy – the well-being of the population largely depends on it.

Georgia has made significant progress in improving energy security and transitioning to a cleaner and more sustainable energy system.

The long-term vision for the energy sector of Georgia envisages a "decarbonization" of the sector through maximizing the usage of renewable energy resources and improving energy efficiency in all sectors of the national economy.

Georgia's energy policy aims to improve the country's energy security which ensures the implementation of national interests by ensuring a sufficient quantity, high quality and uninterrupted supply of various types of energy at an affordable price. Developing and implementing an energy policy is an important prerequisite for economic development and achieving strategic energy goals.

Georgia's Ministry of Economy and Sustainable Development (MESD) is responsible for developing, implementing and monitoring state policies, strategies and state programs in the energy field, attracting investments in the energy sector and, within its competence, taking appropriate actions.

On October 14, 2016, Georgia signed the protocol on the Accession of Georgia to the Treaty Establishing the Energy Community. Georgia's accession to Energy Community implies a legal commitment and legislative harmonization. In particular, Georgia has to reflect all of the directives and regulations of the EU Energy field in the domestic legislation set out in Annex XXV of the Association Agreement. An expected energy market transformation is foreseen under the Energy Community Treaty implementation which will, directly and indirectly, impact renewable energy development.

In terms of introducing renewable energy in Georgia, particular significance is assigned to the **net metering program**. According to the definition of the Georgian National Energy and Water Supply Regulatory Commission (GNERC), net metering is a "process of reverse metering of outflows of excess electricity generated by the micro-generator and the electricity received from the network, whereby the generated and consumed electricity offset each other."[28] The GNERC introduced the program in 2016 and initially it was intended for power plants with a maximum capacity of 100 kW with the condition of being connected to the same network. Since 2019, the maximum capacity limit has been increased to 500 kW and the condition of connecting to the same network has also been removed. As a result, the number of power plants involved in net metering and the total capacity increased significantly. By July 2021, 368 subscribers participated in the program with a total installed capacity of 17.7 MW.

One of the important challenges for the Georgian energy sector remains the delay and failure of the realization of large-scale projects. With rough calculations, the peak load in winter will increase up to 2,800-3,000 MWhs which will require the integration of additional power via regulatory HPPs.

PRIORITIES FOR 2050

Keeping global warming below 2°C is technically possible. It will also be more beneficial from the economic, social and environmental points of view than current plans and policies. The long-term priorities in this sector are to:

- Construct and develop large-scale facilities for the generation of renewable energy;
- Increase the consumption of renewable energies significantly in the overall energy balance;
- Implement large-scale energy-efficient measures in the construction sector;
- Develop energy-efficient technologies in the existing industries;
- Raise additional investments for the introduction of low-carbon technologies.

4.2 Fugitive Emissions Sector

EXISTING POLICY

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories[29] defines "fugitive emissions" as: "Intentional or unintentional release of greenhouse gases may occur during the extraction, processing and delivery of fossil fuels to the point of final use."

In Georgia, fugitive emissions occur during the geological processes of coal formation and from oil and natural gas activities (production, transmission and distribution). There is a number of laws that regulate fugitive emissions (indirectly), for example, the **Law of Georgia on Electricity and Natural Gas**: the law regulates activities and relations of individual entrepreneurs, natural and legal persons in the areas of supply, import, export, transportation, distribution and consumption of natural gas. This law ensures the functioning and development of the natural gas sector in compliance with the principles of a market-oriented economy. The **Law of Georgia on Oil and Gas**: the purpose of the law is to create a unified legal framework for the development of oil and gas resources and oil refining, gas processing or transportation and to pursue a unified state policy in the field of oil and gas develop-

28 Net metering GNERC. (n.d.). accessed on April 18, 2023. https://gnerc.org/ge/user-page/useful-information-for-customers/netoaghritskhva/59

29 2006 IPCC Guidelines for National Greenhouse Gas Inventories. (n.d.). Accessed on April 18, 2023. https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

ment and oil refining, gas processing and transportation. The **Technical Regulation on the Safety of Coal Mines** sets requirements for ensuring safety. It is mandatory for all enterprises that design, build, repair and operate coal mines in Georgia.[30]

PRIORITIES FOR 2050

Substantial reductions in fugitive emissions in terms of climate and health protection lead to direct benefits such as decreased GHG emission levels and reduced air pollution from harmful emissions. In addition, there will be economic benefits caused by creating jobs intended to find methane leaks and conduct respective repairs and the natural gas (methane) instead of losses. The long-term priorities in this sector are:

- Rehabilitation and development of distribution networks;
- Energy efficiency measures in sectors of the economy that reduce the demand for natural gas and consequently reduce the distribution of natural gas;
- Introducing a Supervisory Control and Data Acquisition (SCADA) system and a Production Information Management System (PIMS) for transmission networks can significantly reduce natural gas losses;
- Methane extraction from coal mines.

4.3 Building Sector

CURRENT POLICY

Georgia has taken responsibility for harmonizing its legislation with the European one. The Association Agreement signed between the EU and Georgia implies the transposition of the European Building Performance Directive (EPBD). In 2020, Georgia adopted the Law on Energy Performance of Buildings.

Most of the current Georgian building stock was developed in the Soviet era between 1921 and 1990. The performance of the buildings varies but from today's perspective, all of them have very poor performance (average from 100 to 275 kWh per 1 m^2 annually). New buildings (built after 1991) have even worse performance. The Georgian government has taken responsibility for managing the performance of new developments and existing buildings which is reflected in the relevant Law on the Energy Performance of Buildings. The country plans to fully transpose the European Performance of Buildings Directive (EPBD). In the next decades, this will be a major change in the construction sector as well as in the operation of existing buildings. The policy considers creating a state entity/body to monitor building performance in the country, manage buildings-related data and report to Energy Community Secretariat.

Besides regulative policies, the Georgian Government, as the largest building stock owner, will concentrate on energy efficient operation of its facilities. As by the abovementioned law, annually 3% of

30 On the Approval of Technical Regulations on the Safety of Coal Mines. Legislative Herald of Georgia (n.d.). https://matsne.gov.ge/ka/document/view/2186308?publication=0

the public building stock will be modernized/rehabilitated, upgrading energy performance up to the new norm.

As a result of the new law, the existing buildings market will also be affected so that buyers and potential tenants will have complete energy performance information about what they are buying or renting.

Spectrum of Energy Efficiency Measures for Existing Building Stock
According to the current legislation of Georgia, it is necessary to achieve minimum energy efficiency of buildings after 2022. Minimum energy efficiency requirements apply to all new buildings, parts of new buildings and elements of new buildings and in the case of significant reconstruction - also to all the existing buildings and parts of existing buildings. These requirements are not mandatory if their application is not cost-effective. This implies meeting the following two requirements: a) minimum efficiency of structures and systems and b) the maximum permissible annual energy supply per 1 m^2 air-conditioned area.

PRIORITIES FOR 2050

The GHG emissions to 2050 of the buildings are driven by economic growth and the associated energy demand. Georgia is expected to continue growing above 5% rates up to 2050, expanding its overall economic activity and increasing the energy demand of the economy in a similar proportion. Economic growth, energy demand and GHG emissions are highly correlated as current economic practices and existent technologies are fossil fuel dependent. Therefore, the emissions to 2050 will continue to rise unless sectoral and national policies and practices are implemented and highly efficient technologies are widespread in the country. The long-term priorities in this sector are:

- Maximum thermal insulation of buildings;
- Use of renewable energy (photovoltaics (PV), domestic hot water (DHW) systems, ground source heat pumps, etc.);
- Behavioral changes by switching to climate-friendly practices.

4.4 Transport Sector

CURRENT POLICY

Road transport, maritime transport and railway as well as aviation infrastructure and services fall under the jurisdiction of the Ministry of Economy and Sustainable Development of Georgia. Climate-smart economic development is directly related to the smooth and efficient operation of the transport sector. One of the main priorities of the Government of Georgia is the modernization and construction of transport infrastructure, meeting international standards and the harmonization of the national legislation with the international one. To achieve this, the government is implementing important infrastructure projects that will help to attract additional freight flows to Georgia and increase the efficiency of its transport system.

PRIORITIES FOR 2050

It is envisioned that the transport transformation pathway in Georgia will follow the worldwide transformation pathway and includes:

- By 2050, battery electric vehicle, plug-in hybrid electric vehicle and fuel cell vehicle sales will combine to eclipse internal combustion engine sales globally for light-duty vehicles;
- Despite the growing dominance of electric vehicles, global oil demand from light-duty vehicles is projected to reduce by only 24% over the next 30 years. The main reasons for this are a slow erosion of internal combustion engine vehicles stock and increased demand from emerging economies;
- The technological transformation of urban roadway systems;
- Introduction of smart technologies and artificially intelligent transport systems for travel time reduction and easing congestion.

In addition to the above, there are some additional long-term priorities in the sector:

- Unlock the full transit potential of Georgia;
- Develop the transport infrastructure;
- Deepen international cooperation;
- Harmonize national legislation with the European acquis;
- Develop logistics centers and value-added services;
- Improve the level of security and service;
- Improve pedestrian and bicycle networks;
- Enhance the efficiency of passenger transportation by railway;
- Promote biodiesel production.

4.5 Industrial Sector

CURRENT POLICY

Georgia's economic development, aiming to amplify the country's competitiveness within the region and contribute to job creation and poverty eradication,[31] includes industry enlargement activities.[32] The measures and initiatives supporting the industry sector development in Georgia are associated with enhancing competitive market practices, support in an increase of small and medium-sized enterprises (SMEs), creating conditions for entering international markets and mobilizing international investments.[33] The foreign investment mobilizing platform is expected to be strengthened in the upcoming period. The Government of Georgia has already approved the state program to support

31 State Program for Promoting Foreign Direct Investment Projects - FDI grant (2020). Enterprise Georgia, 2020. Available at: http://www.enterprisegeorgia.gov.ge/en/News/the-state-program-fdi-grant [20 08 2021]

32 State Program for Promoting Foreign Direct Investment Projects - FDI grant (2020). Enterprise Georgia, 2020. Available at: http://www.enterprisegeorgia.gov.ge/en/News/the-state-program-fdi-grant [20 08 2021]

33 Government of Georgia, 2021. BDD, Tbilisi: Ministry of Finance.

foreign investment projects. The program is implemented by the Enterprise Georgia agency, aiming to promote the growth of foreign direct investments (FDI) in the country by introducing technology and creating new jobs.

Furthermore, the state supports entrepreneurs to access international markets by using the potential of the Deep and Comprehensive Free Trade Area Agreement between the EU and Georgia. The industries are supported to develop international standards for products and systems.

The reduction of the COVID-19 pandemic consequences and rapid recovery of the state economy within the post-pandemic period is closely related to the support of the business sector, including SMEs. SME development will be based on strategic approaches considering the principles of the Small Business Act of the EU.

Simultaneously, competitive market environment development is anticipated, supported by the government from various fields of the economy in order to ensure their capacity to operate independently and to develop further.

PRIORITIES FOR 2050

During the world climate crisis, the demand for carbon-neutral solutions is increasing. The achievement of low-carbon development requires all actors, inducing the involvement of industry sector representatives to achieve the goal of the Paris Agreement. The appearance of climate-smart technologies in the international construction market has already been observed. Climate-friendly production is associated with low energy consumption and loss prevention practices. Within the mid-term period, the reduction of marginal costs will lower the production costs supporting the increase of product competitiveness in the climate-friendly niche of the market. In addition, enterprises entering the climate-friendly production industry can participate in emission-trading schemes.[34]

With the enhancement of competitive market practices, industry sector development in Georgia supports the increase of small and medium-sized enterprises (SMEs), creating a convenient environment for entering international markets and mobilizing international investments, thereby enhancing a wide range of activities, including low-carbon solutions.

Long-term priorities for developing the industry in Georgia are to:

- Promote the use of energy-efficient devices and equipment;
- Support the consumption of alternative energy resources;
- Support the transfer of innovative technologies and know-how, including low-carbon solutions.

4.6 Agriculture Sector

CURRENT POLICY

The main goal of the long-term low-emission development strategy in the agricultural sector is to enhance productivity and efficiency while mitigating an accompanying rise in GHG emissions. The

34 Technology Roadmap Low-Carbon Transition in the Cement Industry, Paris: International Energy Agency. IEA, 2019. IEA. Available at: https://www.iea.org/reports/tracking-industry.

country's long-term vision is based on sectoral visions. Unlike other sectors, most agricultural GHG emissions are caused by natural physiological processes and so the ability of technical measures to reduce them is limited.

The international community sets two reframing agendas for the sustainable future of our planet. Countries adopted the Sustainable Development Goals and the Paris Agreement of UNFCCC. Countries pledged to take important steps in reducing their GHG emissions and strengthen their resilience and ability to adapt to climate change. Both agendas acknowledge the critical importance of agriculture in dealing with the current climatic change, the severity of which is likely to increase in the future. Furthermore, both agendas emphasize the importance of safeguarding food security and eradicating hunger in the face of climate change. The role of agriculture is crucial not only in mitigating but also in adapting to climate change.

The reform planned in the forestry sector from 2014 envisages changing the existing approaches to forest management; namely, to create forestry farms and introduce a sustainable forest management model that is focused on creating long-term benefits in the country.

The new management model (under the new Forest Code) ensures the transformation of forest management bodies into multi-purpose forest management bodies that deal with forest management issues. This will include infrastructure development, the management of hunting farms, the use of the forest for recreation, the production of timber materials, the use of other forest resources, selling forest resources, developing-offering tourism and other services. Forest management authorities can also reinvest the proceeds into forest maintenance and restoration, firefighting, infrastructure development and other forestry activities.

PRIORITIES FOR 2050

The baseline scenario analysis shows that significant improvements are needed in all branches of the agricultural sector to fill the sector's development gap and reach high productivity/yields in crop and livestock farming. This will ensure food security and quality and achieve the desired efficiency level in line with international standards, increasing the export of agricultural products. Such improvements are impossible without technological re-equipment. Introducing advanced technologies is the key to increasing productivity while reducing costs and GHG emissions.

The technological transformation necessary to increase the efficiency of the sector includes technologies and innovations are aimed to:

- Halt and reverse the degradation of agricultural lands, increase the efficiency of agricultural soils and pastures (according to the type and severity of degradation: irrigation, drainage, cultivation, amelioration, arrangement of windbreaks, proper management);
- Increase crop yields and intensify crop processing. Achieve relevant qualities for market and export by ensuring adequate quantities, grades, and availability of up-to-date agricultural machinery, fertilizers, refrigerators and transportation;
- Ensure manure processing by the introduction of advanced technologies;
- Increase the production from dairy and meat-producing livestock (on the one hand, by providing fodder and pastures to increase their quantities and, on the other hand, by increasing their productivity);
- Expand the processing of dairy and meat products and improve the processing technologies.

A detailed Technology Needs Assessment, envisaged for the coming years, will identify the necessary technologies and priorities for the mitigation of GHG emissions from the sector and adapting it to climate change as well as the ways for the introduction and the implementation of technologies and necessary legislative, technical and human resources in order to create the ground for all of this. However, rapid results are not expected due to the complexity of this process.

Methane emissions reduction from enteric fermentation. In the case of the baseline scenario, the share of projected methane emissions from enteric fermentation in the total agriculture sector emissions will be high (47% in 2030 and 44% in 2050). Mitigating methane emissions can, therefore, play an important part in achieving an overall reduction in GHG emissions from agriculture. Mitigation measures consider the application of methane-reducing feed additives and supplements and inhibitors (of the methane generation) to reduce enteric methane emissions.

Methane-reducing feed additives and supplements can be synthetic chemicals, natural supplements and compounds such as tannins, seaweed and fats and oils. Fats and oils show the most potential for practical application to farming systems. Dietary manipulation can reduce CH_4 emissions depending on the degree of change and the nature of the intervention. Forage quality also influences CH_4 production.

Methane emission reductions from manure management. Manure can be an alternative energy source for livestock farmers. In anaerobic conditions; i.e., in the absence of oxygen, manure will be partially converted to energy in the form of biogas. One of the most common practices to store manure is using storage structures such as anaerobic (covered) lagoon. Anaerobic lagoons involve placing an impermeable floating cover; e.g., a plastic cover, over the lagoon's surface to capture methane. In a covered lagoon digester, anaerobic digestion of organic matter occurs.

Reducing direct and indirect Nitrous Oxide emissions from agricultural soils. Applied into the soils, nitrogenous fertilizers and manure (N fertilizers and N manure) are not always used efficiently by crops. Improving this efficiency can reduce emissions of N_2O generated by soil microbes largely from surplus Nitrogen.

4.7 Land Use, Land Use Change and the Forestry Sector (LULUCF)

CURRENT POLICY

Forests are one of Georgia's most precious resources. They have a leading multifunctional role as a natural carbon sink and are a renewable natural resource for the country. The reform planned for the forest sector envisages a change in the existing approaches to forest management, particularly the creation of forest farms and the introduction of a sustainable forest management model throughout the country based on long-term benefits.

The new management model (under the new Forest Code) ensures the transformation of forest management bodies into multi-purpose forest management bodies that deal with forest management issues. This will include infrastructure development, the management of hunting farms, the use of the forest for recreation, the production of timber materials, the use of other forest resources, selling forest resources, developing-offering tourism and other services. Forest management authorities can also reinvest the proceeds into forest maintenance and restoration, firefighting, infrastructure development and other forestry activities.

Completing the reforms started in the forestry sector and managing forests with renewed principles by 2030 is important for the low-emission development of the sector. The current process will facilitate the planning of future projections and improve the baseline data which is quite challenging today. It is essential to manage the forest with sustainable management principles and have in place respective monitoring systems to ensure the carbon dioxide accumulation potential by 2040.

PRIORITIES FOR 2050

Emission reduction pathways for the sector align with sustainable forest management principles. Such an approach is an important opportunity to reduce the sector's emissions in parallel to its development and, at the same time, increase the carbon removal potential of the forest ecosystems. Mechanisms supporting low-emission development have been implemented in the sector; e.g., the National Forest Inventory conducted in Georgia for the first time. It helped to determine the accurate figures on the carbon pool of forest lands and the change ranges in carbon pools.

Long-term development priorities in the sector are to:

- Implement sustainable forest management principles throughout the country;
- Maintain and improve the quantitative and qualitative indicators of the forest;
- Implement the principles of climate-smart management of croplands;
- Restore the degraded soils;
- Implement sustainable pasture management practices.

4.8 Waste Sector

CURRENT POLICY

There are additional potential areas for mitigation in the sector that could contribute to enhancing Georgia's progress in achieving its NDC target and complying with the Paris Agreement's temperature target of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (Art 2 § 1 a).

According to the *National Waste Management Strategy and Action Plan*, the following areas are determined as priorities for future action in the solid waste sub-sector:

Moving towards reducing and recycling is Georgia's long-term vision for the waste sector. Georgia's legislation introduces a five-step hierarchy system: a) waste prevention, b) preparation for reusing, c) recycling, d) other types of recovery and e) disposal.

Improved data collection is a necessary component of better waste management. It will embrace the implementation of separation practices all over the country, enabling the identification of fractions of solid waste that are landfilled, recycled, composted, etc. Proper data collection will also allow a more accurate and reliable projection of current and future emissions of the sector, including the addition of missing sources of emissions in the country.

The Strategy for Biodegradable Waste Management (under finalization) envisages the promotion of advanced practices for processing biodegradable waste. It determines country-specific priority types of Biodegradable Waste (BDW), including the corresponding fraction of municipal solid waste and its processing practices. The strategy will also facilitate obtaining permits for composting by companies and stakeholders. After entering into force, this strategy will contribute to reducing and recycling MSW.

The key policy document in the waste sector is the *Waste Management Code* which entered into force in January 2015 and establishes a legal framework for waste management to implement measures that will facilitate waste prevention and environmentally safe treatment, recycling and separation of secondary raw materials, energy recovery and the safe disposal of waste. The objective of this Code is to protect the environment and human health through the prevention or reduction of waste and its adverse impact, the establishment of effective mechanisms for waste management, the reduction of damage caused by the consumption of resources and the more efficient use of resources. Based on this Code, the government drafted and approved 20 bylaws (subordinate normative acts) to introduce best practices for waste management in the country.

The *Waste Management Strategy (2016-2030) and the Action Plan* (2016-2020), built on the Waste Management Code, defines goals and objectives in various directions, among them waste collection and transportation, ensuring the safe landfilling of waste, waste prevention, re-use and recycling and introducing the Producer's Extended Responsibility. This document also provides a timeline for specific waste management targets.

In recent years, the sector has been under a wide range of reforms implemented under the Waste Management Strategy and Action Plan, adopted some years ago. Additional policy papers, strategies and plans under the Code are under different stages of development and implementation. The LEPL Waste Management Company leads the process of reforms on the re-arrangement of solid waste disposal sites and their equipment of modern installations meeting the standards identified by the sectoral policy. However, the process shows a significant delay from the planned schedule.

PRIORITIES FOR 2050

Waste is a significant source of methane that is the major GHG emitter from the sector. This makes the sector a potential source of additional energy if recovered. Municipal waste may serve as a fuel in some industries (e.g., cement production) while sludge from treated wastewater may be processed into agricultural fertilizer rich in nitrogen. Regardless of the great use potential and economic attractiveness, the sector lacks 'greening' technologies and practices in Georgia. There is a big deficiency in using modern practices of processing generated waste like recycling, composting and gas recovery. The reforms undergoing and planned in the sector are conditioned by this urgent need – to transform the sector to meet the modern requirements for ecological welfare of the time and emissions reduction.

The sector needs deep transformation to achieve the desired level of waste and wastewater management, modernization of the waste management practices, the introduction of modern practices including recycling, the enhancement of the practice of composting, thermal processing and methane recovery as well as the optimal use of nitrogen from WW, the enhancement of composting practice and the use of waste as fuel.

Namely, the GHG emissions reduction potential from already identified measures lies in the:

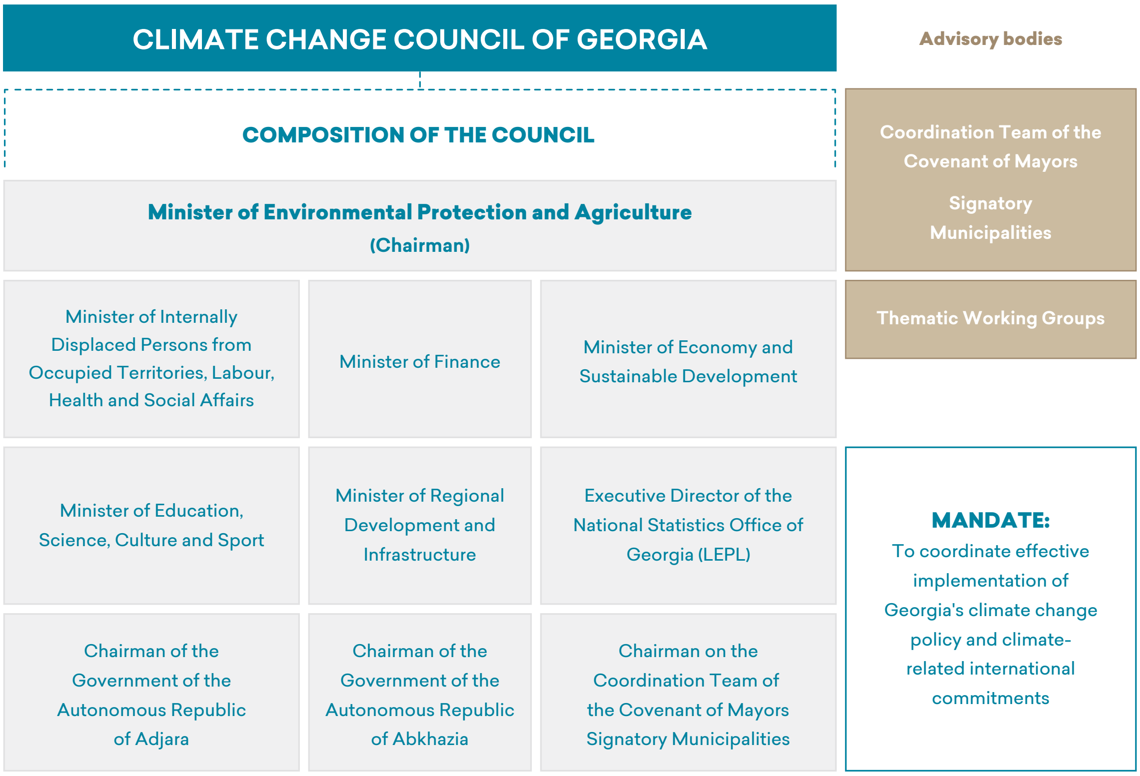
- Increase of methane recovery from every site where this measure is planned (regional landfills, new WW treatment plants);
- Recycling of different fractions of MSW (paper and carton waste);
- Composting of some fraction of MSW (garden and park waste, market waste);
- Nitrogen removal from WW sludge;
- Use of MSW for energy use (for the cement production industry).

5 IMPLEMENTATION

5.1 Implementation and Coordination

The implementation of the LT LEDS will be overseen and coordinated by the consultative body established by the Government of Georgia in January 2020 - the Inter-Agency Climate Change Council, which coordinates the effective implementation of the national climate policy, the Paris Agreement and other international commitments. The Climate Change Council is comprised of members and an advisory body: the Coordination Team of the Covenant of Mayors (CoM), signatories and Technical Working Groups. The Minister of Environmental Protection and Agriculture of Georgia is the chairperson of the Council.

Composition of the Climate Change Council of Georgia (approved with Resolution No54 of the Government of Georgia dated January 15, 2020 - On the Establishment of the Climate Change Council of Georgia)



The CCC is responsible for overseeing all of the national strategies and plans. In addition, the CCC reviews climate-related projects to be submitted to relevant funds and financial institutions and recommends to MEPA whether to support these projects.

Considering the cross-sectoral nature of measures for climate change mitigation and GHG emissions reduction, several ministries and agencies have a role in the identification and implementation of sectoral mitigation measures: MEPA's competence lies with the issues related to environmental protection, agriculture and rural development; waste and chemicals, forest, ambient air, water (except groundwater) and land resources management and protection. The Climate Change Division (CCD) of the Environment and Climate Change Department of MEPA also acts as the Secretariat of the CCC. This structural unit is responsible for preparing and coordinating the implementation of national climate change policy and action plans and participating in fulfilling international climate change commitments.

The Autonomous Republic of Adjara and the Autonomous Republic of Abkhazia are also represented among the CCC members. Their exclusive competencies include the management of land, forest and water resources. Autonomous republics may exercise their authority in various areas, including economy, agriculture and environmental protection.

Out of 69 municipalities on the territory of Georgia, including five self-governing cities and 64 self-governing communities, 24 municipalities are signatories of the Covenant of Mayors. This commits them to developing municipal action plans for sustainable energy development and mitigating climate change impact. In the context of the latter, the municipalities are responsible for municipal waste management and municipal transport services, amongst other statutory responsibilities and competencies. The 24 municipalities, which are the signatories of the Covenant of Mayors, are represented in the CCC by the coordination team of the Covenant of Mayors.

The Climate Change Council – the Council itself and its advisory bodies: the Coordination Team of the CoM signatory municipalities and the Working Groups will serve as one of the tools for stakeholder engagement in the implementation process. The Coordination Team is a mechanism for coordination between the government and self-governing bodies in the field of climate change, consisting of the mayors of CoM signatory municipalities, the deputy mayor of the Tbilisi Municipality and the governors (state representatives). The working group is a mechanism to address specific climate change policy issues in the economic and social sectors, consisting of public officials, experts, NGOs and academic representatives.

The Ministry of Environmental Protection and Agriculture and the LEPL Environmental Information and Education Center will communicate with the general public through digital communication, remote and in-person meetings.

5.2 Vision of Climate Financing

The LT LEDS should be accompanied by Georgia's Climate Financial Strategy (CFS) and describes the major policy directions as well as offering long-term and medium-term activities. The strategy provides basic information about global climate funds and institutions. Moreover, the CFS of Georgia considers eight barriers (see sub-section 1.2. in Situation Analysis) to climate finance and briefly explains them. There are considerable barriers that should be taken into consideration by public authorities while planning and before implementing Georgia's CFS.

In addition, the presented CFS reports six strategic pillars (see Table 5.2.1.) which are recommended for the Government of Georgia. These pillars represent the set of long-term and medium-term actions for executing the CFS in the country. According to the report, the government should conduct the following measures: facilitate data generation and analysis, accelerate the enhancement of green financial instruments and green markets, identify priority climate-friendly projects, establish climate investment cooperation, promote the capacity-building process for developing and implementing mitigation and adaptation projects and integrate green finance in the financial sector.

The climate finance vision considers the factors needed to raise public, private and international funds to successfully implement the LT LEDS. Climate finance includes mobilizing local, national and international finances supporting climate mitigation, climate change adaptation and low carbon development. These finances can be public, private, national, global or from other sources (blended, philanthropic, etc.). The UNFCCC Cancun Agreement (2010) affirms that "scaled-up new and additional, predictable and adequate funding shall be provided to developing countries. Thus, climate finance offers new and interesting opportunities for countries to boost their sustainable development and economic growth. It also creates new opportunities to attract additional funding from overseas and leverage resources and investments from other sources ". In addition, climate finance facilitates integrating climate actions into national development planning and sectoral policies.

Climate finance covers all activities classified as climate mitigation and/or climate adaptation. Consequently, it supports achieving climate-resilient development and a low-carbon economy.

The rationale of climate change is based on the fact that climate change intensifies existing risks and will create new ones for the whole society. Climate finance can play a vital role in reducing climate-induced environmental and economic losses. There are three basic reasons why the role of climate finance has increased over time. First, due to the vulnerability to climate change on natural resources, physical assets and human capital, climate change can cause sizable economic and financial damage in the long run. Second, the awareness of society about the climate change crisis has risen significantly. Therefore, global society has a high demand to deal with climate-induced problems such as environmental destruction, the depletion of natural resources, the unsustainable use of materials and so on. Third, company management tends to run resources sustainably and be socially responsible due to stakeholder requests. Climate change funding and investment mechanisms are a crucial part of the climate financial policy as without leveraging financial resources, it is almost impossible to implement influential and transformative projects. It is recommended to form climate change funding and investment mechanism involving local and international organizations to mobilize financial capital for climate-friendly activities. The complexity of this approach is that these institutions have different missions, goals and policies. These organizations are governments, private companies, commercial banks, investors, non-profit organizations, charities, partnerships, cooperatives, international development banks, etc. During the establishment and execution of funding and investment mechanisms, it is essential to find a common interest among these stakeholders and properly link their objectives for creating bases of future cooperation and funding.

The government's role in forming funding and investment mechanisms is significant. As public funds are limited, they should encourage private investments, create effective capital market systems and facilitate financial flows among stakeholders that will advance climate finance in the country.

Since high risks and uncertainties characterize climate investments, governments should take a leading role and take an initial step towards investment guarantees, green market formation and commercialization to promote climate-friendly activities in the private sector.

Another big issue regarding the funding and investment mechanisms is a public-private partnership. The public-private partnership is a fundamental element of the funding and investment mechanisms. It creates and strengthens trust which is a decisive factor in success. It is also important to note that there are good examples of the successful implementation of public-private partnerships such as the Fund of Fund (Republic of Korea) and the Yozma model (Israel).

The ultimate goal of Georgia's climate finance needs is to ensure that sufficient climate finance will be accessed, mobilized and scaled up for the implementation of the LT LEDS of the country. It focuses on green finances and offers rigorous solutions and robust financing mechanisms to attain the primary aim of the low emission development strategy: the reduction of greenhouse gas emissions by developing, transferring and implementing high-tech, modern and resource-saving mitigation technologies. As underlined earlier, Georgia's climate finance vision is one of the key and integral parts of the country's climate policy. The ultimate objective of the vision is to scale up climate finance to attract climate-friendly investments and achieve the goals of the strategy. As a result, it should facilitate the country's sustainable and climate-resilient development.

Table 5.2.1. represents the strategic pillars and corresponding short-term and long-term actions of Georgia's climate financial strategy. The pillars and actions identify the basic strategic directions to enable synergies with other public policies to achieve Georgia's overall development goals.

TABLE 5.2.1 Georgia's Main Strategic Pillars and Actions of FSC

Strategic Pillar	Actions
1 **PILLAR I:** Data generation, information and analysis	▸ Identify climate goals and financial needs; ▸ Determine sector priorities; ▸ Collect data on public expenditure; ▸ Develop a technically feasible portfolio of projects that contribute to the NDC implementation; ▸ Promote synergies between economic, financial and environmental information; ▸ Identify climate-harmful investments.
2 **PILLAR II:** Facilitating green financial instruments and markets	▸ Strengthen cooperation with financial market participants such as banks, funds and other financial intermediaries; ▸ Introduce sovereign green bonds; ▸ Encourage the design and issuance of different types of green financial instruments such as green bonds, risk reduction insurance and carbon markets; ▸ Initiate an identification process of the multilateral sources of funding; ▸ Pool public and private funds; ▸ Develop government-backed credit guarantees schemes; ▸ Facilitate finances for project funding.
3 **PILLAR III:** Identifying priority climate projects	▸ Align and integrate climate strategies with industrial, energy and agriculture policies and programs; ▸ Identify climate risk and investment opportunities; ▸ Set up the economic feasibility criteria and select the most financially attractive projects for funding.

4 **PILLAR IV:** Establishment of climate investment cooperation	▶ Strengthen cooperation between all stakeholders such as the government, financial intermediaries, business associations and potential investors; ▶ Collaborate and improve coordination with existing forums.
5 **PILLAR V:** Promoting capacity building for developing and implementing mitigation and adaptation projects	▶ Develop mitigation and adaptation project pipelines; ▶ Utilize GCF funds; ▶ Raise the capacity of human resources; ▶ Ensure that climate change is mainstreamed into national development and sectoral plans and budgets.
6 **PILLAR VI:** Strengthening green finance in the financial markets	▶ Set up a long-term platform of dialogue among financial sector actors; ▶ Raise awareness on climate change risks and climate finance opportunities; ▶ Collaborate with the National Bank of Georgia (NBG) and MoF to facilitate climate risks inclusion in their management frameworks; ▶ Establish and introduce analytical models on climate finance with financial entities.

Strategic pillar I is focused on generating information and analysis to mobilize financial capital for climate policy measures coherent with LT LEDS, NDC, Georgia's economic development objectives and governmental responsibilities. This pillar is pivotal for the long-term climate finance vision as every strategy requires relevant and credible data for making correct policy decisions. Therefore, the Government of Georgia needs to coordinate its efforts with public and private entities of all economic sectors to generate reliable and plausible information.

Strategic pillar II is focused on enhancing green financial instruments and green markets. In general, financial instruments are fundamental components of any climate strategy. Several funding instruments have recently been developed to identify innovative approaches to devote capital flows to the relatively new sectors of sustainable housing, renewable energy, energy efficiency, etc. As these investments need a sizable amount of financial assets, leveraging green finances through different instruments is crucial.

In the case of Georgia, it is important to start a dialogue with financial authorities and financial entities such as banks, insurance companies and pension funds about the introduction of green financial products such as green bonds, green insurance, carbon insurance, green mortgages, green home equity loans, green commercial building loans, green investment funds, green project finance, etc. In this regard, it is decisive to create efficient markets and effective regulations for developing markets of green products.

Strategic pillar III focuses on climate-related project preparation and implementation issues. The country needs to have an appropriate capacity to prepare proposals for economically feasible and bankable projects. Attracting financial capital from multilateral climate funds and international donors without proof of financial feasibility in the proposals is complicated. Therefore, Georgia should pay particular attention to the sectors with a relatively high potential for GHG reduction and a clear vision of how to transform the sector.

Strategic pillar IV concentrates on the establishment of climate investment cooperation. This type of collaboration between stakeholders is essential in climate policy as this is a good approach for exchanging relevant information, raising trust, generating ideas, preparing bankable projects based on stakeholder opinions and implementing them properly.

Strategic pillar V is focused on capacity building for developing and implementing mitigation and adaptation projects. In this regard, the most relevant issue is human resource management and development. It is necessary to assess the existing human resources, evaluate gaps and equip the technical personnel with the necessary knowledge and skills to raise the capacity at a sufficient level in the country.

Strategic pillar VI aims at enhancing climate finance in the country's financial sector. Since the transition towards a low emission economy requires a large amount of financial capital, public funds are insufficient. The financial sector's role is vital in financing and fundraising. Furthermore, it is relevant to note that climate change threatens financial and macroeconomic stability. Therefore, financial entities such as the National Bank of Georgia, the Ministry of Finance, commercial banks, insurance companies and pension funds should be aware of this fact. Regarding the awareness of climate change, it is advisable to create a public-private green finance roundtable to respond to climate change challenges.

TABLE 5.2.2 Total Investments Needed by Sectors (2020-2050), Million USD

Sector	Total Investment Needed (WEM)	Total Investment Needed (WAM)	Potential Source(s) of Funding
Energy	5 980	7 310	The private sector, FDI and international financial institutions (GCF, GEF, EBRD, etc.)
Transport	44 000	70 100	State and municipal budgets, private sector, international donor organizations (GCF, GEF, EBRD)
Industry	160	200	Enterprise Georgia, Partnership Fund, WB, ADB, GCF, KfW
Agriculture	33	65	The private sector, state grants and concessional credits, green climate bonds, GCF, GEF, EBRD
Waste	20	20	The state budget, municipal budgets, international organizations
LULUCF	307	414	The state budget, Green Climate Fund, Carbon credit market instruments

From the financial and practical point of view, it is relevant to estimate the investment needs to understand the scale of financial resources required for implementing the proposed climate strategy. According to the estimations made by sectoral experts, the total investment needed is approximately 50.5 billion USD and 78 billion USD for the WeM and WaM scenarios, respectively, for the whole Georgian economy/all the sectors in total. Detailed information on these estimations by sector is presented in Table 5.2.2. As seen from Table 5.2.2., the largest financial resources are required by the transport measures demonstrating the highest GHG emission reduction potential (see Table 5.2.3. below).

For Georgia, it is important to analyze the total potential GHG emission reductions by sector. According to estimations and judgments from sectoral experts, decreasing the country's total GHG emissions by 40,334 Gg CO2 eq is possible through the optimistic scenario. Detailed information on this is presented in Table 5.2.3. As can be seen, the Georgian industry sector has the greatest potential in absolute values in terms of GHG reductions.

Formulating funding policies and schemes to implement Georgia's LT LEDS, satisfy the investment need and attain its primary goals is crucial. This issue is significant for Georgia because the country, like other developing countries, is characterized by high capital costs that are a considerable barrier to attracting funds and the development process in general.

TABLE 5.2.3 Total Potential Greenhouse Gas Emissions Reduction by Sectors (2020-2050), Gg CO_2 eq.

Sector	Potential GHG Emissions Reduction, Gg CO_2 eq. (WEM)	Potential GHG Emissions Reduction, Gg CO_2 eq. (WAM)
Energy	9,984	29,396
Transport	7,323	11,697
IPPU	882	2,224
Agriculture	385	778
Waste*	701	1,692
LULUCF	3,637	6,244

** Including supplementary (to additional) measures*

In this regard, it is worth noting that Georgia should follow the climate need-based finance approach to avoid irrational spending and make financial flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

It should also be highlighted that to ensure an effective and sustainable climate funding policy, Georgia should focus on implementing the projects that have at least one of the following features: mitigation (and/or adaptation) impacts values/indicators, SDG co-benefits, transformative change effect and offering exceptional opportunities for private sector co-financing.

Furthermore, it is important to mention that the Government of Georgia should focus on strengthening the cooperation with multilateral development banks as they are the largest providers of financial resources in developing countries. For instance, their share in Central Asia and the South Caucasus region is 78% of total funds. Technology transfers should be a high priority in this regard.

A significant number of funding instruments can be used to attract funds for climate mitigation (and adaptation) measures such as grants, debts and equities. The largest funding instrument by scale in Central Asia and South Caucasus is the loan which comprises around 89% of the total funding in this region. It is also relevant to underline that in this region, the funding structure in 2013-2018 showed an imbalance where 76%, 19% and 5% of funds were channeled to mitigation, adaptation and cross-cutting activities, respectively. Therefore, to increase finance mobilization scale and access to funds, it is recommended to concentrate on concessional and non-concessional loans because these are the easiest way to attract sizable financial resources for climate actions.

The generally recommended steps for mobilizing funds can be summarized in the following way:

1. the first step is to analyze the current situation, including national circumstances, the cost of capital, access to finance, development level of capital and money markets and existing financial instruments.
2. the second step is to assess the country's regional financial flows, needs and gaps.
3. the next step is formulating and endorsing a climate finance strategy at the highest political level. the final step is identifying the most effective financial instrument(s) and bankable project pipelines for implementation.

In addition, it is to be noted that there are a few financial risks that should be taken into account by policymakers while implementing climate finance strategies. Some of the typical and principal financial risks for a developing country are as follows: inflation risk (that can considerably increase project costs in the future), high vulnerability towards external shocks, high political risks, exchange rate risk, investment and operational risks, project profitability risk, risks related to high uncertainty in GHG emission reductions (that can shrink potential investors and donors/lenders willingness to channel funds in Georgia), lack of awareness of private investors, low future returns and high payback periods.

5.3 Monitoring, Reporting and Updating the LT LEDS

The LT LEDS's operation spreads over the next three decades. In order to track progress towards the decade's interim goals each decadal LEDS is exposed to the periodic MRV procedures. It is conducted to identify the closeness to the target and the extent of progress achieved, analyze the outcomes and make corresponding corrections. The outcomes of the MRV impact on:

- Current LEDS where measures and/or parameters can be modified;
- Next, LEDS where the originally set target, measures or/and parameters can be modified;
- LT LEDS where ultimate or interim targets, their ranges or/and scenarios can be changed.

Thus, MRV and updating processes are tightly interrelated.

MRV (Measurement/Monitoring-Reporting-Verification) is an instrument to enhance transparency by tracking the implementation process of any plan, action or project to make corresponding changes if/when needed.

The LT LEDS envisages a tentative MRV procedure for the future LED Strategies to be built in this frame. The proposed scheme, structure, schedule and process are intended to serve as a basic model of MRV for the consecutive ten-year LED Strategies and a subject to further modification and adjustment.

The key function of MRV for the LT LEDS is to enhance transparency through tracking the impact of mitigation actions, GHG emissions reduction and the climate finance flows received. The MRV will periodically assess whether Strategy-set targets have been achieved and identify corresponding necessary corrections and modifications in the concrete strategy and its mitigation actions.

Monitoring for the LT LEDS will track the implementation progress of specific activities and impacts, including measuring the GHG emission reduction achieved for the reporting period. Beyond measuring the impacts, the *monitoring* implies checking the implementation status of the actions envisaged by the concrete strategy with identifying causes of and responsible entities for the delay, if any, including financial flows. *Reporting* of the monitoring process outcomes aims to transparently communicate them to national stakeholders and the international community to enable necessary changes in the Strategy. *Verification* is a process to add reliance to the outcomes of the monitoring process, aiming to ensure that selected reported information is accurate and complete.

The outcomes of the monitoring processes will serve as reference data for checking the implementation of the measures that may entail changes in the implementation process and parameters of the actions, addition or/and cancellation of some of them, enhancement of funding, etc. The necessary changes should be identified based on the nature of the outcomes and areas of necessary intervention.

The LT LEDS monitoring process also comprises **measuring** and includes:

- Monitoring of the main drivers (population number, GDP, others) used for baseline scenarios (optimistic and pessimistic) /projections;
- Monitoring of the status of implementation of mitigation actions forming the WEM and WAM scenarios;
- Measuring the reduced emissions based on implemented measures;
- Monitoring of financial flows, envisaged/expected for the mitigation measures.

The **monitoring process** will be conducted and the **monitoring report** will be prepared by the entity designed for this purpose (Climate Change Division [CCD] of MEPA). Sector-specific templates for monitoring and reporting the results will be designed. The templates will ensure the standardization of monitoring and reporting requirements and procedures, facilitating the analysis of the monitoring results.

The **monitoring process** will be conducted and the **monitoring report** will be prepared by an entity designed for this purpose. The National MRV system being developed for the CC area will determine the institutional arrangement for LT LED-process MRV.

Verification will be done using independent external sources of relevant information to enhance confidence that data are relevant, complete, accurate, consistent and transparent. National reports to the UNFCCC as BTR, BURs and GHG inventory may be used as sources of verification external to the LT LEDS.

Monitoring and reporting the outcomes after their verification is an entire process and is to take place together. The frequency of the MRV process should be closely related to and tailored to the international CC process, particularly the Paris Agreement process, UNFCCC decisions and related national commitments, including updating the NDC and developing corresponding CAPs.

The frequency of the LEDS MRV should/may be based on the outcomes of the latest CAP monitoring process every two to three years, creating a basis for a further (updated) NDC. Thus, for the next updated NDC (in 2025), the CAP (2020-2023) and the CAP (2024-2025) will be monitored and reported while the consequent CAPs (for 2025-2028 and 2029-2030) will be monitored and reported for the next updated NDC (in 2030).

Based on these considerations, the reasonable frequency seems to be every five years beginning from 2025.

The LT LEDS, as a visional frame for LED strategies, can also be subject to update. By 2025, Georgia plans to update a nationally determined contribution document where more ambitious GHG emission mitigation targets will be presented. Accordingly, the abovementioned can also be the basis for updating LT LEDS. The LT LEDS updating process should be closely related to its MRV process and sometimes entails updates in further development and recalculation scenarios for the next LED(s) elaborated for the next decade(s).

The update of the LT LEDS can also be conditioned by changes in the global CC process, newly emerged international commitments, UNFCCC and EU decisions and national circumstances, including changes in capacities and ambition level in climate action due to introduced technological innovations and/or the economic development rate.

Based on the outcomes and areas of changes identified via the monitoring process (common drivers, economic and social data, statistical trends, CC- and GHG-accounting (target indicators, Action Data (AD), Emission Factors (EF), common drivers, transformational shifts in technology, etc.), the corresponding items of the LT LEDS may be subject to modification to reflect the actual state of affairs in the following LEDS. The update of the LT LEDS may concern baseline and mitigation scenarios, sectoral data, emission factors, implementation details of the actions under WeM and WaM, including cancellation, enhancement and/or addition of some actions, their funding details, etc.

The entity responsible for the entire LT LEDS operation process, including its update, LEDS elaboration, MRV and update, is the Government of Georgia via its MEPA in close inclusion of the CCC.

ANNEX 1

METHODOLOGY AND FORECASTS - APPLIED MODELS, DESCRIPTIONS, ASSUMPTIONS AND PARAMETERS. PROJECTIONS OF NATIONAL GREENHOUSE GAS EMISSIONS FOR 2050

Various sector-relevant methods and models of GHG emission projection were applied for building long-term low-emission development scenarios.

The **TIMES-Georgia** model was applied to energy sector emission projections. The model included energy consumption and emissions from the energy industry (energy generation and transmission), buildings (residential and commercial), industrial processes, agriculture and transport. The model was adjusted to the specifics of Georgia and 2016 data was used for the baseline energy, economic and other parameters. The model relied on general statistics (population, GDP, daylight hours, etc.) and made projections based on existing policy documents, forecasted general drivers (population, GDP) and sectoral drivers (optimistic and pessimistic) to develop baseline (WoM) scenario as well as GHG emission mitigation scenarios based on the measures (existing and planned or additional) considered in the relevant sectors. The model takes account of the technologies available in the sector and the economic (value) criteria.

EX-ACT

EX-ACT - The Ex-Ante Carbon-balance Tool is applied to estimate forest sector emissions and the effect of proposed measures on emissions reductions in forest and agricultural sectors. The EX-ACT is an appraisal system developed by the Food and Agriculture Organization (FAO) of the United Nations, providing estimates of the impact of agriculture and forestry development projects, programs and policies on the carbon balance.

Estimation is done with the so-called C Stock Changes method by observing the changes between carbon stocks of different periods. EX-ACT uses IPCC 2006 Guidelines for National Greenhouse Gas Inventories. According to these guidelines, the calculations made for the forest sector cover five carbon pools: above-ground biomass, below-ground biomass, dead wood, litter and soil organic carbon.

EX-ACT uses geographical, climatic and agroecological variables to process information on land use and agricultural methods. The computing logic of EX-ACT is based on comparing the outcomes of planned measures with the outcomes (carbon stock) of the baseline scenario without the measures.

EX-ACT uses standard emission factors for first-level computing according to the IPCC methodology. According to the National GHG Inventory Report of Georgia (2019), the country-specific emission factor is applied to the agricultural sector data.

IPCC Waste Model (V5, 2019 Improved Version)

The IPCC waste model estimates methane emissions from solid waste landfills according to the waste composition. The model is based on the FAO methodology (the first order decay [FOD] methodology), recommended by the 2006 IPCC Guidelines and allows the modeling of landfill gas or generated methane according to various parameters such as climate type, amount of waste, the composition of waste, landfill management type, etc.

Main Driving Factors

Population size and the gross domestic product – these general driving factors were used to predict the baseline (WoM) scenario. The total numbers of local residents and tourists (P+T) were used based on the country's tourist flow scale. The number of tourists was converted into the number of 'annually staying' tourists. This approach aligns with a similar approach used in the CS/CAP.

Baseline Scenarios

Statistical data for population and GDP growth shows slow and fluctuating growth of population and GDP growth for recent decades. Regardless of the causes of such a trend, the country's long-term development should consider the opportunity of a breakthrough in it, aiming at a tangible increase by the mid-century. For this reason, instead of one close-to-real baseline scenario of development, a range between pessimistic and optimistic paths has been chosen for projections. The pessimistic development scenario is based on the assumption of the slow growth of the population and the GDP that is close to actual (recent) statistics/trends of these parameters while the optimistic scenario implies the most optimistic expectations concerning economic and demographic upheaval.

Thus, two baseline scenarios (pessimistic and optimistic) have been elaborated based on the corresponding series of the projected main drivers, identified preliminarily, and respective coefficients of annual growth calculated and used for long-term projections. So-called "Five-year Moving Average" method was used for prediction. The predicted values of both driving factors are given in Table 1.

TABLE N1. Main Driving Factors

(a) Drivers Projected for an Optimistic Scenario

Driver	Unit	2016	2017	2019	2020	2025
GDP growth	%	3.118064	4.739447	5.113645	-6.1	5.2
GDP (w/o convergency)*	Mln GEL 2015 constant prices	31138.71	32614.51	35947.52	33754.72	43614.75
GDP growth (X -times)	To 2016	1	1.047394	4.766649	1.084012	1.40066
Population		3728.636	3726.374	3723.464	3716.858	3721.618
Population growth	%	0.002	-0.06067	-0.16541	-0.17742	0.032
All-year-long tourists		84.6695	103.148	122.3537	82.2216	163.6558
P+T together	1000 prs	3813.306	3829.522	3845.818	3799.08	3885.274
P+T growth	%	0.5	0.425261	0.007038	-1.2153	0.39766
GDP per capita (only P)		8351.233	8752.345	9654.323	9081.521	11719.3
GDP per capita growth	%		4.803026	5.287797	-5.93311	5.166347

Driver	Unit	2030	2035	2040	2045	2050
GDP growth	%	3.813845	3.68345	4.06694	3.995051	4.055825
GDP (w/o con-vergency)*	Mln GEL 2015 constant prices	56618.1	73514.32	95448.5	123925.1	160896.9
GDP growth (X -times)	To 2016	1.818255	2.360866	3.065269	3.979775	5.167104
Population		3727.576	3733.544	3739.522	3745.509	3751.505
Population growth	%	0.032	0.032	0.032	0.032	0.032
All-year-long tourists		265.726	453.4371	791.9984	1414.56	2583.242
P+T together	1000 prs	3993.302	4186.981	4531.52	5160.069	6334.748
P+T growth	%	0.67761	1.158762	1.935753	3.166355	4.943165
GDP per capita (only P)		15188.98	19690.22	25524.25	33086.31	42888.63
GDP per capita growth	%	5.29735	5.323003	5.326489	5.326781	5.326774

* Projected by moving average for five years from 2021 based on IMF projected 2021-2025 data.

(b) Drivers Projected for a Pessimistic Scenario

Driver	Unit	2016	2017	2019	2020	2025
GDP (convergency)	Mln GEL 2015 constant prices	31138.71	32614.51	35947.52	33754.72	43614.75
GDP growth	%	3.118063	4.739447	5.113645	-6.1	5.2
Population		3728.636	3726.374	3723.464	3716.858	3722.777
Population growth	%		-0.06067	-0.16541	-0.17742	0.031809
All-year-long tourists		84.6695	103.148	122.3537	82.2216	155.1434
P+T together	1,000 prs	3813.305	3829.522	3845.818	3799.08	3877.92
P+T growth	%		0.425261	0.007038	-1.2153	0.32445
GDP per capita (only P)		8351.233	8752.345	9654.323	9081.521	11715.65
GDP per capita growth	%		4.803026	5.287797	-5.93311	5.166548

Driver	Unit	2030	2035	2040	2045	2050
GDP (convergency)	Mln GEL 2015 constant prices	55284.61	68349.66	82718.5	98438.25	115977.3
GDP growth	%	4.636077	4.143124	3.733362	3.429253	3.303
Population		3722.777	3722.777	3722.777	3722.777	3722.777
Population growth	%	0	0	0	0	0
All-year-long tourists		217.5027	299.8656	413.4176	569.9689	785.8024
P+T together	1,000 prs	3940.28	4022.643	4136.195	4292.746	4508.579
P+T growth	%	0.344557	0.46587	0.625644	0.832815	1.096071
GDP per capita (only P)		14850.37	18359.86	22219.57	26442.16	31153.43
GDP per capita growth	%	4.636077	4.143124	3.733362	3.429253	3.303

PROJECTIONS OF NATIONAL GREENHOUSE GAS EMISSIONS FOR 2050

Energy Consumption

Range of Estimated Future Trajectories of Greenhouse Gas Emissions for Baseline (WoM) Scenarios

The figures and tables below illustrate the projected growth in GHG emissions from the energy sector in Georgia from 2016 to 2050. By 2050, the total GHG emissions from the energy sector are expected to reach 34,364 Gg CO_2-eq under the optimistic scenario and 28,544 Gg CO_2-eq under the pessimistic scenario. Projected GHG emissions from energy sub-sectors are given in Table 2. GHG emissions from the transport sub-sector are expected to have the largest emission share within the energy sector (31% optimistic scenario and 27% pessimistic scenario) followed by the residential sector (19% in the case of both scenarios).

TABLE N2. Energy Sector Emissions Under the Optimistic WoM Scenario in Gg CO_2-eq

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy Industries	1,071	1,236	1,906	2,769	2,621	2,472	2,323	2,222
Industry	1,314	1,433	1,887	2,546	3,669	4,797	6,284	5,313
Transport	4,453	4,912	5,675	6,851	7,483	8,332	9,278	10,489
Residential	1,721	2,231	3,011	3,632	4,216	4,708	5,405	6,474
Commercial/Institutional	415	465	573	661	841	1,060	1,360	1,461
Agriculture	68	81	94	106	123	140	159	177
Fugitives	1,972	3,070	3,427	3,817	4,458	5,100	6,664	8,228
Total	**11,015**	**13,428**	**16,573**	**20,384**	**23,410**	**26,610**	**31,473**	**34,364**

FIGURE 1. Energy Sector Emissions (in Gg CO_2-eq) Results Under the Optimistic WoM Scenario

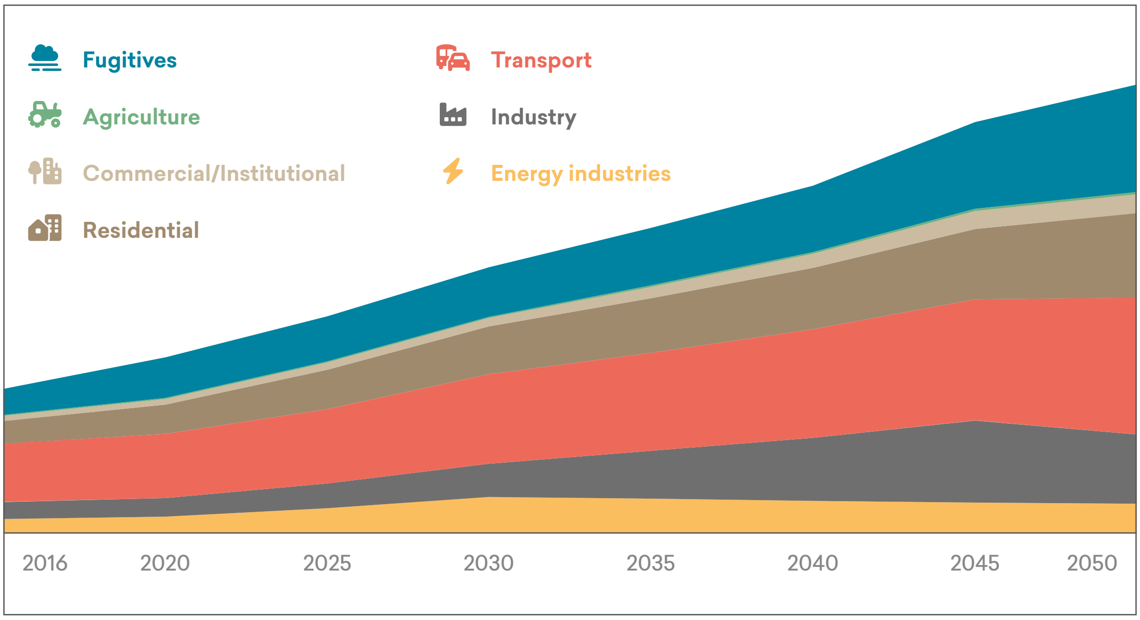
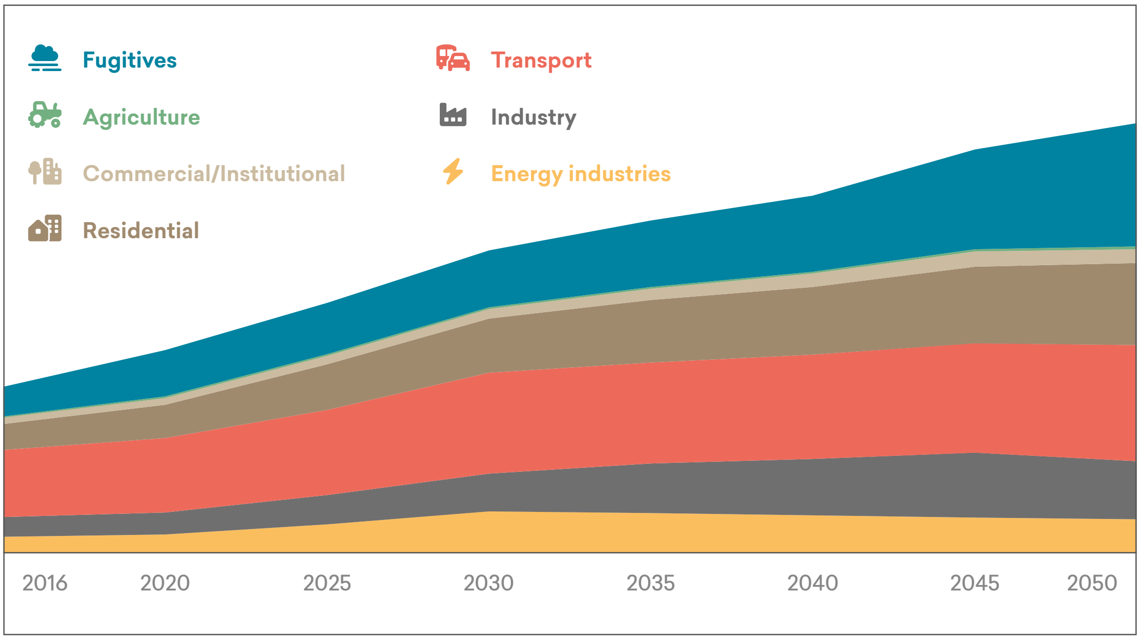


TABLE N3. Energy Sector Emissions Under the Pessimistic WoM Scenario in Gg CO_2-eq

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy Industries	1,071	1,220	1,896	2,753	2,621	2,472	2,323	2,222
Industry	1,314	1,459	1,924	2,500	3,288	3,764	4,323	3,855
Transport	4,453	4,912	5,674	6,694	6,707	6,892	7,264	7,704
Residential	1,721	2,231	3,012	3,609	4,143	4,510	5,061	5,445
Commercial/Institutional	415	459	566	636	766	888	1,019	931
Agriculture	68	81	94	92	107	121	140	159
Fugitives	1,972	3,070	3,427	3,817	4,458	5,100	6,664	8,228
Total	**11,015**	**13,432**	**16,594**	**20,101**	**22,091**	**23,745**	**26,795**	**28,544**

FIGURE 2. Energy Sector Emissions (in Gg CO_2-eq) Results Under the Pessimistic WoM Scenario



Likely Future Emissions Trajectory Range for Baseline Scenario (WoM)

In the WoM scenario, the existing power plants continue to operate as of 2020. Furthermore, the new power plants currently under construction from those included in the Ten-Year Network Development Plan (TYNDP) 2020-2030 have been included in the WoM scenario. The Tbilsresi thermal power plant will stop operation in 2025 and the Mtkvari thermal power plant will stop operation in 2027. Under the WoM scenario, electricity imports are allowed under the TIMES model.

The technologies considered in the WoM scenario are given in the tables below.

TABLE N4. Technologies Considered in the WoM Scenario-existing Plants

Power Plant	Type	Fuel	Capacity, MW
Tkibuli thermal power plant (TPP)	Conventional	Lignite	13
Mtkvari thermal power plant	Conventional	Natural gas	300
Tbilsresi thermal power plant	Conventional		272
G Power thermal power plant	Combined cycle		110
Gardabani thermal power plant	Combined cycle		230
Gardabani 2 thermal power plant	Combined cycle		230
Enguri and Vardnili HPPs	Dam		1520
Regulated HPP	Dam		513
Seasonal (semi-regulated) HPPs	Dam		261
Small HPPs	Run-of-river		663
Kartli wind power plant	On shore		22

TABLE N5. Technologies Considered in the WoM scenario - New (Planned Power Plants)

Power Plant	Type	Start Year	Fossil Fuel	Capacity, MW
Thermal power plant	Combined cycle	2024	Natural gas	230
Thermal power plant	Combined cycle	2026		230
Regulated HPPs	Dam	2026-2028		1,415
Semi-regulated HPPs	Dam	2022-2028		301
Small HPP	Run-of-river	2021-2029		1,485
Wind power plants	On shore	2025-2029		765
Solar power	PV central	2024-2026		28
Solar power	PV commercial	2025-2028		6
Solar power	PV residential	2026-2030		3

Table 6 illustrates the projected GHG emissions from the energy industries sub-sector in the case of the WoM scenario from 2016 to 2050. By 2050, the GHG emissions are expected to be 2,222 Gg CO-2eq in both optimistic and pessimistic scenarios.

TABLE N6. GHG Emissions from the Energy Industries Sub-sector (Gg CO_2-eq), WoM Scenario

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
✓ Optimistic scenario	1,071	1,236	1,906	2,769	2,621	2,472	2,323	2,222
✕ Pessimistic scenario	1,071	1,220	1,896	2,753	2,621	2,472	2,323	2,222

Likely Future Emissions Trajectory Ranges

Mitigation (WeM and WaM) Scenarios

The WeM scenario is built from the WoM by considering the effect of the policies and measures adopted and planned in the country. This definition implies that all technologies considered under the WoM are also considered in the WeM, together with those technologies which will be used as a result of implementing Policies and Measures (PaMs).

Table 7 provides information on the new technologies considered in the WeM.

TABLE N7. Technologies Considered in the WeM Scenario

Power Plant	Type	Fossil Fuel	Capacity, MW
Small HPP	Run-off-river		1,485
Regulated HPPs	Dam		1,415
Semi-regulated HPPs	Dam		301
Gardabani 3 thermal power plant	Combined cycle	Natural gas	230
Gardabani 4 thermal power plant	Combined cycle		230
Wind power plants	On shore		765
Solar power	PV central		28
Solar power	PV commercial		6
Solar power	PV residential		3

Table 8 illustrates the projected GHG emissions from the energy industries sub-sector. By 2050, the total GHG emissions from fuel combustion are expected to reach 2,225 Gg CO2-eq under the optimistic scenario and 1,382 Gg CO2-eq under the pessimistic scenario.

TABLE N8. GHG Emissions from the Energy Industries Sub-sector (in Gg CO2-eq), WeM Scenario

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
✓ Optimistic scenario	1,071	0	0	0	0	0	1,310	2,225
✕ Pessimistic scenario	1,071	0	0	0	0	0	313	1,382

TABLE N9. GHG Emission Reduction Under the WeM Scenario as Compared to the WoM Scenario

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
✓ Optimistic scenario	0	-1,236	-1,906	-2,769	-2,621	-2,472	-1,013	3
✕ Pessimistic scenario	0	-1,220	-1,896	-2,753	-2,621	-2,472	-2,010	-840

The WaM scenario is built on the WeM by considering the effect of additional mitigation actions feasible for the country given the policies and measures currently adopted and planned. This definition implies that all technologies considered under the WoM and the WeM are also considered in the WaM, together with additional technologies.

Table 10 provides information on the additional technologies that have been considered in the WaM.

TABLE N10. Energy Industry: Technologies Considered in the WaM Scenario

Power Plant	Type	Start Year	Capacity, MW
Regulated HPPs	Dam	2038, 2046	450
Semi-regulated HPPs	Dam	2034, 2042	155
Small HPPs	Run-off river	2035-2048	1,700
Wind power plants	On shore	2035-2047	325
Solar power	Concentrated	2040, 2045	450
Solar power	PV central	2033-2047	450
Solar power	PV commercial	2033-2047	75
Solar power	PV residential	2033-2048	130

Table 11 illustrates the projected GHG emissions from the energy industries sub-sector. By 2050, GHG emissions from the energy industries are expected to reach carbon neutrality.

TABLE N11. GHG Emissions from the Energy Industries Sub-sector (in Gg CO2-eq), WaM Scenario

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
✓ Optimistic scenario	1,071	696	0	0	0	0	0	0
✕ Pessimistic scenario	1,071	673	0	0	0	0	0	0

TABLE N12. GHG Emission Reduction Under WaM Scenario as Compared to WoM Scenario

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
✓ Optimistic scenario	0	-540	-1,906	-2,769	-2,621	-2,472	-2,323	-2,222
✕ Pessimistic scenario	0	-547	-1,896	-2,753	-2,621	-2,472	-2,323	-2,222

List of Existing Electricity Power Plants:

Electricity Power Plants	Type	Capacity GW	Electricity Generated, PJ (2020)
Steam turbine	Thermal	0,013	0,059
Mtkvari	Thermal	0,300	2,940
G-Power	Thermal	0,110	0,252
Tbilsresi	Thermal	0,272	0,598
Gardabani 1	Thermal	0,230	4,198
Gardabani 2	Thermal	0,230	4,198
Enguri and Vardnili HPP	Dam	1,520	15,160
Regulated HPPs	Dam	0,513	4,303
Semi-regulated HPPs	Dam	0,261	3,471
Run-off HPPs	Run-off	0,663	10,455
Kartli wind PP	Wind	0,022	0,228
Total		**4,134**	**45,863**

Milestones for 2030 and 2040

The WoM scenario does not consider the implementation of any policies and measures. It is projected considering the main macroeconomic perspectives of Georgia. In the optimistic scenario, the total GHG emissions from the energy sector by 2030 and 2040 would possibly be 20,384 Gg CO2-eq and 26,610 Gg CO2-eq in the case of the optimistic scenario and 20,101 Gg CO_2-eq and 23,745 Gg CO_2-eq, respectively, in the case of the pessimistic scenario.

TABLE N13. GHG Emission Milestones for 2030 and 2040 in the Case of WoM Scenarios

Year	Optimistic scenario	Percent of 1990 level	Pessimistic scenario	Percent of 1990 level
	Gg CO_2-eq.	%	Gg CO_2-eq.	%
1990	36,698		36,698	
2030	20,384	55.5%	20,101	54.8%
2040	26,610	72.5%	23,745	64.7%

The WeM scenario considers the planned and implemented policies and measures in Georgia and assesses how Georgia's mitigation pathway will respond according to these actions. The total GHG emissions from the energy sector by 2030 and 2040 would possibly be approximately 13,961 Gg CO_2-eq and 18,259 Gg CO_2-eq in the case of the optimistic scenario and 13,610 Gg CO_2-eq and 16,243 Gg CO_2-eq in the case of the pessimistic scenario.

TABLE N14. GHG Emission Milestones for 2030 and 2040 in the Case of WeM Scenarios

Year	Optimistic scenario	Percent of 1990 level	Pessimistic scenario	Percent of 1990 level
	Gg CO_2-eq.	%	Gg CO_2-eq.	%
1990	36,698		36,698	
2030	13,951	38.0%	13,610	37.1%
2040	18,259	49.8%	16,243	44.3%

The WaM scenario considers additional measures not yet considered in Georgia's planning process and assesses how Georgia's mitigation pathway will respond according to these actions. The total GHG emissions from the energy sector by 2030 and 2040 would possibly be approximately 10,663 Gg CO2-eq and 8,802 Gg CO2-eq in the case of the optimistic scenario and 10,775 Gg CO2-eq and 8,759 Gg CO2-eq in the case of the pessimistic scenario.

TABLE N15. GHG Emission Milestones for 2030 and 2040 in the Case of WaM Scenarios

Year	Optimistic scenario	Percent of 1990 level	Pessimistic scenario	Percent of 1990 level
	Gg CO_2-eq.	%	Gg CO_2-eq.	%
1990	36,698		36,698	
2030	10,663	29.1%	10,775	29.4%
2040	8,802	24.0%	8,759	23.9%

Range of Likely Future Trajectories of Greenhouse Gas Emissions. Mitigation Scenarios (WeM and WaM)

WeM Scenario

The figures and tables below illustrate the projected growth in GHG emissions from 2016 to 2050 if the main mitigation policies adopted and planned in the country are considered. By 2050, the total GHG emissions from the energy sector are expected to reach 24,391 Gg CO_2-eq under the optimistic scenario and 20,607 Gg CO_2-eq under the pessimistic scenario. The transport subsector is expected to have the largest emission share within the energy sector (35% optimistic scenario and 34% pessimistic scenario) followed by the residential sector (24% and 27%, respectively).

TABLE N16. Energy Sector Emissions Results Under the Optimistic WeM Scenario, in Gg CO_2-eq

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy Industries	1,071	0	0	0	0	0	1,310	2,225
Industry	1,314	1,512	1,709	2,411	3,520	4,168	4,774	4,539
Transport	4,453	4,777	5,301	5,667	6,062	6,801	7,575	8,408
Residential	1,721	2,328	3,169	4,156	4,559	5,013	5,467	5,931
Commercial/Institutional	415	432	321	249	288	392	457	543
Agriculture	68	77	86	94	102	110	113	117
Fugitives	1,972	2,260	1,807	1,374	1,575	1,775	2,202	2,628
Total	**11,015**	**11,385**	**12,393**	**13,951**	**16,107**	**18,259**	**21,899**	**24,391**

FIGURE 3. Energy Sector Emissions Results Under the Optimistic WeM Scenario

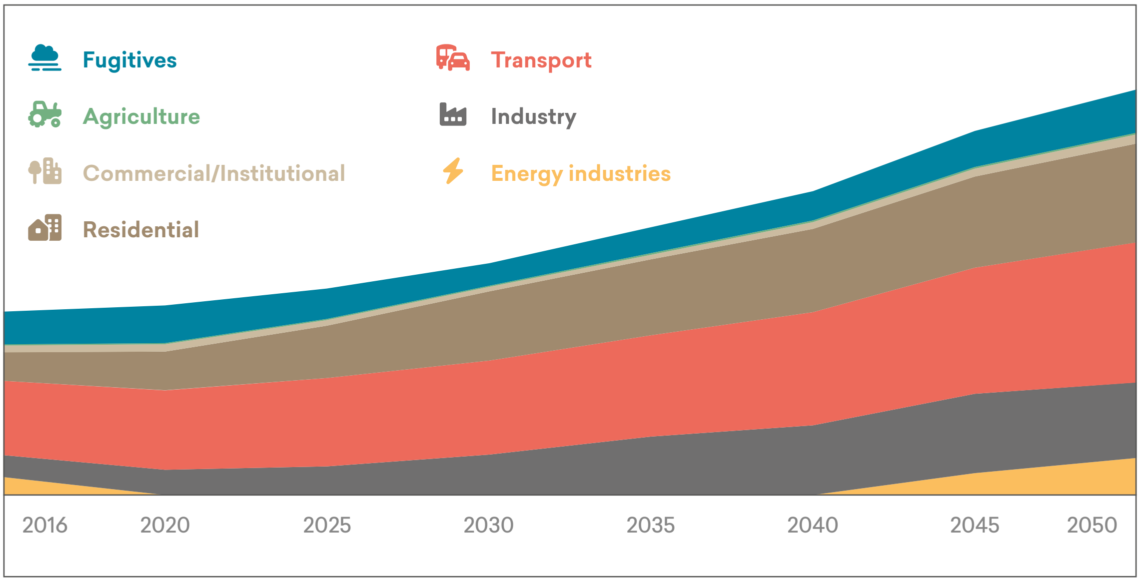


TABLE N17. Energy Sector Emissions (in Gg CO_2-eq) Under the Pessimistic WeM Scenario

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy Industries	1,071	0	0	0	0	0	313	1,382
Industry	1,314	1,512	1,708	2,232	3,112	2,988	3,960	3,609
Transport	4,453	4,777	5,300	5,544	5,763	6,200	6,635	6,960
Residential	1,721	2,328	3,171	4,129	4,474	4,832	5,160	5,473
Commercial/Institutional	415	429	321	245	273	341	404	434
Agriculture	68	77	86	86	97	108	115	122
Fugitives	1,972	2,260	1,807	1,374	1,575	1,775	2,202	2,628
Total	**11,015**	**11,383**	**12,391**	**13,610**	**15,295**	**16,243**	**18,788**	**20,607**

FIGURE 4. Energy Sector Emissions (in Gg CO2-eq) Results Under the Pessimistic WeM Scenario

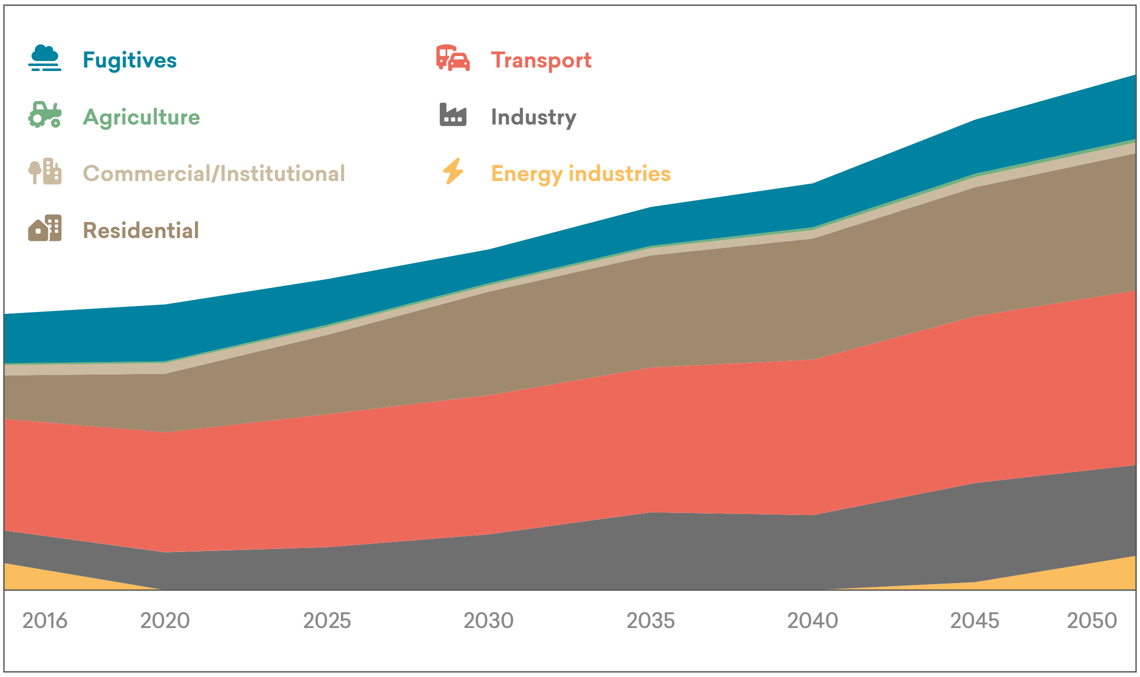


TABLE N18. GHG Emissions Reductions as Compared to the Baseline Scenario

Scenario	GHG emission reduction in Gg CO_2-eq						
	2020	2025	2030	2035	2040	2045	2050
✓ WeM optimistic	-2,042	-4,181	-6,433	-7,303	-8,351	-9,574	-9,973
× WeM pessimistic	-2,049	-4,203	-6,490	-6,796	-7,502	-8,006	-7,936

With Additional Measures (WaM) Scenario

This scenario considers additional PAMs that are not yet taken into account in the planning process of Georgia and assesses how Georgia's mitigation pathway will respond according to these actions.

TABLE N19. Energy Sector Emissions Under the Optimistic WaM Scenario, in Gg CO_2-eq

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy Industries	1,071	696	0	0	0	0	0	0
Industry	1,314	2,205	1,699	1,792	2,232	241	298	380
Transport	4,453	4,634	4,520	4,487	4,589	4,950	3,505	1,997
Residential	1,721	2,283	2,995	3,724	3,631	2,908	2,539	1,866
Commercial/Institutional	415	438	320	247	282	281	259	257
Agriculture	68	72	75	59	60	61	51	40
Fugitives	1,972	1,920	1,127	354	357	360	395	429
Total	11,014	12,248	10,736	10,663	11,151	8,802	7,047	4,969

FIGURE 5. Energy Sector Emissions (in Gg CO_2-eq) Results Under the Optimistic WaM Scenario

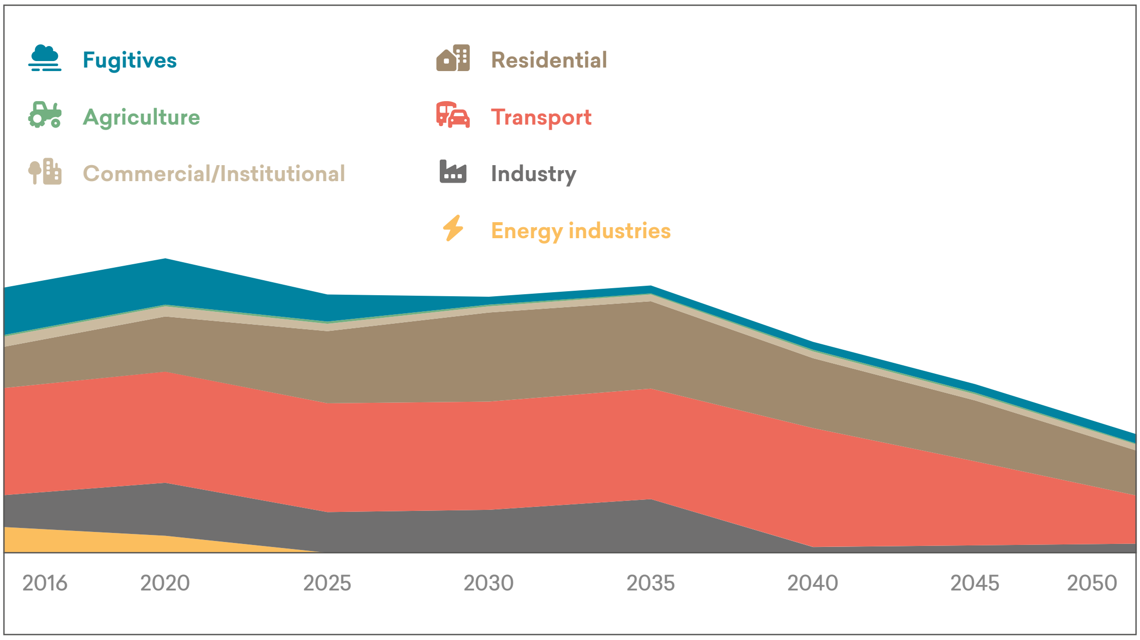


TABLE N20. Energy Sector Emissions Under the Pessimistic WaM Scenario, in Gg CO_2-eq

Sub-sector	2016	2020	2025	2030	2035	2040	2045	2050
Energy Industries	1,071	673	0	0	0	0	0	0
Industry	1,314	1,627	1,717	2,005	2,250	213	242	282
Transport	4,453	4,639	4,532	4,431	4,435	4,754	3,791	2,507
Residential	1,721	2,283	3,002	3,671	3,575	3,066	2,410	1,671
Commercial/Institutional	415	435	321	243	282	288	221	234
Agriculture	68	72	75	72	75	78	73	68
Fugitives	1,972	1,920	1,127	354	357	360	395	429
Total	11,014	11,650	10,774	10,775	10,974	8,759	7,132	5,191

FIGURE 6. Energy Sector Emissions (in Gg CO_2-eq) Results Under the Pessimistic WaM Scenario

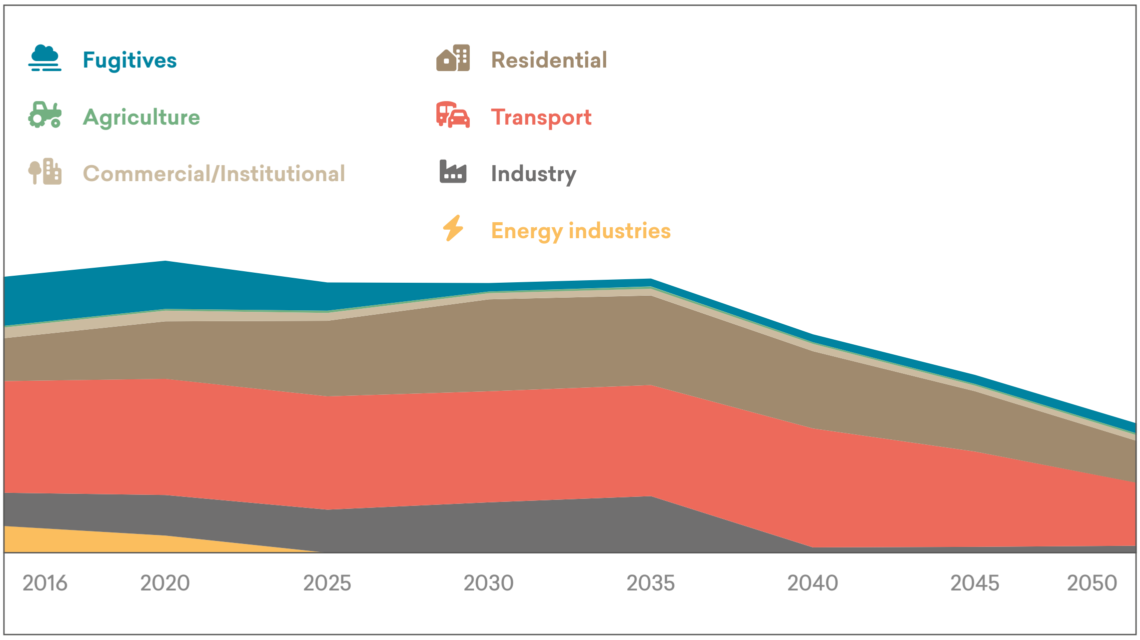


TABLE N21. GHG Emissions Reductions as Compared to the WoM, All Values Reported in Gg CO_2-eq

Scenario	GHG reductions in Gg CO_2-eq						
	2020	2025	2030	2035	2040	2045	2050
✓ WaM Optimistic	-1,180	-5,837	-9,721	-12,259	-17,808	-24,426	-29,395
✕ WaM Pessimistic	-1,782	-5,820	-9,325	-11,116	-14,986	-19,663	-23,353

Fugitive Emissions Sector

Estimated Shares of Fugitive Emissions in National Greenhouse Gas Emissions by 2050

According to Table 22, the WoM scenario fugitive emissions increase each year. The amount of transported and distributed natural gas significantly increased from 2030 to 2050. In the WeM scenario, emissions decrease until 2030 and then they tend to increase. As for the WaM scenario, emissions will also decrease until 2030 which will be more or less stabilized.

The shares of fugitive emissions in national GHG emissions have been estimated, excluding and including LULUCF. With the WeM scenario, the share of fugitive emissions decreases significantly. The change in the share of fugitive emissions in the WaM scenario is similar to the WeM scenario only with lower rates.

TABLE N22. Share of Fugitive Emissions in National GHG Emissions (Excluding LULUCF)

Scenario	Share of fugitive emissions in national GHG emissions						
	2020	2025	2030	2035	2040	2045	2050
WoM	16%	15%	14%	14%	14%	16%	18%
WeM	15%	11%	7%	7%	7%	8%	8%
WaM	11%	7%	2%	2%	2%	3%	4%

TABLE N23. Share of Fugitive Emissions in National GHG Emissions (Including LULUCF)

Scenario	Share of fugitive emissions in national GHG emissions						
	2020	2025	2030	2035	2040	2045	2050
WoM	21%	19%	17%	17%	17%	18%	20%
WeM	24%	16%	10%	10%	10%	11%	12%
WaM	15%	11%	4%	4%	6%	12%	-727%

Range of Likely Future Trajectories of GHG Emissions Mitigation Scenarios (WeM and WaM)

Coal Mining

For mitigation scenarios, methane extraction from mines is envisioned.

TABLE N24. Projected Fugitive Emissions from Coal Mining in Gg CO_2-eq

Year\scenario	Mitigation (WeM scenario)	Mitigation (WaM scenario)
2030	104	91
2040	91	78
2050	78	65

Natural Gas Systems

Distribution

The WeM scenario (unconditional in terms of NDC) assumes that natural gas losses will be reduced and will correspond to normative losses (1.2%). In the case of the WaM scenario, losses will be reduced up to the upper value of the methane emission factor for distribution systems as provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.[35]

35 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Fugitive Emissions https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_4_Ch4_Fugitive_Emissions.pdf

TABLE N25. Methane Emission Factor for Natural Gas Distribution Systems

Baseline (WoM) scenario	Mitigation (WeM) scenario	Mitigation (WaM) scenario	
Losses, %		EF, Gg $CH_4/10^6$ m^3	Losses, %
4.6	1.2	0.0025	0.393

TABLE N26. Projected Fugitive Emissions from Natural Gas Distribution Systems (WeM Scenario)

Year	Distribution	Losses		CH_4	ϱ	CH_4	Fugitive emissions
	Mm^3	Percent	Mm^3	Mm^3	Kg/m^3	Gg	Gg CO_2-eq
2030	2,781	1.2%	33.4	31.7	0.67	21.2	446
2040	3,672	1.2%	44.1	41.9	0.67	28.0	589
2050	5,445	1.2%	65.3	62.1	0.67	41.6	873

TABLE N27. Projected Fugitive Emissions from Natural Gas Distribution Systems (WaM Scenario)

Year	Distribution	Losses		CH_4	ϱ	CH_4	Fugitive emissions
	Mm^3	Percent	Mm^3	Mm^3	Kg/m^3	Gg	Gg CO_2-eq
2030	2,579	0.39%	10.1	9.6	0.67	6.4	135
2040	2,365	0.39%	9.3	8.8	0.67	5.9	124
2050	2,663	0.39%	10.5	9.9	0.67	6.7	140

Transmission

The WeM scenario suggests that natural gas transmission losses will be reduced and correspond to the upper value of methane emission factor for transmission systems according to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.[36] In the case of the WaM scenario – the lower value is used.

TABLE N28. Methane Emission Factor for Natural Gas Transmission Systems (WeM Scenario)

Emission source	EF, Gg $CH_4/10^6$ m^3		Losses, %		Uncertainty % of value)
	Lower	upper	lower	upper	
Fugitives	0.000166	0.0011	0.026	0.173	-40-დან 250-მდე
Venting	0.000044	0.00074	0.007	0.116	-40-დან 250-მდე
In total			**0.033**	**0.289**	

36 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Fugitive Emissions https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_4_Ch4_Fugitive_Emissions.pdf

TABLE N29. Projected Fugitive Emissions from Natural Gas Transmission Systems (WeM Scenario)

Year	Transmission, Mm^3			Losses		CH_4	ϱ	CH_4	Fugitive emissions
	SCP	NSMPG	Total	%	Mm^3	Mm^3	Kg/m^3	Gg	Gg CO_2-eq
2030	18,000	2,359	20,359	0.289	58.8	55.9	0.67	37.5	786
2040	25000	2,379	27,379	0.289	79.1	75.2	0.67	50.4	1,058
2050	40,000	2,422	42,422	0.289	122.6	116.5	0.67	78.0	1,639

TABLE N30. Projected Fugitive Emissions from Natural Gas Transmission Systems (WaM Scenario)

Year	Transmission, Mm^3			Losses		CH_4	ϱ	CH_4	Fugitive emissions
	SCP	NSMPG	Total	%	Mm^3	Mm^3	Kg/m^3	Gg	Gg CO_2eq
2030	18,000	2,307	20,307	0.033	6.7	6.4	0.67	4.3	90
2040	25000	2,309	27,309	0.033	9.0	8.6	0.67	5.7	120
2050	40,000	2,314	42,314	0.033	14.0	13.3	0.67	8.9	187

Estimated fugitive emissions from natural gas systems in different years for mitigation scenarios are given in Table 31.

TABLE N31. Fugitive Emissions from Natural Gas Systems for Mitigation Scenarios in Gg CO_2-eq

Year	Scenario					
	Mitigation (WeM scenario)			Mitigation (WaM scenario)		
	Transmission	Distribution	Total	Transmission	Distribution	Total
2030	786	446	1,233	90	135	225
2040	1,058	589	1,647	120	124	245
2050	1,639	873	2,512	187	140	326

Oil Systems

No mitigation measures are considered.

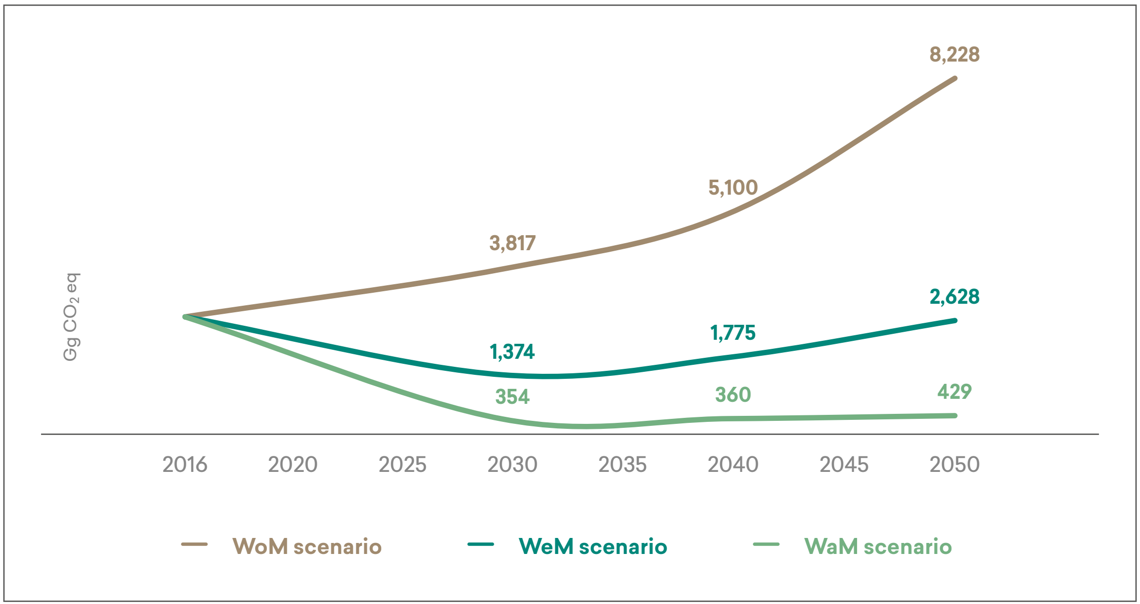
Projected Fugitive Emissions

Projected fugitive emissions from coal mining and oil and natural gas operations in Georgia are given in Table 32.

TABLE N32. Projected Fugitive Emissions

Scenario	Fugitive emissions, Gg CO_2-eq						
	2020	2025	2030	2035	2040	2045	2050
WoM	3,070	3,427	3,817	4,458	5,100	6,664	8,228
WeM	2,260	1,807	1,374	1,575	1,775	2,202	2,628
WaM	1,920	1,127	354	357	360	395	429

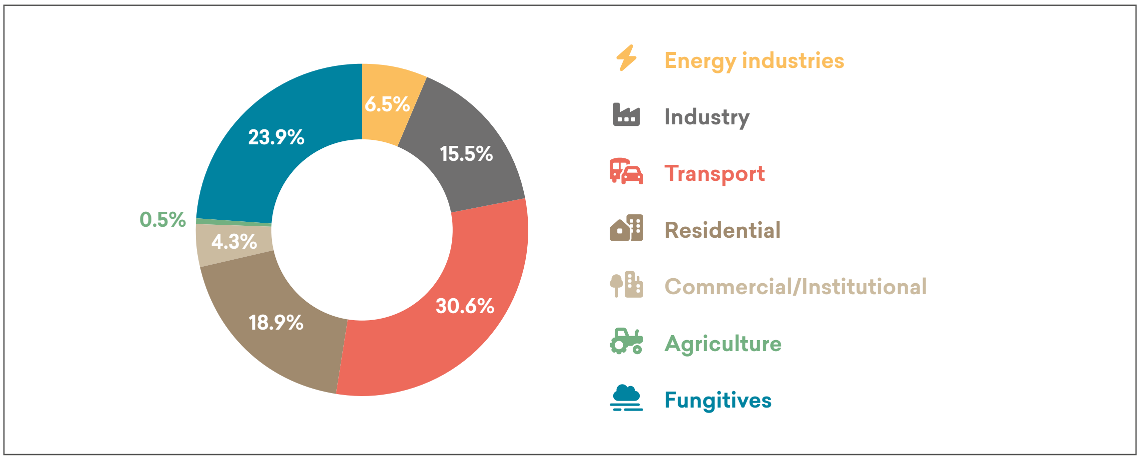
FIGURE 7. Fugitive Emissions from Coal Mining and Oil and Natural Gas Operations



Estimated Likely Share of GHG Emissions of the Buildings Sector in 2050

The split of GHG emissions in the energy sector will change substantially from the latest year of the historical period (i.e., 2019) to 2050. Without considering mitigation actions (in the baseline scenario), the residential sector share will experience some change within the energy sector from 20.7% in 2017 to 18.9% in 2050. The increased number of households and the use of existing technologies drive this increase in emissions in the baseline scenario.

FIGURE 8. Share of GHG Emissions by the End-use Sectors in 2050

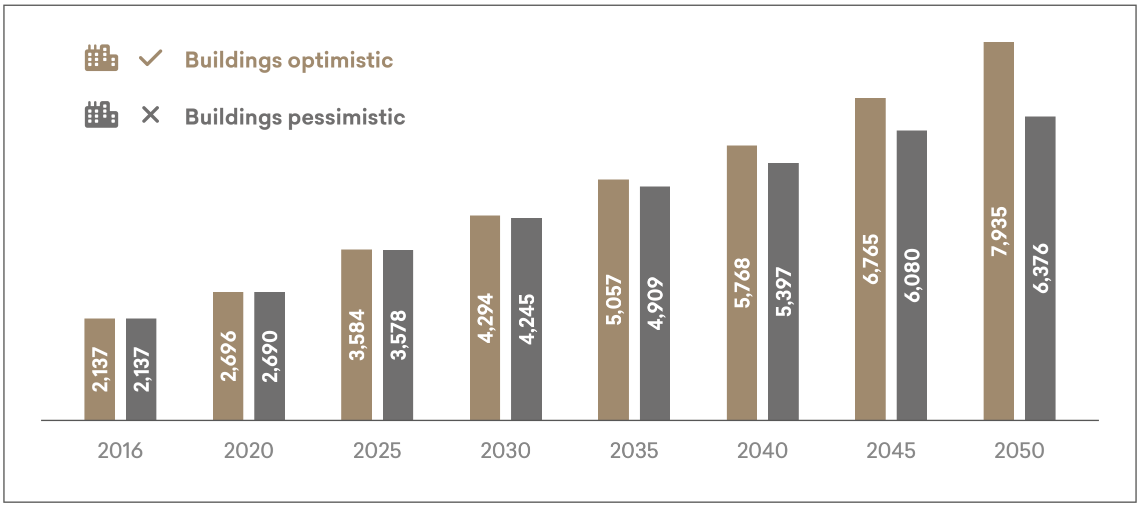


Building Sector

Likely Future Emissions Trajectory Range (WoM)

The figure below illustrates the projected growth in GHG emissions from the buildings sector in Georgia from 2016 to 2050. By 2050, buildings sector (commercial/institutional plus residential sectors) GHG emissions are expected to reach 7,935 Gg CO_2-eq under the optimistic scenario and 6,375 Gg CO_2-eq under the pessimistic scenario.

FIGURE 9. Buildings Sector GHG Emissions by 2050 in the Case of WoM Optimistic and WoM Pessimistic Scenarios



Milestones for 2030 and 2040

The GHG emissions WoM scenario considers the buildings sector development without taking any mitigation measures. The total GHG emissions by 2030 and 2040 would possibly reach approximately 4,294 Gg CO_2-eq and 5,768 Gg CO_2-eq, respectively, in the case of the optimistic approach and 4,245 Gg CO_2-eq and 5,397 Gg CO_2-eq in the case of the pessimistic approach.

TABLE N33. GHG Emissions Milestones for 2030 and 2040 in the Case of WoM Scenarios

Year	Optimistic approach	Percent of 1990 level	Pessimistic approach	Percent of 1990 level
	Gg CO_2 eq.	%	Gg CO_2 eq.	%
1990	4,902		4,902	
2030	4,294	88	4,245	87
2040	5,768	118	5,397	110

The WeM scenario considers buildings sector development with adopted or planned mitigation measures. The GHG emissions by 2030 and 2040 would possibly reach approximately 4,405 Gg CO_2-eq and 5,405 Gg CO_2-eq in the case of the optimistic approach and 4,374 Gg CO_2-eq and 5,173Gg CO_2-eq in the case of the pessimistic approach.

TABLE N34. GHG Emissions Milestones for 2030 and 2040 in the Case of WeM Scenarios

Year	Optimistic approach	Percent of 1990 level	Pessimistic approach	Percent of 1990 level
	Gg CO_2-eq	%	Gg CO_2-eq	%
1990	4,902		4,902	
2030	4,405	90	4,374	89
2040	5,405	110	5,173	106

The WaM scenario considers development with additional mitigation measures conditioned on funding opportunities and Global Market development trends. The GHG emissions from buildings by 2030 and 2040 would possibly reach approximately 3,971 Gg CO_2-eq and 3,189 Gg CO_2-eq in the case of the optimistic approach and 3,914 Gg CO_2-eq and 3,354 Gg CO_2-eq in case of the pessimistic approach.

TABLE N35. GHG Emissions Milestones for 2030 and 2040 in the Case of WaM Scenarios

Year	Optimistic approach	Percent of 1990 level	Pessimistic approach	Percent of 1990 level
	Gg CO_2-eq	%	Gg CO_2-eq	%
1990	4,902		4,902	
2030	3,971	81	3,914	80
2040	3,189	65	3,354	68

Likely Range of Future Emissions Trajectories (WeM and WaM)

Considering the milestones to 2030 and 2040 described above, the emissions from the buildings sector will decrease significantly in the case of the WeM scenario as compared with the baseline scenario. Figure 10 illustrates the projected growth in GHG emissions from the buildings sector in Georgia from 2016 to 2050 if the main mitigation policies adopted and planned in the country are considered.

By 2050, the total GHG emissions from the buildings sector in the case of the WeM scenario are expected to reach 6,473 Gg CO_2-eq (from 7,935 Gg CO_2-eq in the baseline scenario) under the optimistic scenario and 5,906 Gg CO_2-eq (from 6376 Gg CO_2-eq in the baseline scenario) under the pessimistic scenario.

The impact of policies and measures is reflected in the difference between the baseline and the mitigation scenarios. For the optimistic scenario, the annual GHG emission impact by 2050 is 1,461 Gg CO_2-eq. In the pessimistic scenario, this amount is reduced to 469 Gg CO_2-eq.

FIGURE 10. Buildings Sector GHG Emissions by 2050 in the Case of WeM Optimistic and WeM Pessimistic Scenarios

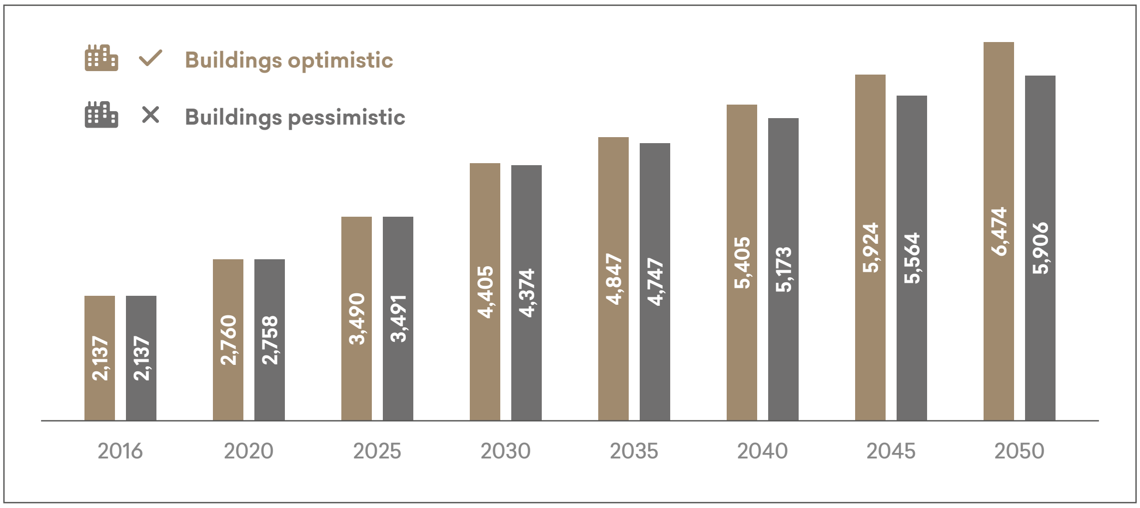


Table 36 shows the impact of policies and measures (the difference between GHG emissions for WoM and WeM scenarios) in the mitigation WeM scenario for the buildings sector.

TABLE N36. Impact of PAMs for WeM Scenarios

Scenario	Difference between WoM and WeM, Gg CO2 eq					
	2016	2025	2035	2040	2045	2050
✓ (WoM – WeM) Optimistic scenario	0	95	210	363	841	1,461
✕ (WoM – WeM) Pessimistic scenario	0	87	162	224	517	469

FIGURE 11. GHG Emissions for WoM and WeM Optimistic Scenarios

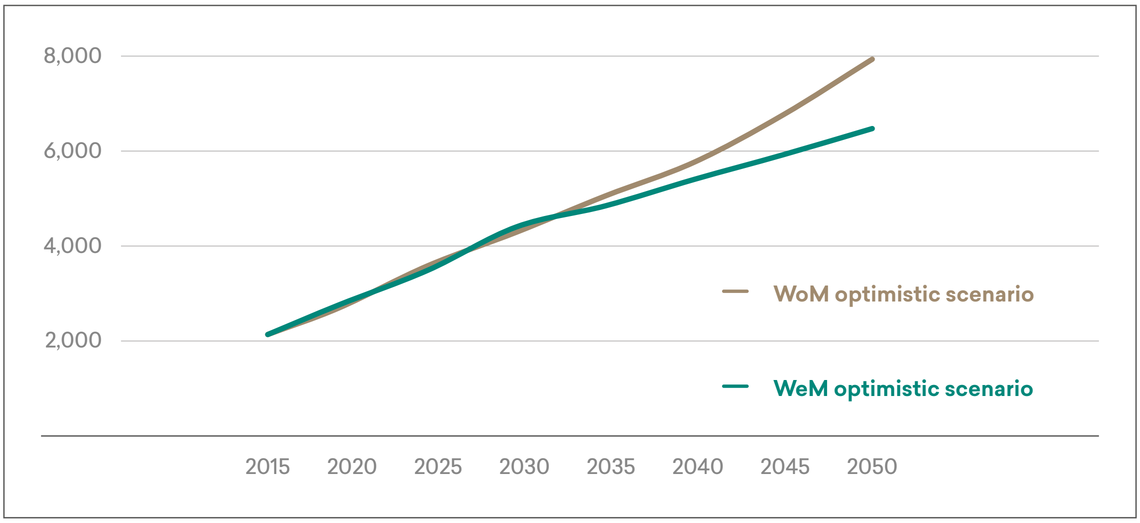
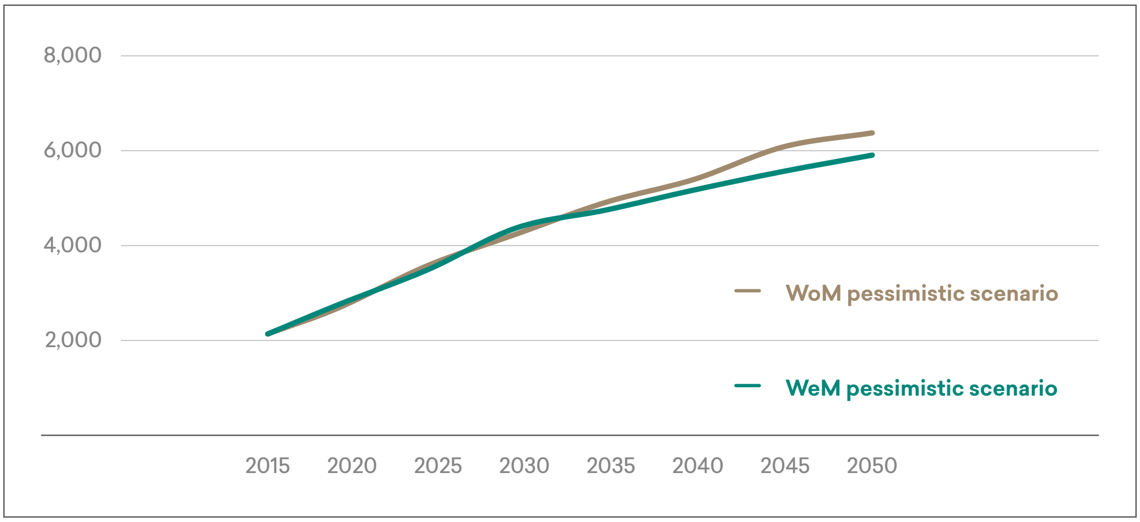


FIGURE 12. GHG Emissions for WoM and WeM Pessimistic Scenarios



Technologies and Assumptions Considered in the WeM Mitigation Scenario

The mitigation scenario (WeM) is built from the baseline scenario (WoM) by considering the effect of the policies and measures adopted and planned in the country. This definition implies that all policies and measures considered under the WoM are also considered in the WeM together with those technologies which will be used as a result of the implementation of PAMs.

The following tables provide information on the new technologies that have been considered in the mitigation scenario.

TABLE N37. Additional Technologies Considered in the WeM Scenario

Technologies	Fuel	Efficiency (Energy Consumed/m²)
RESIDENTIAL HEATING: Electricity Air Heat Pump-Improved	Electricity	2.642
RESIDENTIAL HEATING: Electricity Ground Heat Pump-Standard	Electricity	3.100
RESIDENTIAL HEATING: Natural Gas Individual-Improved	Natural gas	0.870
RESIDENTIAL HEATING: Natural Gas Individual-Better	Natural gas	0.960
RESIDENTIAL HEATING: Primary Solid Biofuels Individual-Standard	Biomass	0.500
RESIDENTIAL HEATING: Primary Solid Biofuels Individual-Improved	Biomass	0.700
RESIDENTIAL COOLING: Electricity Air Heat Pump-Standard	Electricity	3.810
RESIDENTIAL COOLING: Electricity Air Heat Pump-Improved	Electricity	4.100
RESIDENTIAL COOLING: Electricity Air Heat Pump-Better	Electricity	6.450

RESIDENTIAL COOLING: Electricity Ground Heat Pump-Standard	Electricity	4.161
COMMERCIAL COOLING: Electricity Air Heat Pump-Improved	Electricity	55.373
COMMERCIAL COOLING: Electricity Air Heat Pump-Advanced	Electricity	68.066
COMMERCIAL COOLING: Electricity Ground Heat Pump-Improved	Electricity	351.140
COMMERCIAL COOLING: Electricity Central AC-Improved	Electricity	45.991
COMMERCIAL COOLING: Electricity Central AC-Advanced	Electricity	97.501
COMMERCIAL COOLING: Electricity Centrifugal Chiller-Improved	Electricity	23.455
COMMERCIAL COOLING: Electricity Centrifugal Chiller-Advanced	Electricity	28.974
COMMERCIAL COOLING: Electricity Scroll, Recipe or Screw Chiller-Improved	Electricity	46.911
COMMERCIAL COOLING: Electricity Scroll, Recipe or Screw Chiller-Advanced	Electricity	53.809
COMMERCIAL COOLING: Electricity Rooftop AC-Improved	Electricity	67.147
COMMERCIAL COOLING: Electricity Rooftop AC-Advanced	Electricity	180.284
COMMERCIAL COOLING: Electricity Wall/Window AC-Improved	Electricity	17.976
COMMERCIAL COOLING: Electricity Wall/Window AC-Advanced	Electricity	27.437
COMMERCIAL HEATING: Electricity Air Heat Pump-Improved	Electricity	33.619
COMMERCIAL HEATING: Electricity Air Heat Pump-Advanced	Electricity	41.326
COMMERCIAL HEATING: Natural Gas Boiler-Improved	Natural gas	13.659
COMMERCIAL HEATING: Natural Gas Boiler-Advanced	Natural gas	13.001
COMMERCIAL HEATING: Natural Gas Furnace-Improved	Natural gas	4.738
COMMERCIAL HEATING: Primary Solid Biofuels Boiler-Standard	Biomass	12.957
COMMERCIAL LIGHTING: Electricity LED-Standard	Electricity	416.953
COMMERCIAL WATER HEATING: Electricity Heat Pump-Improved	Electricity	79.322

COMMERCIAL WATER HEATING: Natural Gas Tank-Advanced		Natural gas	7.534
COMMERCIAL WATER HEATING: Fuel Oil Tank-Improved		Fuel Oil	16.061
RESIDENTIAL WATER HEATING: Electricity -On Demand-Advanced		Electricity	0.670
RESIDENTIAL WATER HEATING: Natural Gas -Tank-Better		Natural gas	0.850
RESIDENTIAL WATER HEATING: Natural Gas -Tank-Advanced		Natural gas	0.530

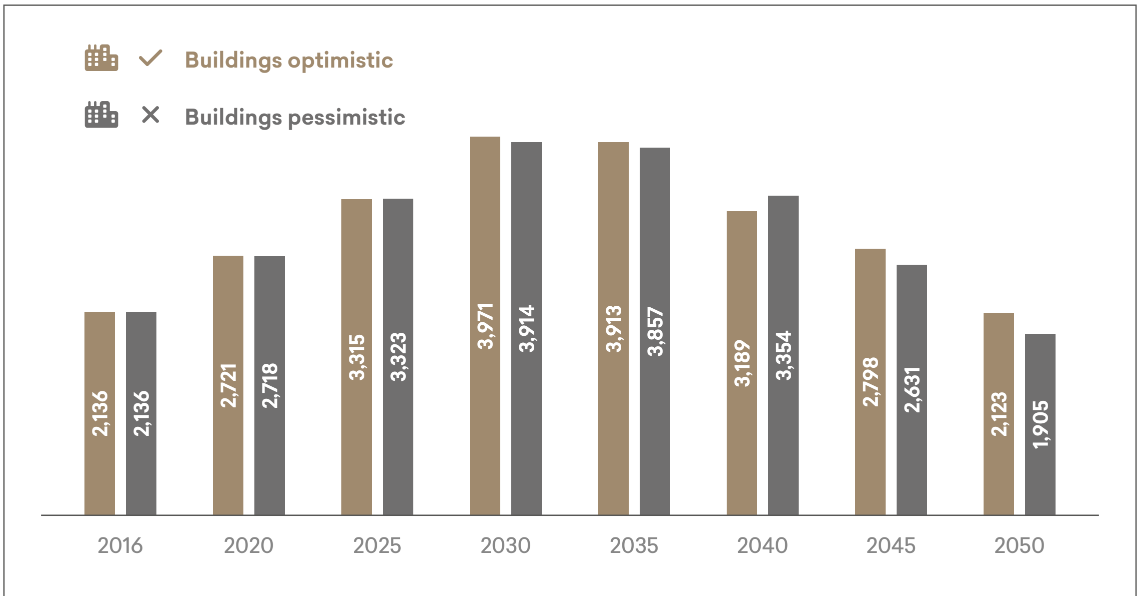
SOURCE: AA: EPBD transposition

Potential Measures for Mitigation and Their Prioritization

Considering additional technologies and increased penetration of low carbon technologies (WaM scenario), the building sector emissions will decrease significantly. Figure 13 illustrates the projected growth in GHG emissions from the buildings sector in Georgia from 2016 to 2050 with additional GHG emission reductions resulting from additional policies and measures.

By 2050, the total GHG emissions from the buildings sector are expected to reach 2,123 Gg CO_2-eq under the optimistic scenario and 1,905 Gg CO_2-eq under the pessimistic scenario.

FIGURE 13. Buildings Sector GHG Emissions by 2050 in the Case of WaM Optimistic and WaM Pessimistic Scenarios



Impact of Policies and Measures Considered in the Additional Mitigation Scenario (WaM)

The impact of policies and measures, additional technologies and targets is reflected in the difference between the baseline (WoM) and the mitigation scenario (WaM).

Table 38 shows the impact of policies and measures (the difference between GHG emissions for WoM and WaM scenarios) considered in the mitigation WaM scenario for the buildings sector.

TABLE N38. Impact of PAMs for WaM Scenarios

	Scenario	2016	2025	2030	2035	2040	2045	2050
✓	(WoM – WaM) Optimistic scenario	0	269	322	1,144	2,579	3,968	5,812
✗	(WoM – WaM) Pessimistic scenario	0	255	331	1,052	2,044	3,449	4,471

FIGURE 14. GHG Emissions for WoM and WaM Optimistic Scenarios

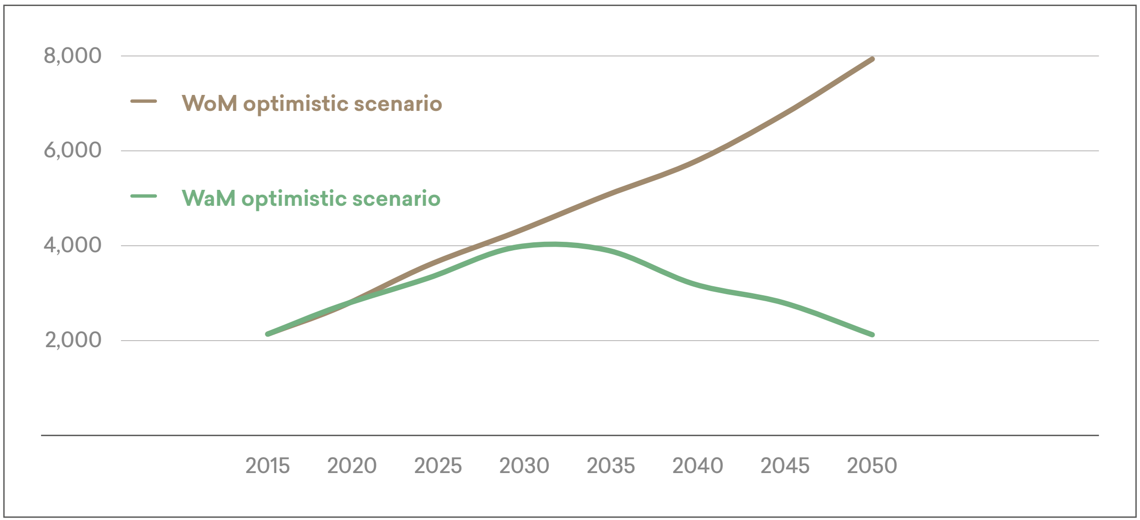
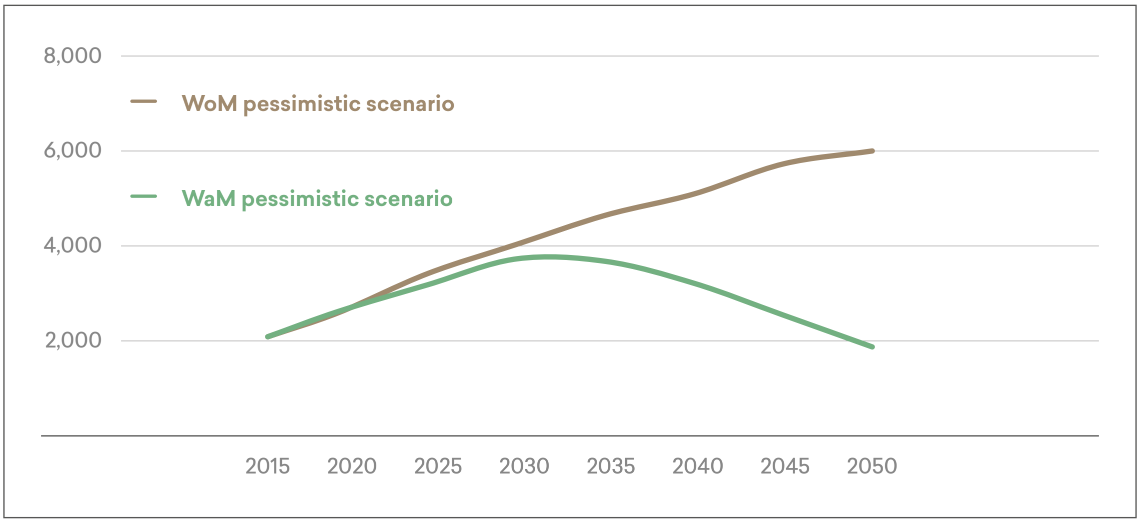


FIGURE 15. GHG Emissions for WoM and WaM Pessimistic Scenarios



Technologies and Assumptions Considered in the Mitigation Scenario (WaM Scenario)

The WaM scenario is built from the WeM by considering the effect of additional mitigation actions that are feasible for the country given the policies and measures currently adopted and planned. This definition implies that all technologies considered under the WoM and the WeM are also considered in the WaM together with additional technologies.

The following tables provide information on the additional technologies considered in the WaM.

TABLE N39. Technologies Considered in the WaM Scenario

Technologies	Fuel	Efficiency (Energy Consumed/m²)
COMMERCIAL HEATING: Primary Solid Biofuels Boiler-Improved	Biomass	14.037
COMMERCIAL HEATING: rimary Solid Biofuels Boiler-Advanced	Biomass	15.117
COMMERCIAL WATER HEATING: Fuel Oil Tank-Advanced	Fuel Oil	19.416
RESIDENTIAL HEATING: Other Bituminous Coal Central-Standard	Coal	0.830
RESIDENTIAL COOLING: Natural Gas Heat Pump-Standard	Natural gas	0.700
RESIDENTIAL COOLING: Electricity Central-Standard	Electricity	3.810
RESIDENTIAL COOLING: Electricity Central-Improved	Electricity	4.250
RESIDENTIAL COOLING: Electricity Central-Advanced	Electricity	7.030
RESIDENTIAL WATER HEATING: Diesel -Tank-Advanced	Diesel	0.620
RESIDENTIAL WATER HEATING: LPG -Tank-Standard	LPG	0.670
RESIDENTIAL WATER HEATING: LPG -Tank-Improved	LPG	0.820
RESIDENTIAL WATER HEATING: LPG -Tank-Better	LPG	0.850
RESIDENTIAL WATER HEATING: LPG -Tank-Advanced	LPG	1.000
COMMERCIAL COOLING: Natural Gas Heat Pump-Standard	Natural gas	3.810
COMMERCIAL COOLING: Natural Gas Absorption Chiller-Standard	Natural gas	4.250
COMMERCIAL COOLING: Natural Gas Rooftop AC-Standard	Natural gas	7.034
COMMERCIAL COOKING: LPG Range-Standard	LPG	0.800
COMMERCIAL HEATING: Electricity Ground Heat Pump-Improved	Electricity	3.700
COMMERCIAL HEATING: Electricity Ground Heat Pump-Advanced	Electricity	4.000

TABLE N40. Additional Technologies Considered in the WaM Scenario

Technology	Efficiency	Comments
Building shell, advanced thermal insulation	Minus 50% of the standard annual energy consumption per m^2	Will be mandatory starting from 2023 after the full transposition of the EPBD to Georgia
Low-temperature water radiators	Minus 5% of annual energy consumption per m^2	Will be widely used after wide use of condensation boilers to achieve minimum energy performance based on EPBD requirements
Temperature-adjusting valves and other simple management systems for recirculated water	Minus 3% of annual energy consumption per m^2	Currently used rarely. Will be widely used to achieve required performance after EPBD full transposition from 2023 to achieve minimum energy performance
Building management systems	Minus 3% of annual energy consumption per m^2	Currently used rarely. Will be widely used in many sites to achieve required performance after EPBD full transposition from 2023
Solar PV systems	Minus 10% of annual energy consumed per m^2	Currently used rarely. Will be widely used after full transposition of EPBD after 2023 to achieve minimum energy performance
Solar hot water systems	Minus 10% of annual energy consumed per m^2	Currently used rarely. Will be widely used after full transposition of EPBD after 2023 in order to achieve minimum energy performance
Hot water storage systems	Minus 5% to annual energy consumption per m^3	Most applicable in large buildings and multi-apartment buildings due to the large initial cost
Cooling tower (in the residential sector applied in multistoried blocks of flats only)	Minus 10% energy consumption per m^2	Used in very few cases to achieve HVAC system performance, it is feasible in large sites and single-family dwellings
Efficient electrical cookers and other equipment	Minus 20% energy consumption per m^2	Not used now, will be used after GDP growth and energy prices increase due to high initial cost
Ventilation heat recovery systems	minus 10% of the annual energy consumption per m^2	Used in very few cases. It will be used in every mechanically ventilated site to achieve the required HVAC system performance

Estimated Share of Buildings in Total GHG Emissions by 2050

GHG emissions from buildings and their share in national emissions have been estimated.

TABLE N41. Projected GHG Emissions from Buildings in 2020-2050, Optimistic Scenario

Scenario	GHG emissions, Gg CO_2-eq						
	2020	2025	2030	2035	2040	2045	2050
WoM	2,696	3,584	4,294	5,057	5,768	6,765	7,935
WeM	2,760	3,490	4,405	4,847	5,405	5,924	6,474
WaM	2,721	3,315	3,971	3,913	3,189	2,798	2,123

TABLE N42. Projected GHG Emissions from Buildings in 2020-2050, Pessimistic Scenario

Scenario	GHG emissions, Gg CO_2-eq						
	2020	2025	2030	2035	2040	2045	2050
WoM	2,690	3,578	4,245	4,909	5,397	6,080	6,376
WeM	2,758	3,491	4,374	4,747	5,173	5,564	5,906
WaM	2,718	3,323	3,914	3,857	3,354	2,631	1,905

TABLE N43. Share of Buildings in the National GHG Emissions (Including LULUCF), Optimistic Scenarios

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	22%	25%	26%	26%	26%	25%	26%
WeM	22%	30%	38%	40%	54%	69%	91%
WaM	22%	32%	42%	43%	54%	90%	-3,910%

TABLE N44. Share of Buildings in the National GHG Emissions (Including LULUCF), Pessimistic Scenarios

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	17%	21%	22%	22%	22%	21%	19%
WeM	19%	24%	28%	28%	29%	27%	27%
WaM	23%	32%	43%	45%	63%	101%	-390%

Calculations are also made without consideration of emission removals by the LULUCF sector. With both optimistic and pessimistic WoM and WeM scenarios, the share of agricultural GHG emissions decreases each year while it increases in the case of WaM.

TABLE N45. Share of the Agricultural Sector in the National GHG Emissions (Excluding LULUCF), Optimistic Scenarios

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	16%	19%	20%	21%	21%	22%	23%
WeM	16%	21%	25%	26%	32%	37%	43%
WaM	15%	20%	24%	23%	22%	22%	20%

TABLE N46. Share of Buildings in the National GHG Emissions (Excluding LULUCF), Pessimistic Scenarios

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	13%	16%	18%	18%	19%	18%	17%
WeM	16%	19%	22%	22%	22%	22%	21%
WaM	16%	20%	24%	23%	23%	21%	19%

Transport Sector

Range of Likely Future GHG Emissions Trajectories for Baseline (WoM) Scenarios

The GHG emissions by 2050 from the transport sector in the case of the baseline (WoM scenario) are driven by economic growth and the associated transportation demand. Georgia's GDP is expected to continue growing above 5% up to 2050 (on average by 5.7% in the case of an optimistic scenario and on average by 5% in the case of a pessimistic scenario), expanding its overall economic activity and increasing in a similar proportion the transportation demand of the economy. Economic growth, transportation demand and GHG emissions are highly correlated as current economic practices and existing technologies are fossil fuel dependent.

Activity for both passenger and freight transport has been gradually increasing in Georgia, following a large fall in activity in 1991, and is projected to continue increasing in the future. The envisioned car mileage will constitute 28 km per day in 2030 and 40 km per day in 2050. Therefore, the emissions up to 2050 will continue to rise unless sectoral and national policies and practices are implemented and highly efficient technologies are widespread in the country.

Projected GHG emissions from the transport sector in the case of WoM optimistic and WoM pessimistic scenarios are given in Figures 16 and 17. GHG emissions are projected to increase by approximately 133% from 2016 levels to 10,489 Gg CO2-eq in 2050 under WoM optimistic scenario and approximately by 72% from 2016 levels to 7,704 Gg CO2-eq in 2050 under the WoM pessimistic scenario.

FIGURE 16. Projected GHG Emissions from the Transport Sector in Gg CO2-eq (WoM Optimistic Scenario)

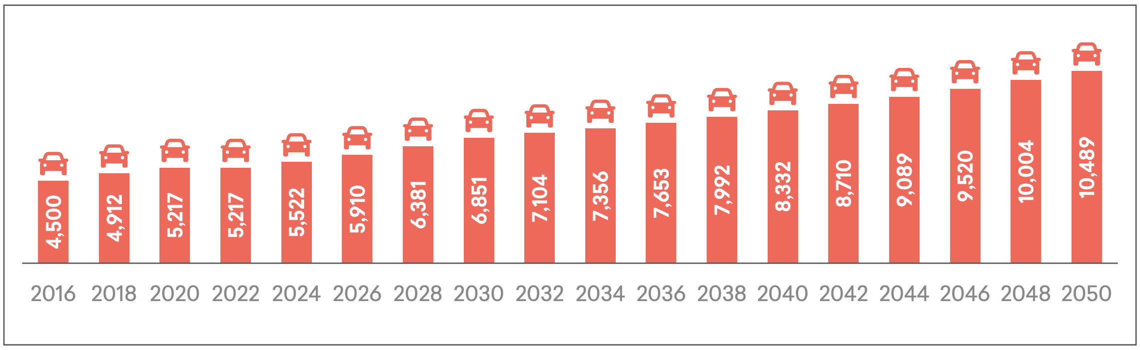
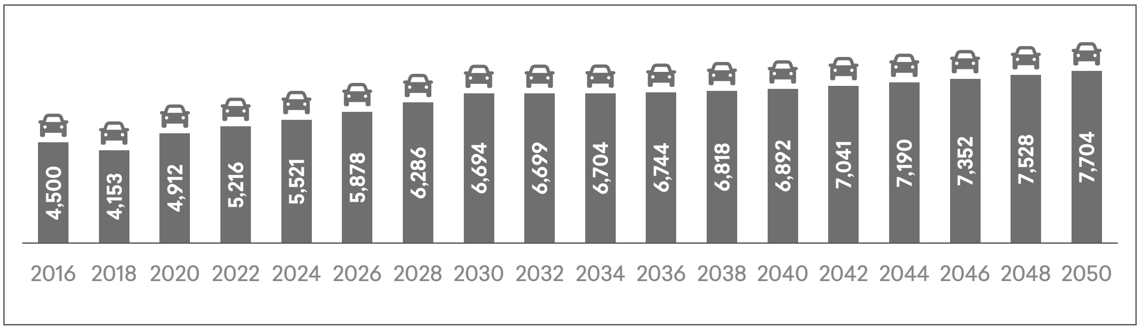


FIGURE 17. Projected GHG Emissions from the Transport Sector in Gg CO2-eq (WoM Pessimistic Scenario)



Milestones for 2030 and 2040

The WoM scenario does not consider the implementation of any policies and measures but is projected considering the main macroeconomic perspectives of Georgia. The total GHG emissions from the transport sector by 2030 and 2040 would possibly reach 6,851 Gg CO_2-eq and 8,332 Gg CO_2-eq in the case of the optimistic scenario and 6,694 Gg CO_2-eq and 6,892 Gg CO_2-eq respectively in the case of the pessimistic scenario.

TABLE N47. GHG Emissions Milestones for 2030 and 2040 in WoM Scenarios

Year	Optimistic scenario	Percent of 1990 level	Pessimistic scenario	Percent of 1990 level
	Gg CO_2-eq	%	Gg CO_2-eq	%
1990	3,901		3,901	
2030	6,851	176	8,332	214
2040	6,694	172	6,892	177

The WeM scenario considers the planned and implemented policies and measures in Georgia and assesses how Georgia's mitigation pathway will respond according to these actions. The total GHG emissions from the transport sector by 2030 and 2040 would possibly reach approximately 6,306 Gg CO_2-eq and 5,654 Gg CO_2-eq in the case of the optimistic scenario and 6,095 Gg CO_2-eq and 5,411 Gg CO_2-eq in the case of the pessimistic scenario.

TABLE N48. GHG Emissions Milestones for 2030 and 2040 in WeM Scenarios

Year	Optimistic scenario	Percent of 1990 level	Pessimistic scenario	Percent of 1990 level
	Gg CO_2-eq	%	Gg CO_2-eq	%
1990	3,901	---	3,901	---
2030	6,306	162	6,095	156
2040	5,654	145	5,411	139

The WaM scenario considers additional measures that are not yet included in Georgia's planning process and assesses how the country's mitigation pathway will respond according to these actions. The total GHG emissions from the transport sector by 2030 and 2040 would possibly reach approximately 5,079 Gg CO_2-eq and 4,067 Gg CO_2-eq in the case of the optimistic scenario and 4,909 Gg CO_2-eq and 3,892 Gg CO_2-eq in the case of the pessimistic scenario.

TABLE N49. GHG Emissions Milestones for 2030 and 2040 in WaM Scenarios

Year	Optimistic scenario	Percent of 1990 level	Pessimistic scenario	Percent of 1990 level
	Gg CO_2-eq	%	Gg CO_2-eq	%
1990	3,901		3,901	
2030	5,079	130	4,909	126
2040	4,067	104	3,892	100

Range of Likely Future GHG Emissions Trajectories
Mitigation Scenarios (WeM and WaM)

The decarbonization of the transport sector will be driven mainly:

1. by the change of technologies from conventional fossil vehicles to highly efficient cars and low carbon technologies such as hybrid and electric,
2. by modal shift; e.g., from private transport to public transport, more use of rail and water transport, etc. and
3. by fuel economy improvement. Despite their small shares in GHG emissions, national aviation and navigation will also play a role in the decarbonization with the gradual increase in the share of advanced technologies.

The mitigation scenario (WeM) is built from the baseline scenario (WoM) by considering the effect of the policies and measures adopted and planned in the country. The WaM scenario is built from the WeM by considering the effect of additional mitigation actions which are feasible for the country given the policies and measures planned.

Considering additional technologies and increased penetration of low carbon technologies, the emissions from the transport sector in WeM and WaM scenarios will decrease significantly as compared to the baseline (WoM scenario). Figures 18-21 show the projected GHG emissions from the transport sector in WeM and WaM scenarios.

By 2050, GHG emissions from the transport sector will be reduced by 19.8% in the case of the WeM optimistic scenario and by 81% % in the case of the WeM optimistic scenario and by 9.7% in the case of the WeM pessimistic scenario and by 67.5% % in the case of the WeM pessimistic scenario.

FIGURE 18. Projected GHG Emissions from the Transport Sector in Gg CO2-eq (WeM Optimistic Scenario)

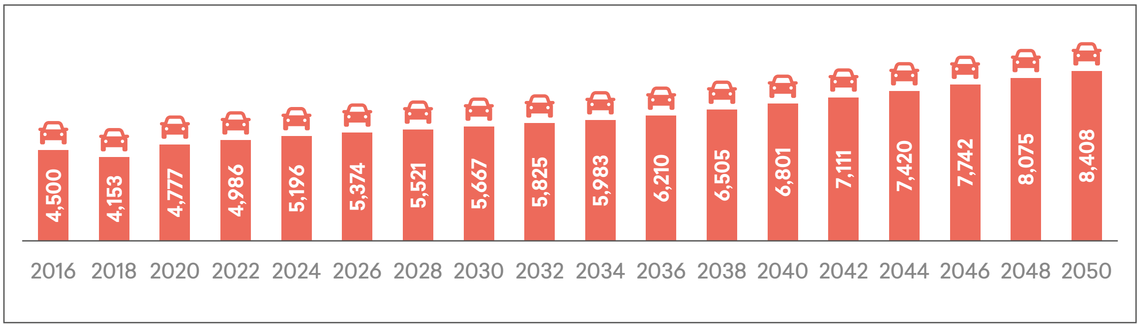


FIGURE 19. Projected GHG Emissions from the Transport Sector in Gg CO2-eq (WeM Pessimistic Scenario)

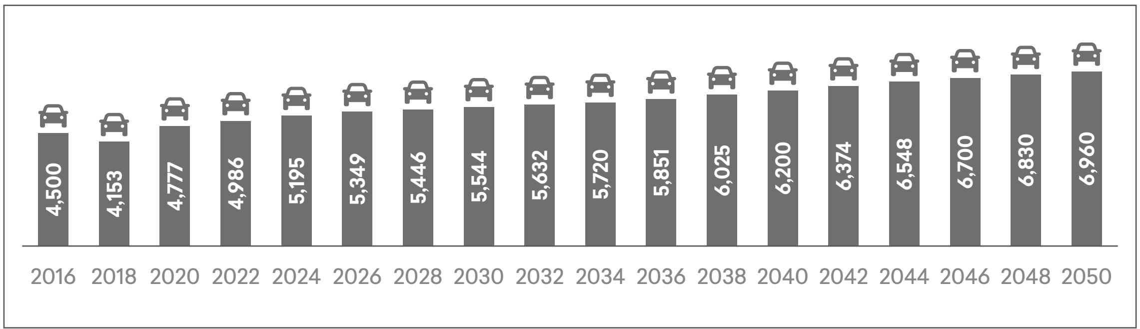


FIGURE 20. Projected GHG Emissions from the Transport Sector in Gg CO2-eq (WaM Optimistic Scenario)

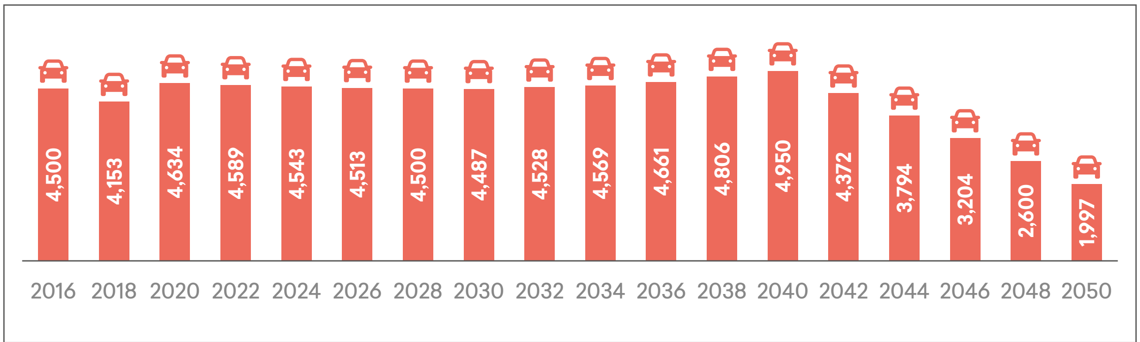


FIGURE 21. Projected GHG Emissions from the Transport Sector in Gg CO2-eq (WaM Pessimistic Scenario)

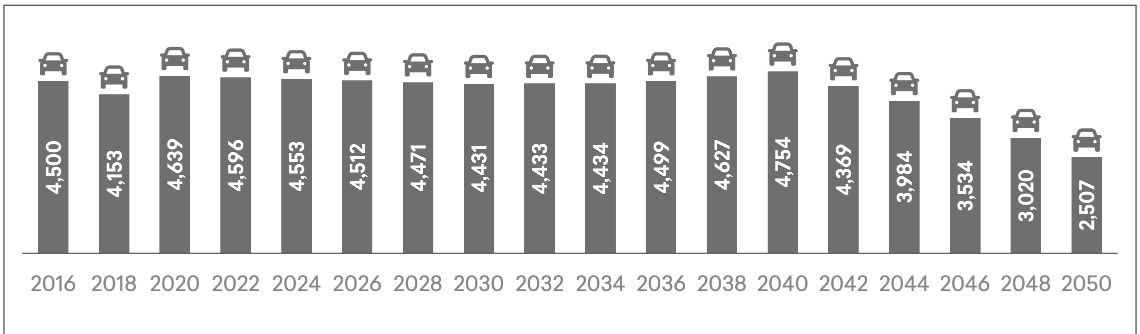


FIGURE 22. Projected GHG Emissions from the Transport Sector in Gg CO2-eq (Optimistic Scenario)

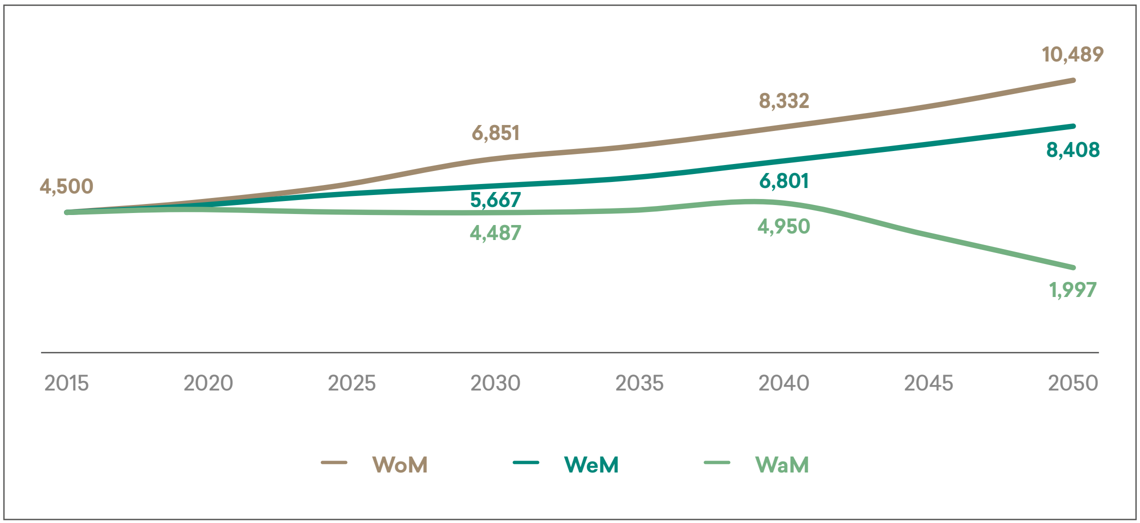
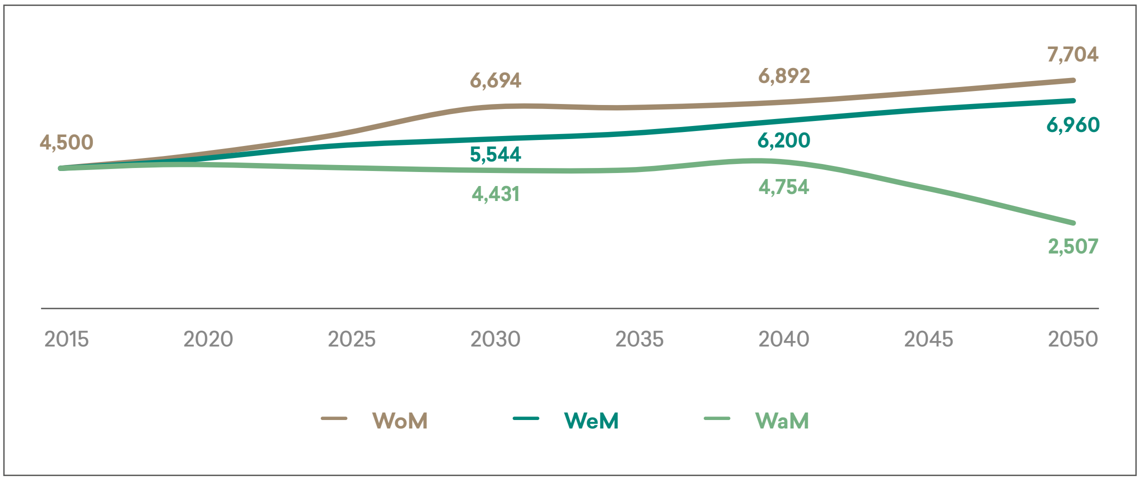


FIGURE 23. Projected GHG Emissions from the Transport Sector in Gg CO2-eq (Pessimistic Scenario)



Estimated Share of GHG Emissions from the Transport Sector in National GHG Emissions

Table 50 shows an estimated share of GHG emissions from the transport sector in national GHG emissions (including the LULUCF sector). In optimistic and pessimistic WaM scenarios, the transport sector's share drastically increased as national GHG emissions are small due to an increase in GHG absorption by LULUCF.

TABLE N50. Share of GHG Emissions from the Transport Sector in National GHG Emissions (Including the LULUCF Sector), Optimistic Scenario

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	34%	31%	30%	28%	27%	25%	26%
WeM	50%	47%	42%	40%	40%	37%	38%
WaM	37%	44%	48%	51%	85%	113%	-3,678%

TABLE N51. Share of GHG Emissions from the Transport Sector in National GHG Emissions (Excluding the LULUCF Sector), Optimistic Scenario

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	25%	25%	25%	24%	24%	23%	23%
WeM	33%	32%	29%	28%	28%	27%	28%
WaM	26%	27%	27%	27%	33%	27%	19%

TABLE N52. Share of GHG Emissions from the Transport Sector in National GHG Emissions (Including the LULUCF Sector), Pessimistic Scenario

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	34%	31%	31%	27%	26%	24%	23%
WeM	39%	41%	40%	37%	38%	36%	35%
WaM	39%	44%	48%	52%	89%	145%	-514%

TABLE N53. Share of GHG Emissions from the Transport Sector in National GHG Emissions (Excluding the LULUCF Sector), Pessimistic Scenario

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	25%	25%	25%	23%	22%	21%	21%
WeM	28%	29%	28%	26%	27%	26%	25%
WaM	27%	27%	27%	27%	33%	30%	24%

Industry Sector

Estimated Likely Share of Sector GHG Emissions in 2050

Within four major sectors (energy, agriculture, industry and waste), the industry sector is in the third place with its share of non-energy related actual emissions in total GHG emissions in Georgia since the energy-related emissions are counted in the energy sector. The possible energy and non-energy-related emissions for the mid-century period have been projected based on three different scenarios such as without measures (WoM), with existing (adopted and planned) measures (WeM) and with additional measures (WaM) scenarios. The optimistic and pessimistic development paths have been assumed for the baseline (WoM) scenario, entailing optimistic and pessimistic WeM and WaM by imposing measures on respective WoM scenarios.

The WoM scenario considers the industry development without taking any mitigation measures for the manufacturers. The total emissions from the IPPU sector by 2050 would possibly reach 4,846 Gg CO_2-eq in the case of the optimistic approach and 3,902 Gg CO_2-eq in the case of the pessimistic approach. The total emissions from energy-related emissions from the industry sector by 2050 would possibly reach 5,313 Gg CO_2-eq in the case of the optimistic approach and 3,855 Gg CO_2-eq in the case of the pessimistic approach (Table 54).

TABLE N54. Energy and Non-energy Related Emissions from the Industry Sector by 2050, WoM Scenario

Year	Optimistic approach	Percent of 1990 level	Pessimistic approach	Percent of 1990 level
	Gg CO_2 eq	%	Gg CO_2 eq	%
	Energy-related emissions			
1990	7,566.0		7,566.0	
2050	5,313.2	70%	3,854.9	51%
	Non-energy-related emissions			
1990	3,812.2		3,812.2	
2050	4,845.7	127%	3,901.8	102%

The WeM scenario considers the industry development with adopted or planned mitigation measures by the manufacturers. The total emissions from the IPPU sector by 2050 would possibly reach 3,964 Gg CO_2-eq in the case of the optimistic approach and 3,169 Gg CO_2-eq in the case of the pessimistic approach, comprising 26% and 10% of total GHG emissions. The total emissions from energy-related emissions from the industry sector by 2050 would possibly reach 4,539 Gg CO_2-eq in the case of the optimistic approach and 3,609 Gg CO_2-eq in the case of the pessimistic approach, comprising 30% and 12% of total GHG emissions (Table 55).

TABLE N55. Energy and Non-energy Related Emissions from the Industry Sector by 2050, WeM Scenario

Year	Optimistic approach	Percent of 1990 level	Pessimistic approach	Percent of 1990 level
	Gg CO_2 eq	%	Gg CO_2 eq	%
	Energy related emissions			
1990	7,566.0		7,566.0	
2050	4,539.3	60%	3,608.8	48%
	Non-energy related emissions			
1990	3,812.2		3,812.2	
2050	3,964.2	104%	3,169.4	83%

The WaM scenario considers the industry development with additional mitigation measures conditional to the funding opportunities and Global Market development trends with respect to manufacturing. The total emissions from the IPPU sector by 2050 would reach 2,622 Gg CO_2-eq in the optimistic approach and 2,140 Gg CO_2-eq in the case of the pessimistic approach, comprising 25% and 21% of total GHG emissions. The total emissions from energy-related emissions from the industry sector by 2050 would possibly reach 380 Gg CO_2-eq in the case of the optimistic approach and 282 Gg CO_2-eq in the case of the pessimistic approach, comprising 36% and 28% % of total GHG emissions (Table 56).

TABLE N56. Energy and Non-energy Related Emissions from the Industry Sector by 2050, WaM Scenario

Year	Optimistic approach	Percent of 1990 level	Pessimistic approach	Percent of 1990 level
	Gg CO_2 eq	%	Gg CO_2 eq	%
	Energy-related emissions			
1990	7,566		7,566	
2050	380	5%	282	4%
	Non-energy related emissions			
1990	3,812		3,812	
2050	2,622	69%	2,140	56%

Ranges of Future Likely Emissions Trajectory Baseline Scenario (WoM)

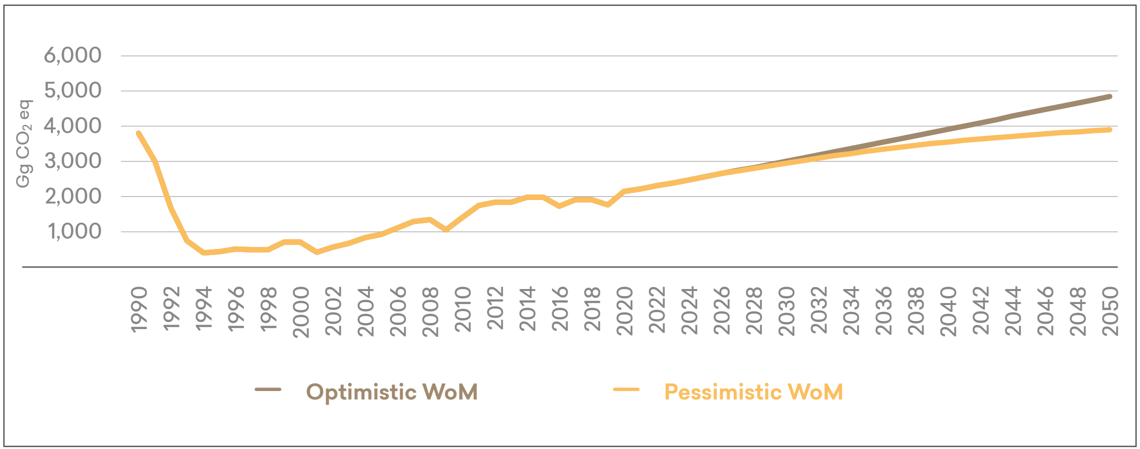
The emission projections from the IPPU sector consider the manufacturing activities in Cement Production, Nitric Acid Production, Ammonia Production, Iron and Steel Production and Ferroalloys Production. In addition, the projections consider the F-gases growth in the market. Pursuant to the 5th National GHG Inventory (2019), the emissions from the category of Product Use as substitutes for ODS have shown an increasing trend since 2000 by estimating HFCs emissions from refrigeration and air-conditioning source-category. As mentioned above, the emissions from source-categories, such as foam blowing agents, fire protection and aerosols, have not been estimated yet and are indicated with notation key NE. According to Paragraph 9 of Updated Nationally Determined Contribution (NDC 2021), the coverage of GHGs' estimation, including HFCs, will continue. Subsequently, it is expected that the accuracy and completeness of the national GHG emission inventory will increase within the period of NDC implementation. Since the LT LEDS incorporates a few upcoming decades, the estimation of possible actual emissions from the abovementioned source categories is included in the projections.

The projected emissions for the mid-century from the IPPU sector would possibly reach 4, 836 Gg CO_2-eq. The difference between the optimistic and pessimistic scenarios is about 19 percent. The projected emissions for 2050 are 1.3 times higher than those estimated for 1990, the base year for Georgia.

In 2030, the projected emissions would reach 3,005 Gg CO_2-eq and 2,955 Gg CO_2-eq in the case of optimistic and pessimistic scenarios, respectively.

The emissions projections for the IPPU sector are presented in Figure 24.

FIGURE 24. GHG Emissions Projections for 2050 in the IPPU Sector (WoM [BAU] Optimistic and Pessimistic Scenarios)



Along with the infrastructure development in Georgia, an increase in demand for cement, concrete and steel products is expected. Pursuant to the current WoM projections, cement production is expected to increase 1.8 times and steel production – three times by the year 2050, comprising 104% (78% in the case of mineral production and 140% in the case of metal production) of GHG emissions increase if considering the following two assumptions: (1) maintain the national mineral and steel production level in the market within the competitive ranges and (2) continue business as usual vis-à-vis the development of manufacturing.

The increased demand for chemical products (ammonia and nitric acid) in the international market is expected to be kept in the upcoming decades since the fields using these chemical products as raw materials, such as effective food production, textiles and dye manufacturing, are growing. Pursuant to the current WoM projections, chemical production in Georgia is expected to increase 1.8 times by the year 2050, resulting in 224% of GHG emissions growth in the same assumptions as listed above for mineral and metal production.

The mitigation scenarios consider that the GHG emissions from the use of fluorinated gases will gradually decrease due to prohibitions regarding placing certain F-gases on the market according to EC regulation on F-gases (517/2014) and the EU-GE AA requiring a phasing-out of F-gases and ODS as well as according to prohibition to mobile air-conditioning systems designed to contain F-gases with a global warming potential higher than 150 from a certain date. Since some goods and vehicles are subject to import from the EU countries, the abovementioned regulations will affect F-gases emissions in Georgia.

Milestones for 2030 and 2040

The GHG emissions WoM scenario considers the industry development without taking any mitigation measures by the manufacturers. The total energy-related emissions from the industry sector by 2030 and 2040 would possibly reach 2,546 Gg CO_2-eq and 4,797 Gg CO_2-eq in the case of the optimistic approach, comprising 9.2% and 13.6% of total GHG emissions, and 2,500 Gg CO_2-eq and 3,764 Gg CO_2-eq in the case of the pessimistic approach, comprising 9.4% and 11.9% of total GHG emissions. The total non-energy related emissions from the IPPU sector by 2030 and 2040 would possibly reach 3,005 Gg CO_2-eq and 3,915 Gg CO_2-eq, respectively, comprising 10.9% and 11.1% of total GHG emissions in the case of the optimistic approach and 2,955 Gg CO_2-eq and 3,549 Gg CO_2-eq in the case of the pessimistic approach, comprising 11.09% and 11.3% of total GHG emissions (Table 57).

TABLE N57. GHG Emissions Milestones for 2030 and 2040, WoM Scenarios

Year	Optimistic approach	Percent of 1990 level	Pessimistic approach	Percent of 1990 level
	Gg CO_2 eq	%	Gg CO_2 eq	%
	Energy-related emissions			
1990	7,566.0		7,566.0	
2030	2,546.4	34	2,499.9	33
2040	4,797.5	63	3,763.8	50
	Non-energy-related emissions			
1990	3,812.2		3,812.2	
2030	3,004.5	79	2,954.7	78
2040	3,914.9	103	3,549.2	93

The WeM scenario considers the industry development with adopted or planned mitigation measures by the manufacturers. The non-energy related GHG emissions from the IPPU sector by 2030 and 2040 would possibly reach 2,826 Gg CO_2-eq and 3,425 Gg CO_2-eq. in the case of the optimistic approach, comprising 13.7% and 13.3% of total GHG emissions, respectively, and 2,710 Gg CO_2-eq and 3,066 Gg CO_2-eq in the case of the pessimistic approach, comprising 13.7% and 14.8% of total GHG emissions. The total energy-related emissions from the IPPU sector by 2030 and 2040 would possibly reach 2,411 Gg CO_2-eq and 4,168 Gg CO_2-eq, respectively, comprising 11.7% and 16.2% of total GHG emissions in the case of the optimistic approach and 2,232 Gg CO_2-eq and 2,987 Gg CO_2-eq, respectively, comprising 11.3% and 12.9% of total GHG emissions in the case of the pessimistic approach.

TABLE N58. GHG Emissions Milestones for 2030 and 2040, WeM Scenarios

Year	Optimistic approach	Percent of 1990 level	Pessimistic approach	Percent of 1990 level
	kt of CO_2 eq	%	kt of CO_2 eq	%
	Energy-related emissions			
1990	7,566.0		7,566.0	
2030	2,410.9	32	2,232.0	30
2040	4,167.7	55	2,987.5	39
	Non-energy related emissions			
1990	3,812.2		3,812.2	
2030	2,825.5	74	2,709.6	71
2040	3,425.2	90	3,065.6	54

The WaM scenario considers the industry development with additional mitigation measures conditioned with funding opportunities and Global Market development trends for manufacturers. The non-energy related emissions from the IPPU sector by 2030 and 2040 would possibly reach 2,547 Gg CO_2-eq and 2.646 Gg CO_2-eq, respectively, comprising 12.3% and 10.3% of total GHG emissions in the case of the optimistic approach and 2,505 Gg CO_2-eq and 2,408 Gg CO_2-eq, respectively, in the case of the pessimistic approach, comprising 12.6% and 10.4% of total GHG emissions. The total energy-related emissions from the IPPU sector by 2030 and 2040 would possibly reach 1,792 Gg CO_2-eq and 241 Gg CO_2-eq, comprising 8.7% and 0.9% of total GHG emissions in the case of the optimistic approach and 2,005 Gg CO_2-eq and 213 Gg CO_2-eq in the case of the pessimistic approach, comprising 10.1% and 0.9% of total GHG emissions (Table 59).

TABLE N59. GHG Emissions Milestones for 2030 and 2040, WaM Scenarios

Year	Optimistic approach	Percent of 1990 level	Pessimistic approach	Percent of 1990 level
	Gg CO_2 eq	%	Gg CO_2 eq	%
	Energy-related emissions			
1990	7,566.0		7,566.0	
2030	1,791.6	24	2,004.6	26
2040	241.5	3	213.4	3
	Non-energy-related emissions			
1990	3,812.2		3,812.2	
2030	2,547.0	67	2,504.8	66
2040	2,646.0	69	2,408.3	63

Likely Range of Future Emissions Reduction (Mitigation Scenarios)

The LT LEDS describes two different packages of mitigation measures for energy and non-energy-related emissions in the industry sector. The WeM scenario includes adopted and planned mitigation measures and the WaM scenario consists of additional mitigation measures offered internationally with low-carbon technologies or considered in a global market.

According to the WeM scenario, the energy and non-energy-related GHG emissions will reach levels 11 and 18 percent lower than the WoM scenario by the mid-century. In optimistic and pessimistic projections, the energy-related GHG emissions for 2050 will comprise 4,539 Gg CO_2-eq and 3,609 Gg CO_2-eq. These figures will be about 40 and 52 percent lower than the estimates for 1990. The non-energy related GHG emissions for 2050 comprise approximately 3,964 Gg CO_2-eq and 3,169 Gg CO_2-eq in optimistic and pessimistic projections, respectively, being 19% and 18% lower than in the case of the WoM scenario. Concerning 1990 values, these figures will be about 4 percent higher and 17 percent lower.

In the case of the WaM scenario, the cumulative mitigation effect for energy and non-energy-related emissions will reach 53 and 46 percent as compared with the WoM scenario by 2050. The energy-related GHG emissions from the industry sector for mid-century will be 95 and 96 percent lower (380

Gg CO_2-eq and 282 Gg CO_2-eq in optimistic and pessimistic projections, respectively) than was estimated for the baseline year. The implementation of potential energy-efficient measures conditions for fast reduction of emissions in 2030-2040: implementation of energy-efficient measures in the process of steel production and using of natural gas in heat production, improvement of diesel-fuel-based appliances in food production, and implementation of mitigation measures in the power generation sector (see section 4.1). In optimistic and pessimistic projections, the non-energy related GHG emissions from the IPPU sector for mid-century will be 31 and 34 percent lower (2,622 Gg CO_2-eq and 2,140 Gg CO_2-eq), respectively, than the baseline year (1990) estimate.

Figures 25 and 26 illustrate the WeM and WaM mitigation scenarios and the baseline WoM scenario in optimistic projections for both non-energy and energy-related emissions from the industry sector.

FIGURE 25. WoM, WeM and WaM Scenarios in Optimistic Projections for Non-energy Related Emissions (Gg CO_2-eq)

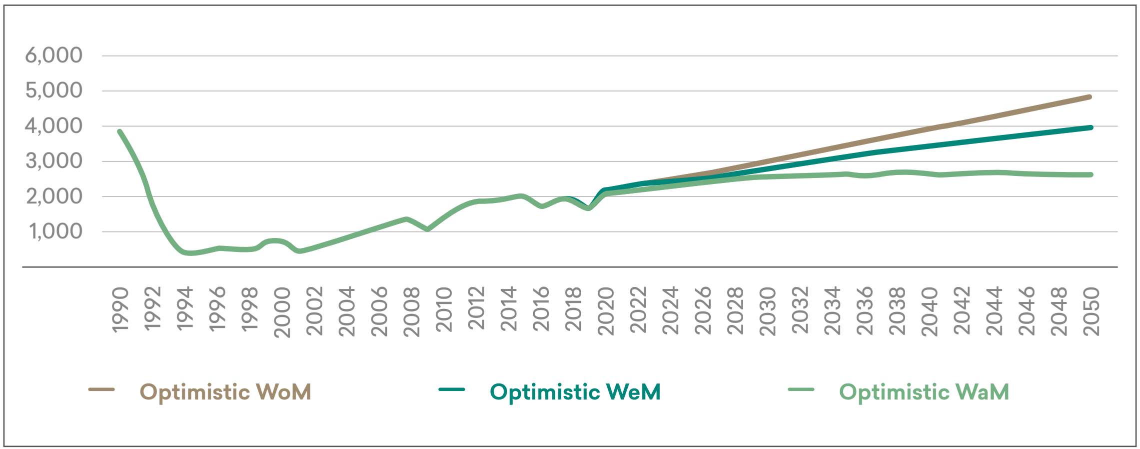
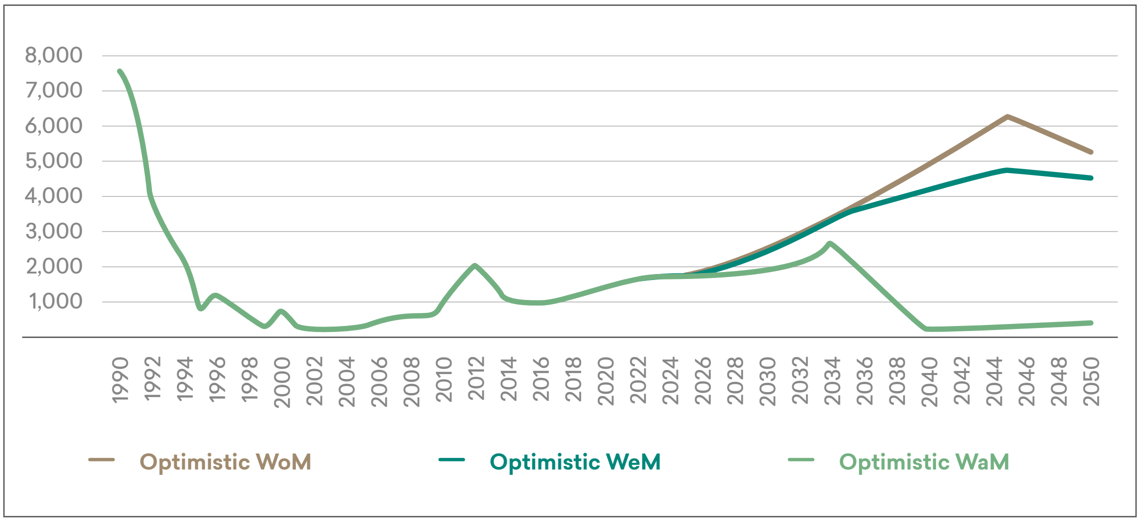


FIGURE 26. WoM, WeM and WaM Scenarios in Optimistic Projections for Energy-related Emissions (Gg CO_2-eq)



Figures 27 and 28 illustrate the WeM and WaM mitigation scenarios and the baseline WoM scenario in pessimistic projections for both non-energy and energy-related emissions from the industry sector.

FIGURE 27. WoM, WeM and WaM Scenarios in Pessimistic Projections for Non-energy Related Emissions (Gg CO_2-eq)

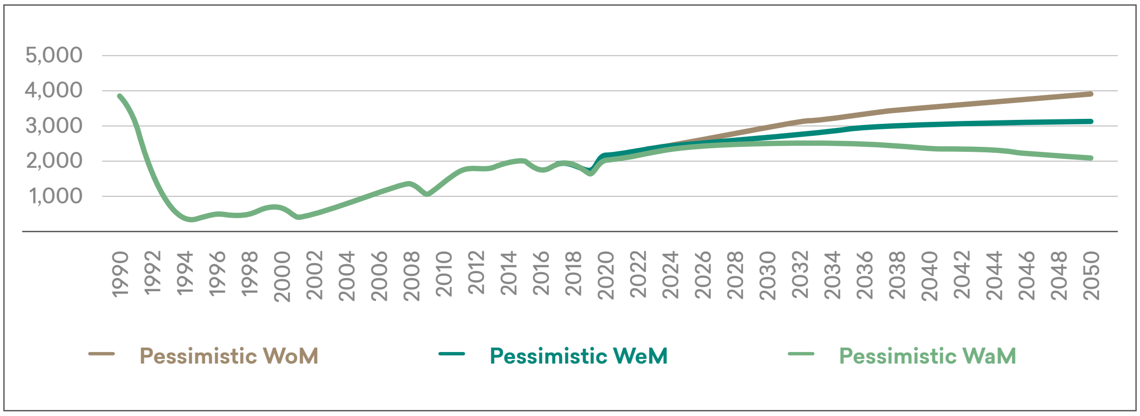


FIGURE 28. WoM, WeM and WaM Scenarios in Pessimistic Projections for Energy-related Emissions (Gg CO_2-eq)

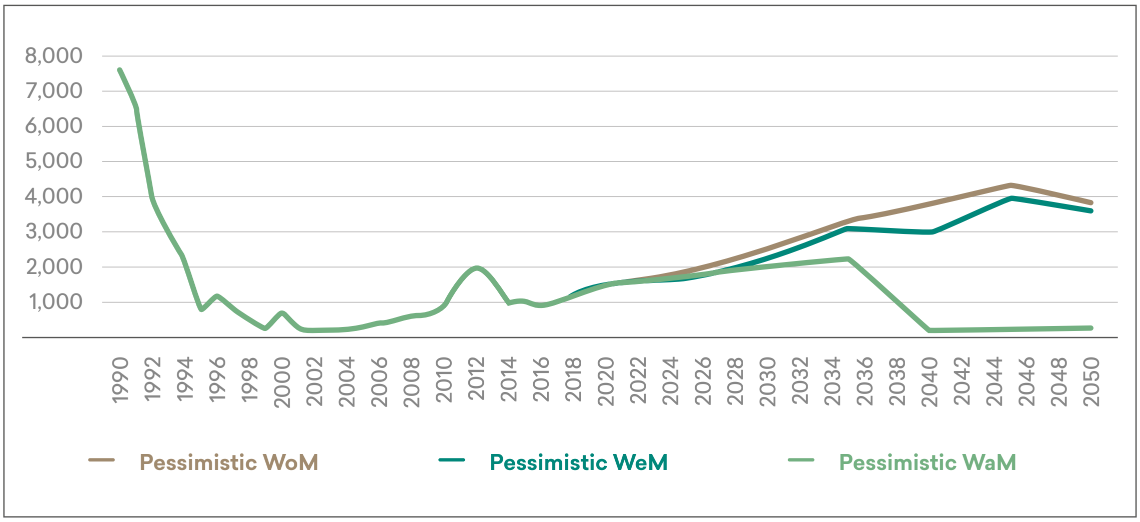


TABLE N60. WoM, WeM and WaM Scenarios in Optimistic and Pessimistic Projections for Non-energy Related GHG Emissions (Gg CO_2-eq)

Years	WoM		WeM		WaM	
	Optimistic	Pessimistic	Optimistic	Pessimistic	Optimistic	Pessimistic
1990	3,812.2	3,812.2	3,812.2	3,812.2	3,812.2	3,812.2
1991	3,002.7	3,002.7	3,002.7	3,002.7	3,002.7	3,002.7
1992	1,670.0	1,670.0	1,670.0	1,670.0	1,670.0	1,670.0
1993	755.2	755.2	755.2	755.2	755.2	755.2
1994	403.6	403.6	403.6	403.6	403.6	403.6
1995	437.8	437.8	437.8	437.8	437.8	437.8
1996	520.0	520.0	520.0	520.0	520.0	520.0
1997	498.7	498.7	498.7	498.7	498.7	498.7
1998	495.7	495.7	495.7	495.7	495.7	495.7
1999	706.0	706.0	706.0	706.0	706.0	706.0
2000	718.2	718.2	718.2	718.2	718.2	718.2
2001	423.6	423.6	423.6	423.6	423.6	423.6
2002	566.4	566.4	566.4	566.4	566.4	566.4
2003	672.6	672.6	672.6	672.6	672.6	672.6
2004	830.8	830.8	830.8	830.8	830.8	830.8
2005	938.3	938.3	938.3	938.3	938.3	938.3
2006	1,113.7	1,113.7	1,113.7	1,113.7	1,113.7	1,113.7
2007	1,288.3	1,288.3	1,288.3	1,288.3	1,288.3	1,288.3
2008	1,344.5	1,344.5	1,344.5	1,344.5	1,344.5	1,344.5
2009	1,063.9	1,063.9	1,063.9	1,063.9	1,063.9	1,063.9
2010	1,408.1	1,408.1	1,408.1	1,408.1	1,408.1	1,408.1
2011	1,743.7	1,743.7	1,743.7	1,743.7	1,743.7	1,743.7
2012	1,839.2	1,839.2	1,839.2	1,839.2	1,839.2	1,839.2
2013	1,845.7	1,845.7	1,845.7	1,845.7	1,845.7	1,845.7
2014	1,987.1	1,987.1	1,987.1	1,987.1	1,987.1	1,987.1
2015	1,992.7	1,992.7	1,992.7	1,992.7	1,992.7	1,992.7
2016	**1,736.6**	**1,736.6**	**1,736.6**	**1,736.6**	**1,736.6**	**1,736.6**
2017	1,911.1	1,911.1	1,911.1	1,911.1	1,903.2	1,903.2
2018	1,920.6	1,920.6	1,920.6	1,920.6	1,892.9	1,892.9
2019	1,760.2	1,760.2	1,760.2	1,760.2	1,714.6	1,714.6
2020	**2,155.2**	**2,155.2**	**2,155.2**	**2,155.2**	**2,071.6**	**2,071.6**

Years	WoM		WeM		WaM	
	✓ Optimistic	✗ Pessimistic	✓ Optimistic	✗ Pessimistic	✓ Optimistic	✗ Pessimistic
2021	2,219.4	2,219.4	2,219.4	2,219.4	2,108.5	2,108.5
2022	2,304.3	2,304.3	2,304.3	2,304.3	2,164.7	2,164.7
2023	2,388.9	2,388.9	2,388.9	2,388.9	2,219.2	2,219.2
2024	2,477.6	2,477.6	2,386.7	2,300.7	2,275.6	2,275.6
2025	**2,566.0**	**2,566.0**	**2,459.8**	**2,374.5**	**2,330.1**	**2,330.1**
2026	2,654.1	2,651.0	2,545.0	2,459.8	2,411.5	2,408.6
2027	2,742.0	2,729.9	2,608.4	2,521.1	2,421.4	2,410.4
2028	2,829.7	2,807.3	2,683.7	2,588.3	2,471.0	2,451.2
2029	2,917.2	2,882.2	2,758.3	2,653.5	2,518.9	2,488.5
2030	**3,004.5**	**2,954.7**	**2,825.5**	**2,709.6**	**2,547.0**	**2,504.8**
2031	3,096.0	3,028.1	2,887.0	2,754.7	2,557.3	2,501.5
2032	3,187.4	3,098.0	2,941.6	2,794.1	2,546.3	2,475.8
2033	3,278.6	3,165.1	3,010.1	2,843.8	2,578.2	2,490.4
2034	3,369.8	3,229.3	3,069.8	2,883.1	2,581.9	2,476.7
2035	**3,460.9**	**3,290.3**	**3,143.7**	**2,933.1**	**2,634.3**	**2,507.1**
2036	3,551.9	3,348.1	3,186.5	2,951.8	2,598.0	2,453.1
2037	3,642.8	3,402.8	3,251.6	2,988.5	2,628.9	2,460.4
2038	3,733.6	3,454.6	3,315.6	3,021.8	2,657.4	2,464.0
2039	3,824.3	3,503.3	3,376.8	3,050.4	2,672.5	2,454.7
2040	**3,914.9**	**3,549.2**	**3,425.2**	**3,065.6**	**2,646.0**	**2,408.3**
2041	4,008.0	3,594.5	3,480.3	3,082.7	2,637.2	2,377.2
2042	4,101.0	3,637.3	3,541.9	3,105.1	2,656.9	2,369.6
2043	4,194.1	3,677.4	3,602.4	3,124.6	2,674.3	2,359.1
2044	4,287.2	3,715.2	3,657.9	3,138.1	2,679.8	2,337.7
2045	**4,380.3**	**3,750.6**	**3,716.3**	**3,152.2**	**2,692.6**	**2,322.0**
2046	4,473.4	3,784.0	3,749.4	3,144.3	2,631.1	2,245.9
2047	4,566.5	3,815.6	3,802.7	3,151.8	2,626.3	2,217.1
2048	4,659.6	3,845.4	3,855.0	3,157.4	2,618.8	2,186.5
2049	4,752.6	3,874.2	3,902.7	3,158.4	2,600.1	2,147.6
2050	**4,845.7**	**3,901.8**	**3,964.2**	**3,169.4**	**2,621.9**	**2,139.7**

TABLE N61. WoM, WeM and WaM Scenarios in Optimistic and Pessimistic Projections for Energy-related GHG Emissions (Gg CO2 eq)

Years	WOM		WEM		WAM	
	✓ Optimistic	✗ Pessimistic	✓ Optimistic	✗ Pessimistic	✓ Optimistic	✗ Pessimistic
2016	1314.37	1314.37	1,314	1314.37	1314.37	1,293
2020	1433	1459.36	1,512	1511.57	2204.8	1,627
2025	1886.63	1924.35	1,709	1707.56	1698.91	1,717
2030	2546.4	2499.87	2,411	2232.03	1791.61	2,005
2035	3668.56	3288.39	3,520	3112.34	2231.95	2,250
2040	4797.49	3763.75	4,168	2987.52	241.47	213
2045	6283.63	4323.1	4,774	3960.11	298.01	242
2050	5313.22	3854.87	4,539	3608.8	379.64	282

The priorities for these actions are determined based on their importance by different criteria and are presented in the table below.

TABLE N62. Results of the Criteria Selection Process with a Level of Priority and Assigned Weights for WaM

Decision Context	Criteria	Criteria Description	Priority 4 - very important 3 - important 2 - medium importance 1 - low importance											Weight (total of 100)
			1	2	3	4	5	6	7	8	9	10	11	
Technology Characteristics	1	Low Capital Investment Cost	3	4	4	4	3	4	3	3	3	3	3	20
Country Application	2	Instructed Operation and Maintenance	3	4	4	3	2	3	3	2	3	3	2	20
	3	Acceptability to Local Stakeholders	2	3	3	3	3	2	2	2	3	3	2	15
Mitigation Potential	4	GHG Abatement Potential	1	3	3	3	3	3	1	1	1	1	3	15
Development Benefit	5	Economic Benefits	3	2	3	3	2	2	3	3	2	3	3	20
	6	Social Benefits	3	2	3	3	3	3	2	1	2	2	3	10
	7	Environmental Benefits	1	3	2	3	3	3	1	1	1	1	2	10

Agriculture Sector

Milestones for 2030 and 2040

Following the current situation in the agricultural sector, technological re-equipment is expected to be implemented gradually, phase-by-phase: in the first phase, a legal framework will be created to introduce and implement the necessary technologies based on the results of the 2025-2030 Technology Needs Assessment Round III (within the framework of Georgia's third Technology Needs Assessment project), technical staff will be trained and service centers created in order to provide adequate services. Further, relevant countries and manufacturers will be identified and work on the transfer of specific technologies will commence.

The second phase involves introducing and implementing various technologies in 2030-2040.

In the third phase, the process of introducing new technologies (2040-2050) will be completed and new ones will fully replace old technologies.

No major shifts in terms of technological re-equipment of the sector are foreseen until 2030 with a baseline scenario. Moreover, planned and potential GHG mitigation measures, largely set out in the 2020-2030 Climate Change Strategy and the 2021-2023 (and subsequent) Action Plan(s), are unlikely to provide GHG emission reductions that would prevail over the emission increase in the WoM scenario.

The expected technological re-equipment in 2030-2040 is a turning point when productivity begins to increase in all sector branches; however, the trend of GHG emissions is still increasing by 2040 – the key year after which GHG emissions begin to decline.

Range of Likely Future Emissions Trajectory or Range Mitigation (WEM and WAM) Scenarios

Projected GHG emissions from the agriculture sector in the case of the WeM optimistic scenario constitute 2,442 Gg CO_2eq in 2030, 2,560 Gg CO_2eq in 2040 and 2,435 Gg CO_2eq in 2050. In the case of the pessimistic WeM scenario, they are 2,184 Gg CO_2eq in 2030, 2,318 Gg CO_2eq in 2040 and 2,217 Gg CO_2eq in 2050. Projected GHG emissions in the case of the WaM optimistic scenario constitute 2,352 Gg CO_2eq in 2030, 2,400 Gg CO_2eq in 2040 and 2,042 Gg CO_2eq in 2050. In the case of the pessimistic WaM scenario – 2,108 Gg CO_2eq in 2030, 2,178 Gg CO_2eq in 2040 and 1,868 Gg CO_2eq in 2050.

Parameters applied in optimistic and pessimistic (in parentheses) scenarios are listed in Table 63.

TABLE N63. Parameters Applied in WeM and WaM Scenarios. Values in Parentheses Correspond to the Pessimistic Scenario

Parameter	2030		2040		2050	
	WeM	WaM	WeM	WaM	WeM	WaM
Cattle in thousands	900 (800)	900 (800)	950 (850)	950 (850)	1,000 (900)	1,000 (900)
Native breeds, %	45	45	42.5	42.5	40	40
Caucasus Chestnut, %	45	45	42.5	42.5	40	40
Dairy cattle, %	10	10	15	15	20	20
Buffalos in thousands	15	15	15	15	15	15
Sheep in thousands	900 (800)	900 (800)	1,050 (950)	1,050 (950)	1,200 (1,100)	1,200 (1,100)
Goats in thousands	50	50	55	55	60	60
Swine in thousands	350 (300)	350 (300)	475 (425)	475 (425)	600 (500)	600 (500)
Poultry in thousands	15,000	15,000	15,000	15,000	15,000	15,000
Horses in thousands	22	22	22	22	22	22
Mules and Asses in thousands	5	5	5	5	5	5
Cattle manure in anaerobic lagoon, %	5	5	15	15	20	20
Methane extraction, %	2.5	5	7.5	12.5	12.5	15
Swine manure in anaerobic lagoon, %	5	5	15	15	20	20
Methane extraction, %	2.5	5	7.5	12.5	12.5	15
Sown area, thousand ha	300 (250)	300 (250)	400 (350)	400 (350)	500 (450)	500 (450)
Applied Nitrogen fertilizers, kg/ha	120	100	90	60	60	30
CH4 emissions reduction from enteric fermentation, %	2.5	5	7	10	23	40

The projected GHG emissions from the agricultural sector in 2020-2050 with optimistic and pessimistic WeM and WoM scenarios are given in Tables 64 and 65.

TABLE N64. GHG Emissions from Agriculture in 2020-2050 with Optimistic WeM and WaM Scenarios

Scenario	GHG emissions, Gg CO_2-eq						
	2020	2025	2030	2035	2040	2045	2050
WeM	2,240	2,341	2,442	2,501	2,560	2,498	2,435
WaM	2,240	2,296	2,352	2,376	2,400	2,221	2,042

TABLE N65. GHG Emissions from Agriculture in 2020-2050 with Pessimistic WeM and WaM Scenarios

Scenario	GHG emissions, Gg CO_2-eq						
	2020	2025	2030	2035	2040	2045	2050
WeM	2,240	2,212	2,184	2,251	2,318	2,265	2,211
WaM	2,240	2,174	2,108	2,143	2,178	2,023	1,868

Range of Estimated Future Trajectories of Greenhouse Gas Emissions for Baseline (WoM) Scenarios

Food security is a vital necessity for society and its members. Food independence provides the basis for food security. The share of domestic production in food products supply is low in Georgia; more than 50% of consumed meat and dairy products are imported (Table 1.8.3a). Moreover, consumption of essential products - meat and dairy - is low. Per capita meat consumption (average of around 40 kg) is significantly less than in the EU (on average 64 kg per capita in 2016). Dairy product consumption in 2016 constituted 184 kg/capita (in Europe, 288 kg/capita).

TABLE N66(A). Per Capita Meat Consumption and Share of Import

Indicator	Beef				Pork				Sheep and Goats			
	2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
kg/capita	7.4	7.6	8.2	8.5	10.8	11.2	11.3	12.1	1.5	2.0	2.7	1.8
Import, %	21	24	24	29	56	59	54	56	15	11	7	12

TABLE N66(B). Per Capita Meat Consumption and Share of Import

Indicator	Poultry				Meat in total			
	2016	2017	2018	2019	2016	2017	2018	2019
kg/capita	21.2	20.1	20.1	20.8	40.8	41.0	42.2	43.2
Import, %	70	70	69	70	55	55	53	56

Assumption: in order to increase the consumption of meat and dairy products and reduce the share of imports by 2030, 2040 and 2050, the number of cattle will be 900,000, 950,000 and 1,000,000, in the case of the optimistic scenario, and 800,00, 850,000 and 850,000 in the case of the pessimistic scenario. The number of pigs and sheep will also increase. Detailed data are given in Table 67.

Part of dairy cattle and swine manure is disposed of in anaerobic lagoons. The use of an anaerobic lagoon is one of the most common practices for storing manure on big farms. By 2030, no methane extraction is considered in the baseline scenario. The assumption was made for 2040 and 2050.

A significant part of the agricultural soil of Georgia is highly degraded, mainly due to soil erosion. As a result, soil productivity, essential to agricultural development, food security and the support of the livelihoods of poor populations, is very low in Georgia. For instance, the yield of cereals, which are strategic for the country - wheat and corn (maize) - is in the range of 2.5 t/ha which is much lower than the average yield in the European Union (5.66 t/ha wheat and 8.8 t/ha maize). It is supposed that the sown area will reach 300,000 ha in 2030, 400,000 ha in 2040 and 500,000 ha in 2050, in the case of the optimistic scenario, and 250,000 ha in 2030, 350,000 ha in 2040 and 450,000 ha in 2050 in the case of the pessimistic scenario. Improving soil fertility and plant nutrition is essential to sustain adequate crop yield. For the baseline scenario, it is supposed that by 2030, N fertilizer consumption will constitute, on average, 140 kg/ha and gradually decrease to 90 kg/ha in 2050.

Estimated GHG emissions from the agriculture sector in case of an optimistic baseline (WoM) scenario constitute 2,532 Gg CO_2eq in 2030, 2,740 Gg CO_2eq in 2040 and 2,819 Gg CO_2eq in 2050; in the case of a pessimistic baseline (WoM scenario) – 2,260 Gg CO_2eq in 2030, 2,453 Gg CO_2eq in 2040 and 2,569 Gg CO_2eq in 2050.

FIGURE 29. Projected GHG Emissions (Gg CO_2eq) for 2030 (WoM Optimistic Scenario)

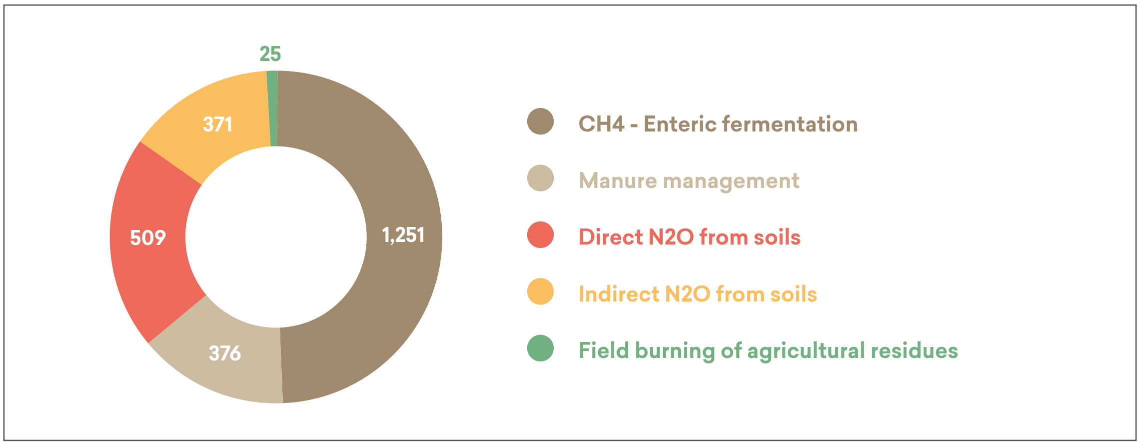


FIGURE 30. Projected GHG Emissions (Gg CO_2eq) for 2050 (WoM Optimistic Scenario)

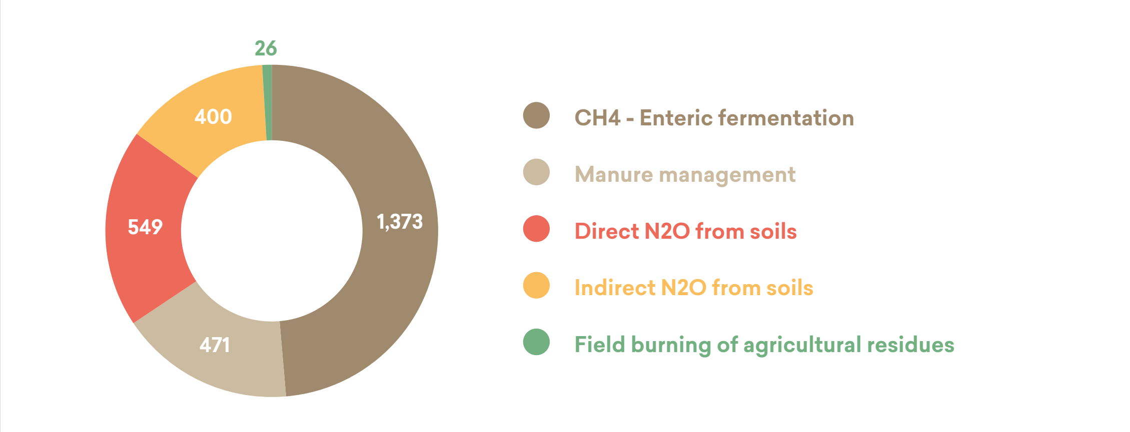


FIGURE 31. Projected GHG Emissions for 2030 (WoM Pessimistic Scenario)

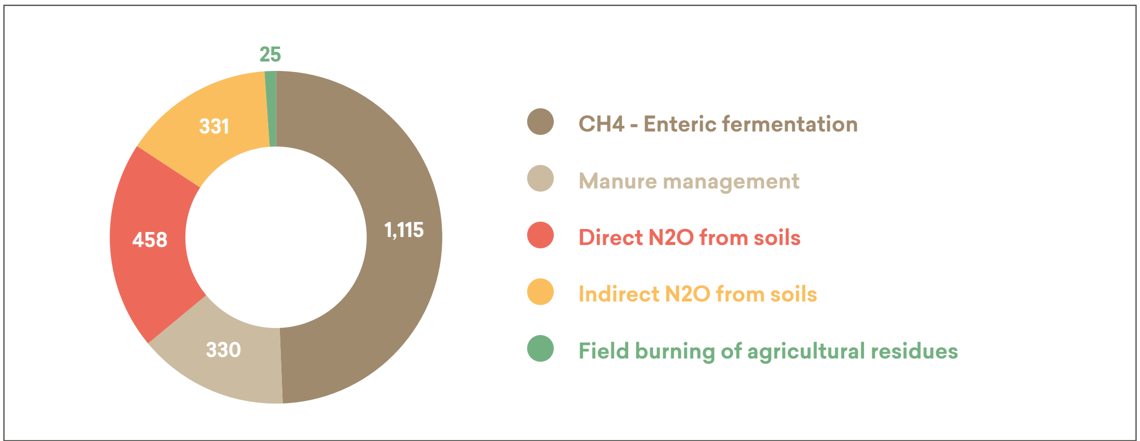
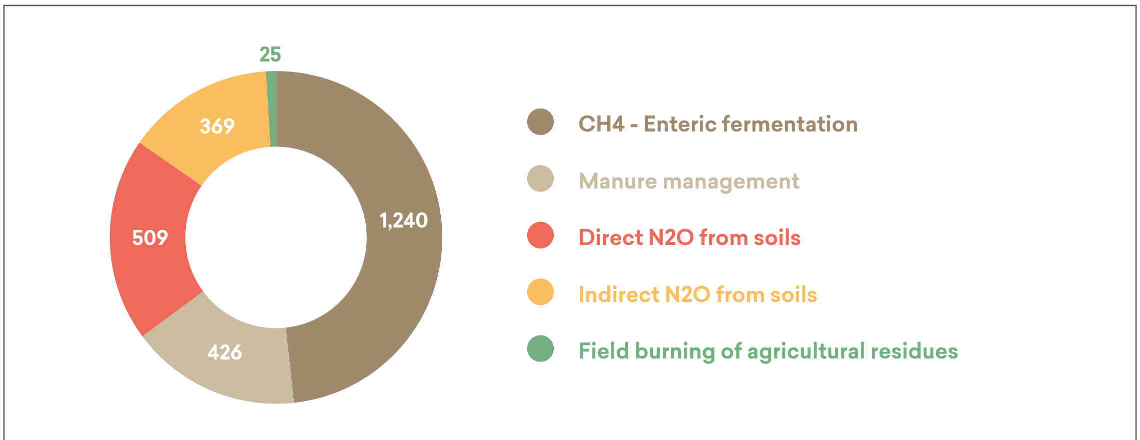


FIGURE 32. Projected GHG Emissions for 2050 (WoM Pessimistic Scenario)



All used parameters are given in Table 67. Parameters in parentheses correspond to pessimistic scenarios.

TABLE N67. Applied Parameters for WoM Scenario. Parameters for the Pessimistic Scenario are Given in Parentheses

Parameter	2030	2040	2050
Cattle in thousands	900 (800)	950 (850)	1,000 (900)
Native breeds, %	45	42.5	40
Caucasian brown, %	45	42.5	40
Dairy cattle, %	10	15	20
Buffalos in thousands	15	15	15
Sheep in thousands	900 (800)	1,050 (950)	1,200 (1,100)
Goats in thousands	50	55	60
Swine in thousands	350 (300)	475 (425)	600 (500)
Poultry in thousands	15,000	15,000	15,000
Horses in thousands	22	22	22
Mules and Asses in thousands	5	5	5
Cattle manure in anaerobic lagoon, %	5	15	20
Methane extraction, %	0	2.5	7.5
Swine manure in anaerobic lagoon, %	5	15	20
Methane extraction, %	0	2.5	7.5
Sown area, thousand ha	300 (250)	400 (350)	500 (450)
Applied Nitrogen fertilizers, kg/ha	140	120	90
CH4 emissions reduction from enteric fermentation, %	0	2.5	7

Estimated Share of Agricultural Sector in Total Greenhouse Gas Emissions by 2050

Greenhouse gas emissions from the agricultural sector and their share in national emissions have been estimated. National emissions take account of emission removals by the LULUCF sector. With both optimistic and pessimistic scenarios, WeM and WaM emissions will decrease from 2040. However, in WoM and WeM scenarios, the share of emissions decreases while in the case of WaM, it increases.

TABLE N68. Projected GHG Emissions from the Agricultural Sector in 2020-2050, Optimistic Scenario

Scenario	GHG emissions, Gg CO_2-eq						
	2020	2025	2030	2035	2040	2045	2050
WoM	2,240	2,386	2,531	2,636	2,740	2,780	2,820
WeM	2,240	2,341	2,442	2,501	2,560	2,498	2,435
WaM	2,240	2,296	2,352	2,376	2,400	2,221	2,042

TABLE N69. Projected GHG Emissions from the Agricultural Sector in 2020-2050, Pessimistic Scenario

Scenario	GHG emissions, Gg CO_2-eq						
	2020	2025	2030	2035	2040	2045	2050
WoM	2,240	2,250	2,260	2,357	2,453	2,511	2,569
WeM	2,240	2,212	2,184	2,251	2,318	2,265	2,211
WaM	2,240	2,174	2,108	2,143	2,178	2,023	1,868

TABLE N70. Share of the Agricultural Sector in the Total National GHG Emissions (Including LULUCF), Optimistic Scenarios

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	14.9%	12.5%	11.0%	9.9%	9.2%	8.1%	7.7%
WeM	17.8%	16.9%	15.9%	14.8%	14.5%	12.9%	12.5%
WaM	17.5%	21.0%	23.6%	25.7%	48.1%	78.1%	-6,831%

TABLE N71. Share of the Agricultural Sector in the Total National GHG Emissions (Including LULUCF), Pessimistic Scenarios

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	14.9%	11.8%	10.0%	9.2%	8.9%	8.2%	7.9%
WeM	17.8%	16.2%	14.8%	14.1%	14.9%	13.8%	13.7%
WaM	18.2%	20.0%	21.1%	23.3%	40.6%	64.2%	307.7%

Calculations are also made without consideration of emission removals by the LULUCF sector. With both optimistic and pessimistic WoM and WeM scenarios, the share of agricultural GHG emissions decreases each year while it increases in the case of WaM.

TABLE N72. Share of the Agricultural Sector in the Total National GHG Emissions (Excluding LULUCF), Optimistic Scenarios

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	11.2%	10.0%	9.1%	8.4%	8.0%	7.1%	6.8%
WeM	12.6%	12.1%	11.5%	10.8%	10.4%	9.3%	8.8%
WaM	12.3%	13.3%	13.7%	13.7%	17.2%	17.5%	19.1%

TABLE N73. Share of the Agricultural Sector in the Total National GHG Emissions (Excluding LULUCF), Pessimistic Scenarios

Scenario	2020	2025	2030	2035	2040	2045	2050
WoM	11.2%	9.4%	8.2%	7.8%	7.6%	7.1%	6.9%
WeM	12.6%	11.6%	10.6%	10.1%	10.3%	9.4%	9.1%
WaM	12.6%	12.6%	12.3%	12.4%	15.2%	15.5%	16.5%

GHG emission reductions by specific measures with optimistic and pessimistic scenarios are given in Tables 74 and 75 in quantities (Gg CO_2 eq) and percent (concerning sectoral emissions). The contributions by different emission sources are shown in Figures 33 to 38.

Figures 39 and 40 show the projected GHG emissions from the agricultural sector (in Gg CO_2 eq) with optimistic and pessimistic scenarios, respectively.

TABLE N74. Estimated GHG Emissions and Emissions Reductions due to Mitigation Measures (Optimistic Scenario)

Year	Scenario		GHG emissions	Feed additives - enteric fermentation	CH4 capture from anaerobic lagoons	Optimal application of N fertilizers
2030	WoM		2,531			
	WeM	GHG	2,442			
		Reduction	89 (3.5%)	31 (35%)	4 (4%)	54 (61%)
	WaM	GHG	2,352			
		Reduction	179 (7.1%)	62 (35%)	9 (5%)	108 (60%)
2040	WoM		2,740			
	WeM	GHG	2,560			
		Reduction	180 (6.6%)	61 (34%)	11 (6%)	108 (60%)
	WaM	GHG	2,400			
		Reduction	340 (12.4%)	102 (30%)	22 (6%)	216 (64%)
2050	WoM		2,820			
	WeM	GHG	2,435			
		Reduction	385 (13.7%)	237 (62%)	4 (1%)	135 (35%)
	WaM	GHG	2,042			
		Reduction	778 (27.6%)	488 (63%)	20 (3%)	270 (35%)

TABLE N75. Estimated GHG Emissions and Emissions Reductions due to Mitigation Measures (Pessimistic Scenario)

Year	Scenario		GHG emissions	Feed additives - enteric fermentation	CH4 capture from anaerobic lagoons	Optimal application of N fertilizers
2030	WoM		2,260			
	WeM	GHG	2,184			
		Reduction	76 (1.2%)	28 (37%)	3 (4%)	45 (59%)
	WaM	GHG	2,108			
		Reduction	152 (6.7%)	56 (37%)	6 (4%)	90 (59%)
2040	WoM		2,453			
	WeM	GHG	2,318			
		Reduction	135 (5.5%)	55 (41%)	6 (4%)	74 (55%)
	WaM	GHG	2,178			
		Reduction	275 (11.2%)	68 (25%)	18 (7%)	189 (69%)
2050	WoM		2,569			
	WeM	GHG	2,211			
		Reduction	358 (13.9)	218 (61%)	19 (5%)	121 (34%)
	WaM	GHG	1,868			
		Reduction	701 (27.3%)	440 (63%)	18 (3%)	242 (35%)

FIGURE 33. Contribution of Basic Sub-categories in Sectoral Emissions Gg CO2 eq (WoM Optimistic Scenario)

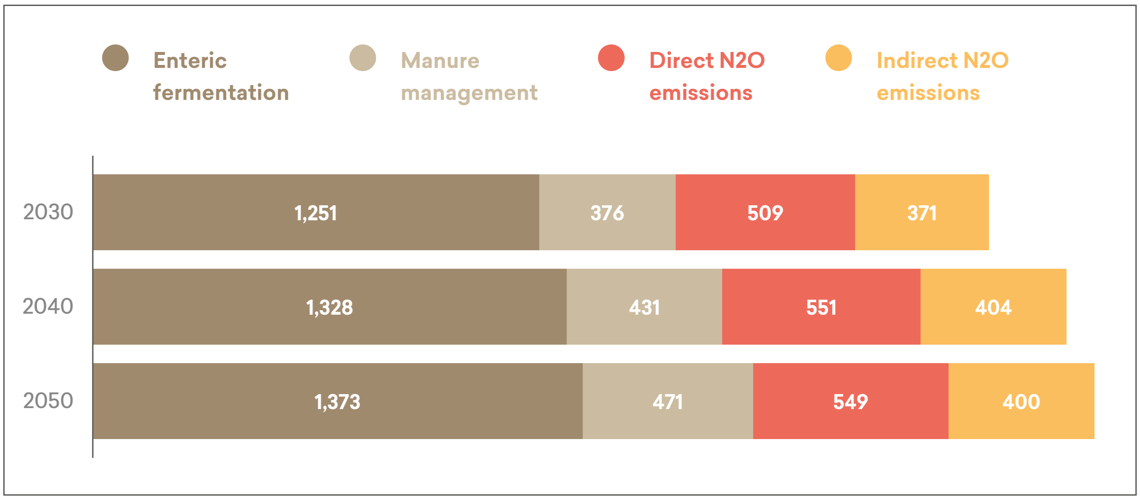


FIGURE 34. Contribution of Basic Sub-categories in Sectoral Emissions Gg CO2 eq (WeM Optimistic Scenario)

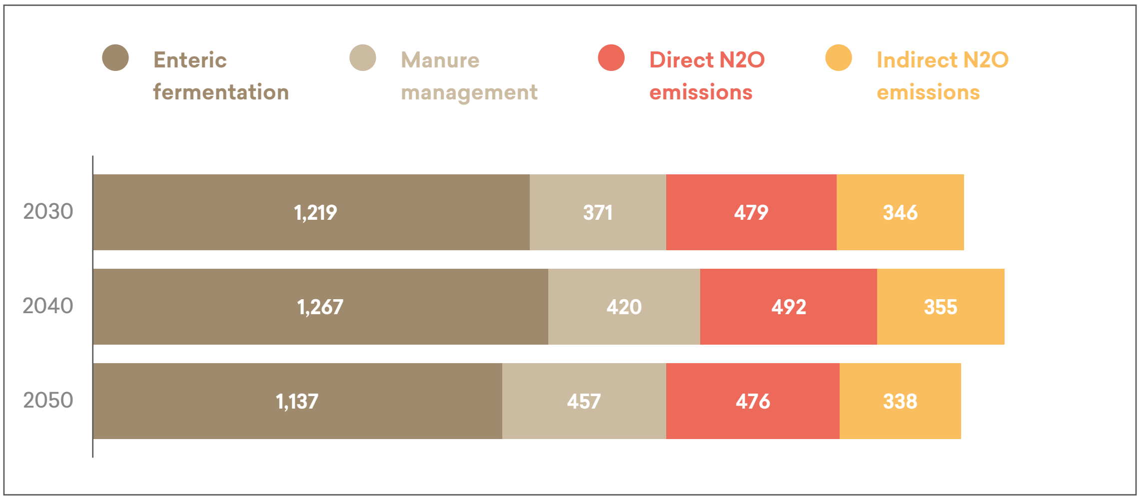


FIGURE 35. Contribution of Basic Sub-categories in Sectoral Emissions Gg CO2 eq (WaM Optimistic Scenario)

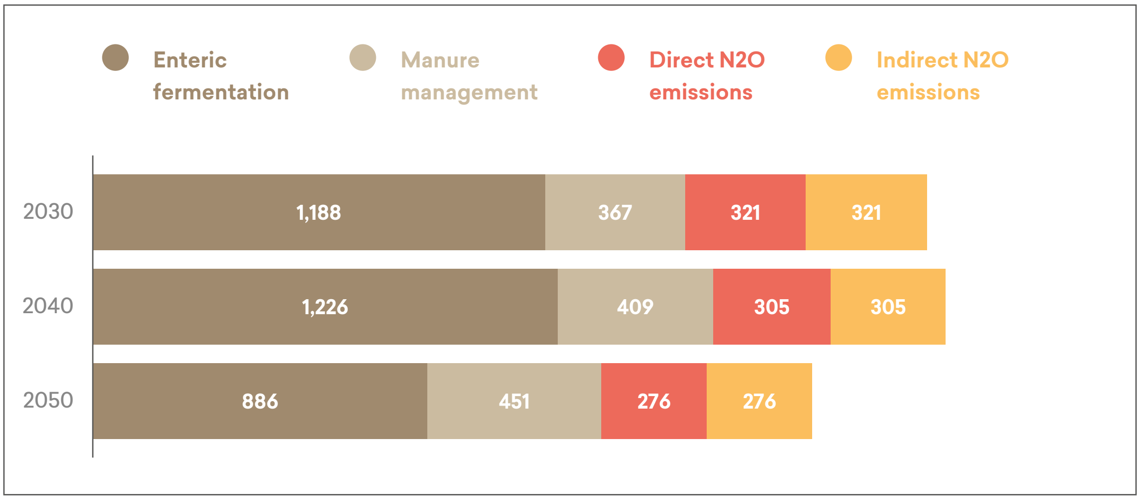


FIGURE 36. Contribution of Basic Sub-categories in Sectoral Emissions Gg CO2 eq (WoM Pessimistic Scenario)

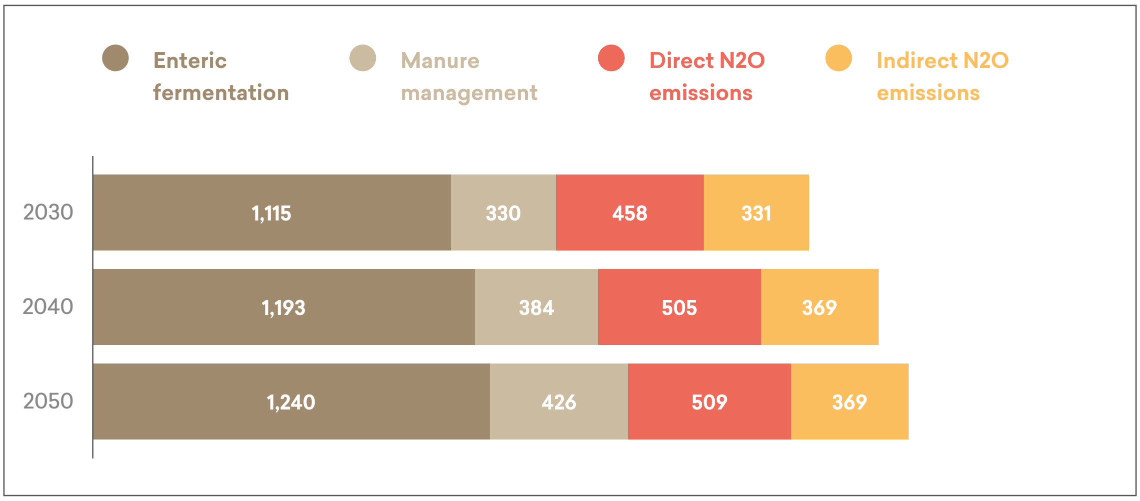


FIGURE 37. Contribution of Basic Sub-categories in Sectoral Emissions Gg CO2 eq (WeM Pessimistic Scenario)

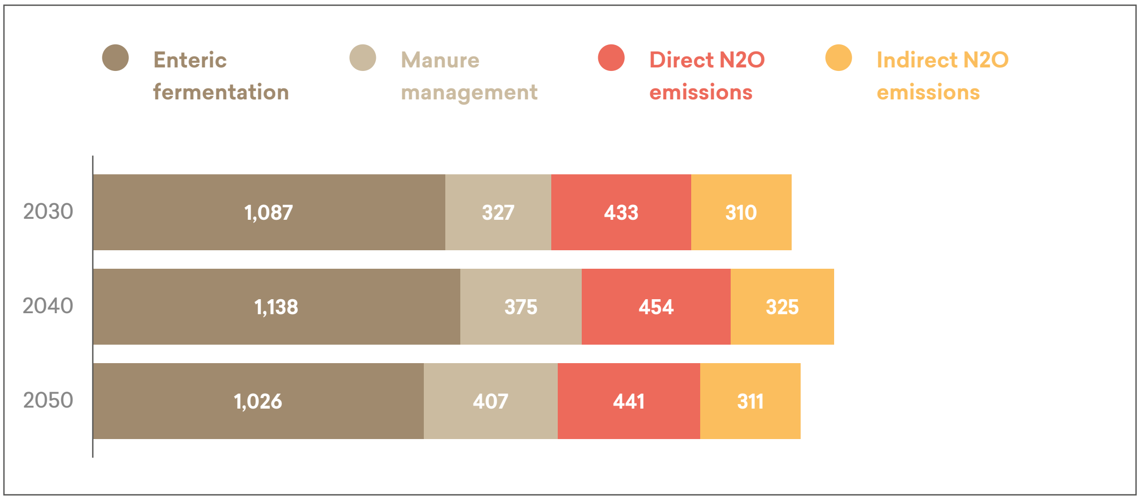


FIGURE 38. Contribution of Basic Sub-categories in Sectoral Emissions Gg CO2 eq (WaM Pessimistic Scenario)

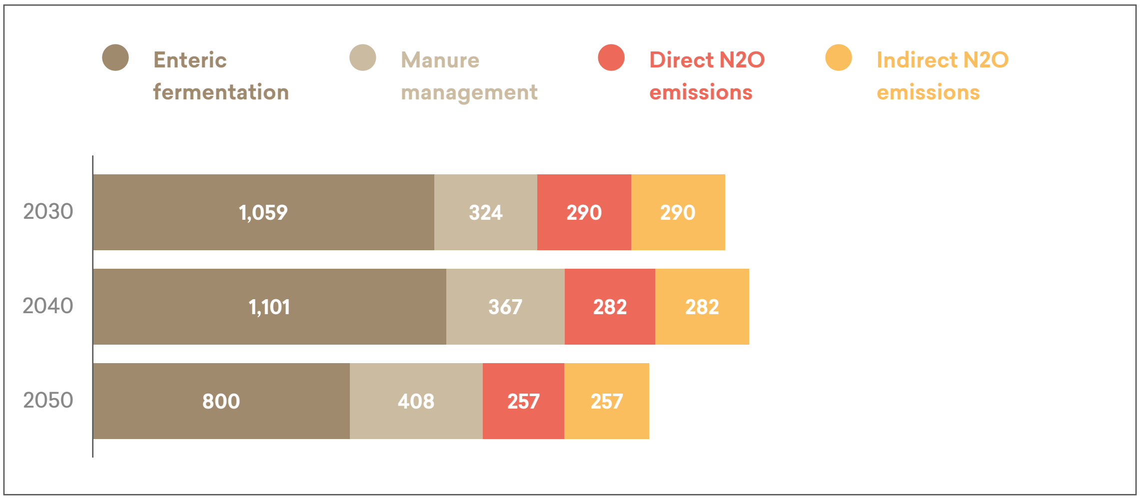


FIGURE 39. Projected GHG Emissions from Agriculture Sector in Gg CO2-eq (Optimistic Scenario)

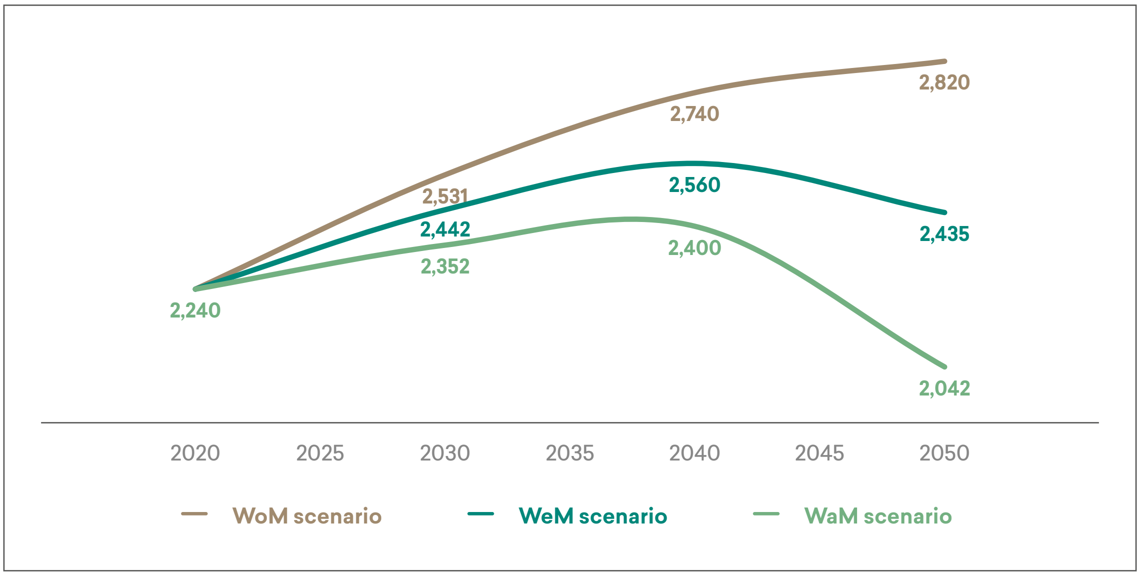
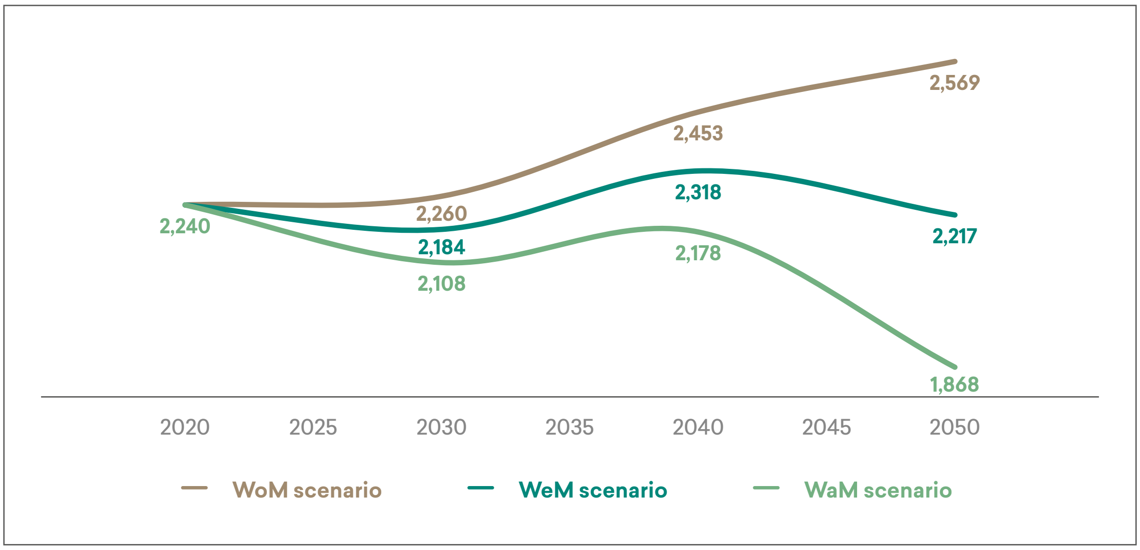


FIGURE 40. Projected GHG Emissions from Agriculture Sector in Gg CO2-eq (Pessimistic Scenario)



Baseline and Mitigation Scenarios

Assumptions:

- Fuel consumption for the field operations (traditional plowing, harrowing, fertilization, herbicide treatment, seeding, and harvesting) per hectare varies between 80-100 kg/ha, on average 90 kg/ha.
- In the case of minimum tillage, fuel consumption equals 47 kg/ha and no-tillage - 34 kg/ha.
- Diesel fuel is the main source of fuel in agricultural machinery.
- Natural gas is mainly used for heating in farm buildings and in greenhouses.
- Electricity is used mainly for water pumping for irrigation and for lighting.

Sown areas with optimistic and pessimistic scenarios are given in Table 67. Optimistic and pessimistic scenarios differ in the scales of mitigation measures.

Scenario without Measures (WoM Scenario)

The WoM scenario considers that the field is fully cultivated according to conventional tillage practice. No measures for improving the energy efficiency of buildings are implemented and agricultural machinery is only fossil fuel-based.

Scenario with Existing Measures (WeM scenario)

The WeM scenario considers that part of the field is cultivated by applying minimum tillage and no-tillage technologies. Measures to improve the energy efficiency of buildings are implemented and agricultural machinery remains fossil fuel-based.

Table 76 provides mitigation measures considered under the optimistic scenario and Table 77 – under the pessimistic scenario.

TABLE N76. Mitigation Measures in WeM Optimistic Scenario

Year	Measure			
	Sown area with minimum tillage	Sown area with no tillage	Electric machinery	Energy efficiency improvement of buildings
2030	10 %	10 %	0 %	15 %
2040	20 %	20 %	0 %	20 %
2050	30 %	30 %	0 %	40 %

TABLE N77. Mitigation Measures in WeM Pessimistic Scenario

Year	Measure			
	Sown area with minimum tillage	Sown area with no tillage	Electric machinery	Energy efficiency improvement of buildings
2030	5 %	5 %	0 %	10 %
2040	10 %	10 %	0 %	15 %
2050	20 %	20 %	0 %	20 %

Scenario with Additional Measures (WaM Scenario)

The WaM scenario considers all measures from the WeM scenario. In addition, it assumes that part of agricultural machinery (tractors, combines, etc.) will be electric.

TABLE N78. Mitigation Measures in Optimistic WaM Scenario

Year	Measure			
	Sown area with minimum tillage	Sown area with no tillage	Electric machinery	Energy efficiency improvement of buildings
2030	10%	10%	20%	20%
2040	15%	15%	30%	40%
2050	20%	20%	50%	50%

TABLE N79. Mitigation Measures in Pessimistic WaM Scenario

Year	Measure			
	Sown area with minimum tillage	Sown area with no tillage	Electric machinery	Energy efficiency improvement of buildings
2030	10%	10%	10%	10%
2040	15%	15%	20%	15%
2050	20%	20%	30%	20%

Results – Projected GHG Emissions

Optimistic scenario

Greenhouse gas emissions and emission reductions were calculated based on the above mitigation measures. In the case of the WeM Scenario, emissions increase over the years, although at a lower rate than in the WoM scenario. With the WaM scenario, emissions increase insignificantly up until 2025 and then they start to decrease.

TABLE N80. GHG Emissions. WoM, WeM and WaM

Scenario	GHG emissions (Gg CO_2-eq)							
	2016	2020	2025	2030	2035	2040	2045	2050
WoM	68	81	94	106	123	140	159	177
WeM	68	77	86	94	102	110	113	117
WaM	68	72	75	59	60	61	51	40

TABLE N81. GHG Emissions Reductions with Optimistic WeM and WaM Scenarios

Scenario	GHG emission reduction (Gg CO_2-eq)						
	2020	2025	2030	2035	2040	2045	2050
WeM	-4	-8	-12	-21	-30	-45	-60
WaM	-10	-19	-47	-63	-79	-108	-137

Pessimistic scenario

With the WeM scenario, emissions increase year after year while in the case of the WaM scenario, they are more or less stabilized.

TABLE N82. GHG Emissions. WoM, WeM and WaM Pessimistic Scenarios

Scenario	GHG emissions (Gg CO_2-eq)							
	2016	2020	2025	2030	2035	2040	2045	2050
WoM	68	81	94	92	107	121	140	159
WeM	68	77	86	86	97	108	115	122
WaM	68	72	75	72	75	78	73	68

Unlike the WoM scenario, emission reductions under the WeM and WaM scenarios tend to increase over the years.

TABLE N83. GHG Emissions Reductions with Pessimistic WeM and WaM Scenarios

Scenario	GHG emission reduction ($GgCO_2$-eq)						
	2020	2025	2030	2035	2040	2045	2050
WeM	-4	-8	-6	-10	-14	-25	-37
WaM	-10	-19	-20	-32	-44	-67	-90

FIGURE 41. GHG Emissions from Fuel Combustion in the Agriculture Sector (Optimistic Scenario)

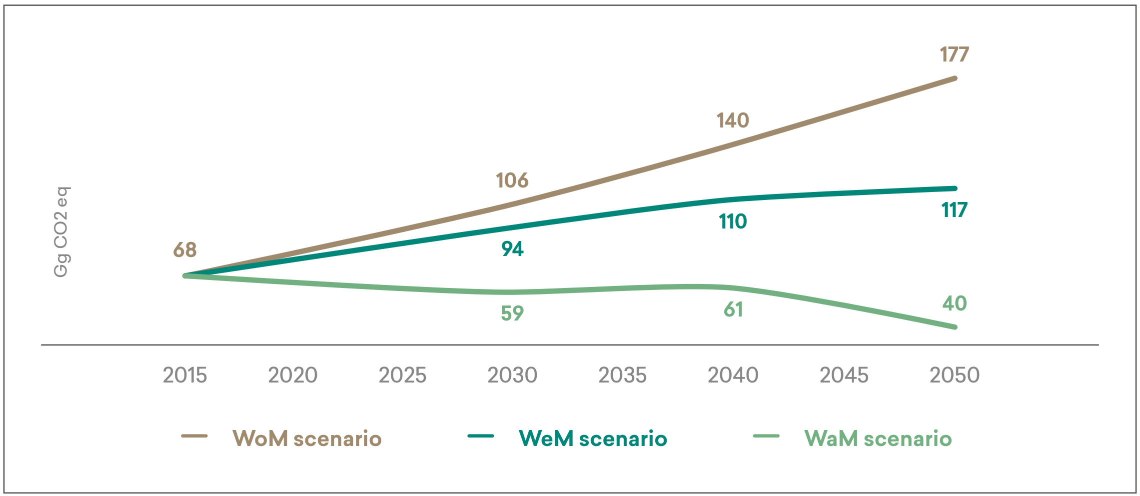
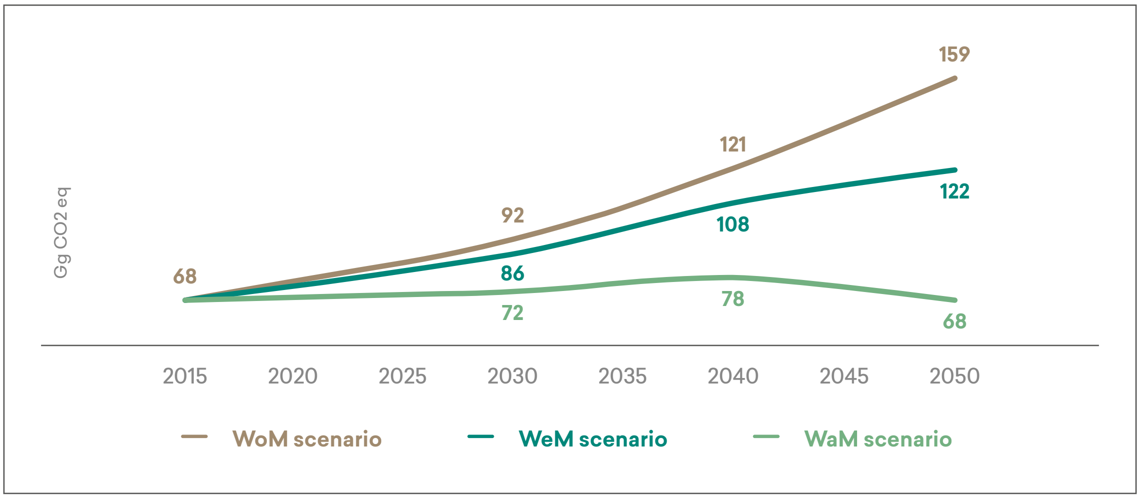


FIGURE 42. GHG Emissions from Fuel Combustion in the Agriculture Sector (Pessimistic Scenario)



Baseline and Mitigation Scenarios

Assumptions:

- Fuel consumption for the field operations (traditional plowing, harrowing, fertilization, herbicide treatment, seeding and harvesting) per hectare varies between 80-100 kg/ha, on average 90 kg/ha.
- In the case of minimum tillage, fuel consumption equals 47 kg/ha, and no-tillage - 34 kg/ha.
- Diesel fuel is the main source of fuel in agricultural machinery.
- Natural gas is mainly used for heating in farm buildings and in greenhouses.
- Electricity is used mainly for water pumping, irrigation and lighting.

Sown areas with optimistic and pessimistic scenarios are given in Table 67. Optimistic and pessimistic scenarios differ in the scales of mitigation measures.

Scenario without Measures (WoM Scenario)

The WoM scenario considers that the field is fully cultivated according to conventional tillage practice. No measures for improving the energy efficiency of buildings are implemented and agricultural machinery is only fossil fuel-based.

Scenario with Existing Measures (WeM Scenario)

The WeM scenario considers that part of the field is cultivated by applying minimum tillage and no-tillage technologies. Measures to improve the energy efficiency of buildings are implemented and agricultural machinery remains fossil fuel-based.

Table 84 provides mitigation measures considered under the optimistic scenario and Table 85 – under the pessimistic scenario.

TABLE N84. Mitigation Measures in WeM Optimistic Scenario

Year	Measure			
	Sown area with minimum tillage	Sown area with no tillage	Electric machinery	Energy efficiency improvement of buildings
2030	10 %	10 %	0 %	15 %
2040	20 %	20 %	0 %	20 %
2050	30 %	30 %	0 %	40 %

TABLE N85. Mitigation Measures in WeM Pessimistic Scenario

Year	Measure			
	Sown area with minimum tillage	Sown area with no tillage	Electric machinery	Energy efficiency improvement of buildings
2030	5 %	5 %	0 %	10 %
2040	10 %	10 %	0 %	15 %
2050	20 %	20 %	0 %	20 %

Scenario with Additional Measures (WaM Scenario)
The WaM scenario considers all measures from the WeM scenario. In addition, it assumes that part of agricultural machinery (tractors, combines, etc.) will be electric.

TABLE N86. Mitigation Measures in Optimistic WaM Scenario

Year	Measure			
	Sown area with minimum tillage	Sown area with no tillage	Electric machinery	Energy efficiency improvement of buildings
2030	10%	10%	20%	20%
2040	15%	15%	30%	40%
2050	20%	20%	50%	50%

TABLE N87. Mitigation Measures in Pessimistic WaM Scenario

Year	Measure			
	Sown area with minimum tillage	Sown area with no tillage	Electric machinery	Energy efficiency improvement of buildings
2030	10%	10%	10%	10%
2040	15%	15%	20%	15%
2050	20%	20%	30%	20%

Results – Projected GHG Emissions

Optimistic scenario
Greenhouse gas emissions and emission reductions were calculated based on the above mitigation measures. In the case of the WeM scenario, emissions increase over the years, although at a lower rate than in the WoM scenario. With the WaM Scenario, emissions increase insignificantly until 2025 and then they decrease.

TABLE N88. GHG Emissions. WoM, WeM and WaM

Scenario	GHG emissions (Gg CO_2-eq)							
	2016	2020	2025	2030	2035	2040	2045	2050
WoM	68	81	94	106	123	140	159	177
WeM	68	77	86	94	102	110	113	117
WaM	68	72	75	59	60	61	51	40

TABLE N89. GHG Emissions Reductions with Optimistic WeM and WaM Scenarios

Scenario	GHG emission reduction (Gg CO_2-eq)						
	2020	2025	2030	2035	2040	2045	2050
WeM	-4	-8	-12	-21	-30	-45	-60
WaM	-10	-19	-47	-63	-79	-108	-137

Pessimistic scenario

With the WeM scenario, emissions increase year after year while in the case of the WaM scenario, they are more or less stable.

TABLE N90. GHG Emissions. WoM, WeM and WaM Pessimistic Scenarios

Scenario	GHG emissions (Gg CO_2-eq)							
	2016	2020	2025	2030	2035	2040	2045	2050
WoM	68	81	94	92	107	121	140	159
WeM	68	77	86	86	97	108	115	122
WaM	68	72	75	72	75	78	73	68

Unlike the WoM scenario, emission reductions under the WeM and WaM scenarios tend to increase over the years.

TABLE N91. GHG Emissions Reductions with Pessimistic WeM and WaM Scenarios

Scenario	GHG emission reduction (GgCO_2-eq)						
	2020	2025	2030	2035	2040	2045	2050
WeM	-4	-8	-6	-10	-14	-25	-37
WaM	-10	-19	-20	-32	-44	-67	-90

FIGURE 43. GHG Emissions from Fuel Combustion in the Agriculture Sector (Optimistic Scenario)

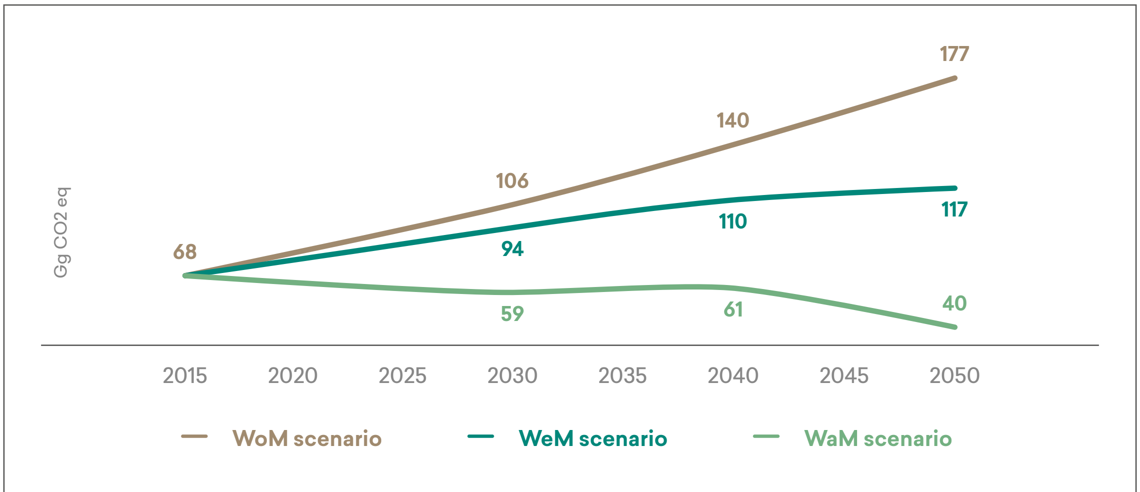
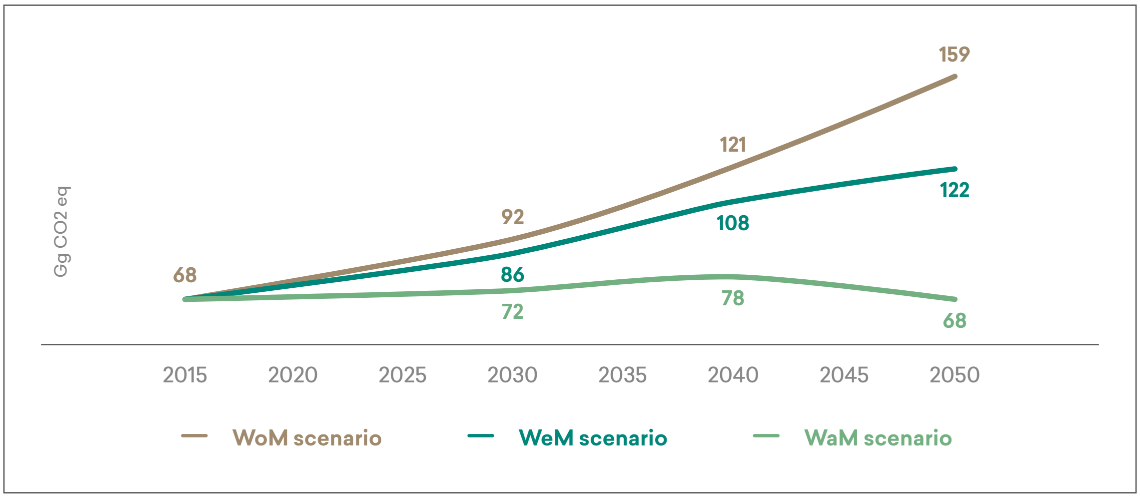


FIGURE 44. GHG Emissions from Fuel Combustion in the Agriculture Sector (Pessimistic Scenario)



Land Use, Land Use Change and Forest Sector (LULUCF)

Range of Estimated Future Trajectories of GHG Emissions for Baseline (WoM) Scenarios

The long-term (2030 and 2050) low-emission development of the LULUCF sector is projected in three scenarios:

- **WOM** - The scenario includes baseline projections expected in the sector without measures;
- **WEM** - In other words, the scenario with existing measures assumes the changes that would occur by 2030 as a result of ongoing and planned measures as well as projected emission savings by 2050;
- **WAM** - The scenario includes projections for 2030 and 2050, assuming additional measures are implemented.

For the LULUCF sub-sectors where the GHG inventory was conducted, emission projections were made using the FAO EX-ACT model. Ongoing and planned activities in the sub-sectors were used for calculations and for selecting relevant assumptions for the model.

It should be noted that the model does not use general drivers (population, GDP) for projections; therefore, 'pessimistic' and 'optimistic' scenario groups are not considered for this sector.

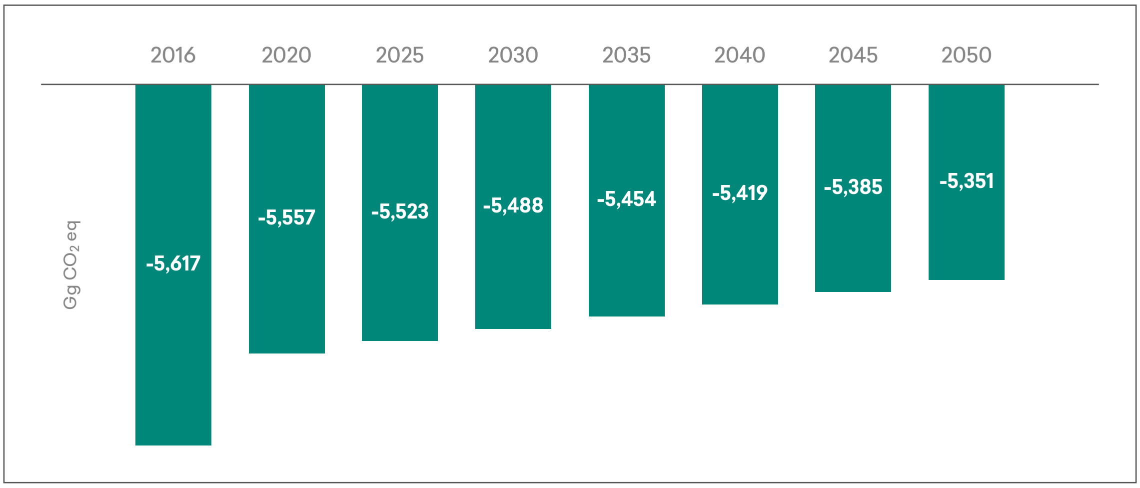
In the beginning, we will overview the baseline WoM scenario according to the different sub-sectors. As mentioned, and the WOM scenario provides emissions projections in the LULUCF sub-sectors (forest land, cropland, grassland) without measures.

Forest Lands

Forest lands are the main source of GHG removals/emissions in the LULUCF sector in Georgia. Despite the degradation of forest areas and the excessive consumption of timber resources, forest lands represent a carbon reservoir; i.e., a carbon sink.

Under the **WoM** scenario; i.e., the baseline scenario without actions, timber resource consumption on forest lands will increase by 2030 and 2050, similar to the 1990-2016 dynamics. At the same time, adherence to the sustainable forest management principles is minimal. Consequently, degraded areas are increasing.

FIGURE 45. Dynamics of Net Removals from Forest Lands, WoM Scenario

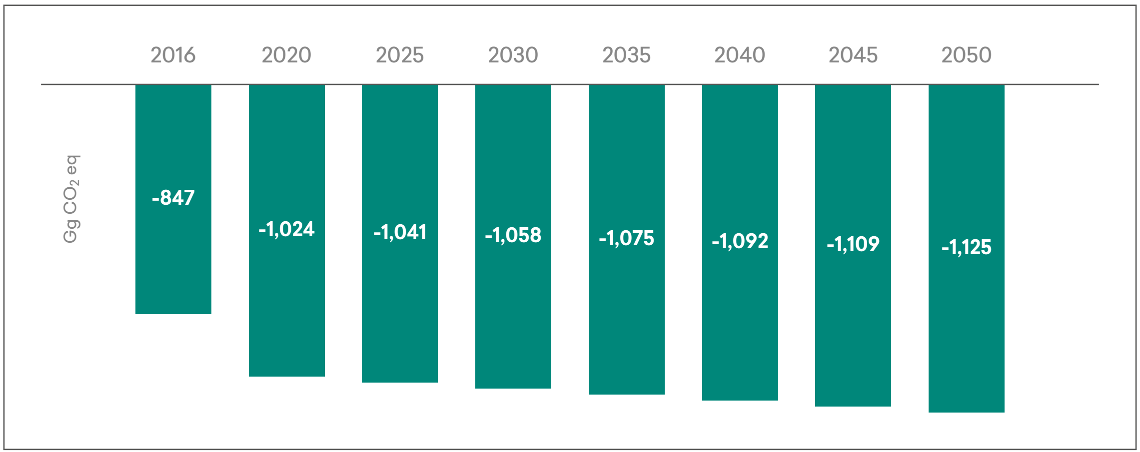


As the above figure illustrates, the annual removal potential of the sub-sector has a decreasing trend in the WoM scenario. In 2050, the removals will decrease by -227.6 Gg CO_2 as compared to 2017 and reach -5,350.5 Gg CO_2.

Croplands

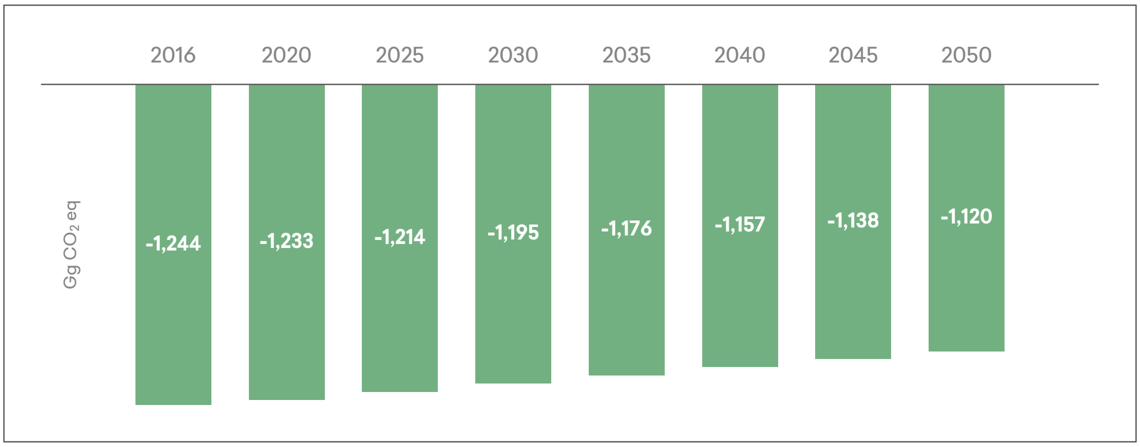
In the **WoM** scenario, cropland management methods stay unchanged. There is an increase in cropland areas and at the same time, no work is conducted for soil fertility maintenance, restoration, etc. Croplands are not managed in a climate-smart way. The model assumes that degraded areas will increase by 2050 as compared to 2030. As for the areas covered by perennial crops (fruit plantations, orchards, vineyards, etc.), plantation establishment work is carried out slowly according to the scenario; in particular, the crop planting rate is not maintained and the increase in the areas covered with perennial crops is minimal.

FIGURE 46. Dynamics of Net Emissions/Removals in Perennial Crops, WoM Scenario



As seen in the figure, the annual removal potential of perennial crops is growing slowly under the WoM scenario. By 2050, removals increase by111.6 Gg CO_2 as compared to 2017, reaching -1,125 Gg CO_2.

FIGURE 47. Dynamics of Net Emissions/Removals in Croplands, WoM Scenario

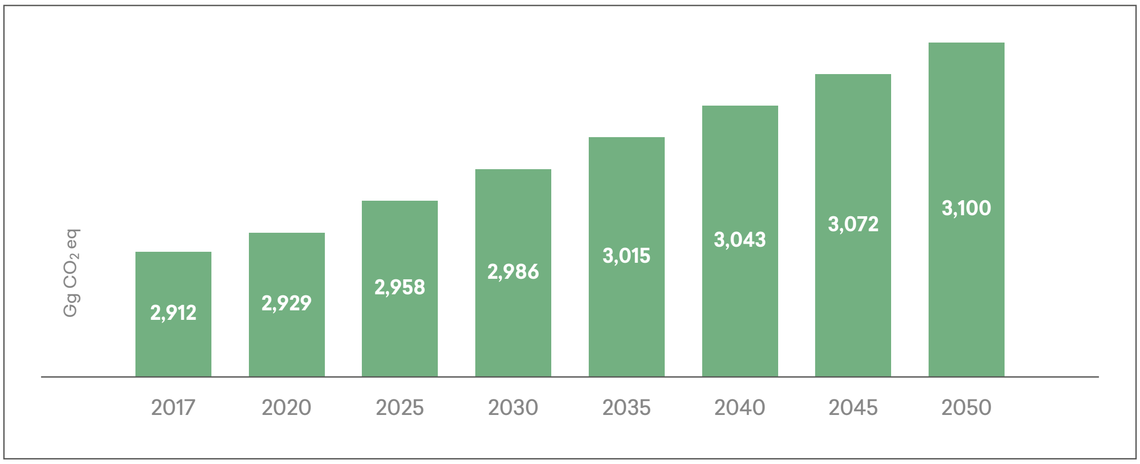


As the above figure illustrates, the annual removal potential of croplands takes a decreasing trend in the WoM scenario. By 2050, removals decrease by124.4 Gg CO_2 as compared to 2017, reaching -1,120 Gg CO_2.

Grasslands (Hay Lands and Pastures)

Grasslands are the only net emitter sub-sector due to the degradation of pastures. Under the **WoM** scenario, the current condition of grasslands does not change; on the contrary, they continue to degrade due to the irrational utilization of grassland, leading to increased emissions.

FIGURE 48. Dynamics of Net Removals/Emissions from Grasslands, WoM Scenario



As the above figure illustrates, the WoM scenario of grasslands has a growing trend of annual emissions (as already mentioned, grasslands are the emitter of carbon dioxide). By 2050, emissions will increase by 187.9 Gg CO_2 as compared to 2017, reaching 3,100 Gg CO_2.

In conclusion, the LULUCF sector retains its carbon removal potential by 2040 and 2050 but with a downward trend under the WoM scenario. According to the figure below, carbon removals will decrease by 300 Gg CO_2 in 2040 as compared to 2017 with 428.3 Gg CO_2 by 2050.

FIGURE 49. Trend of Net Removals/Emissions in the LULUCF Sector, WoM Scenario

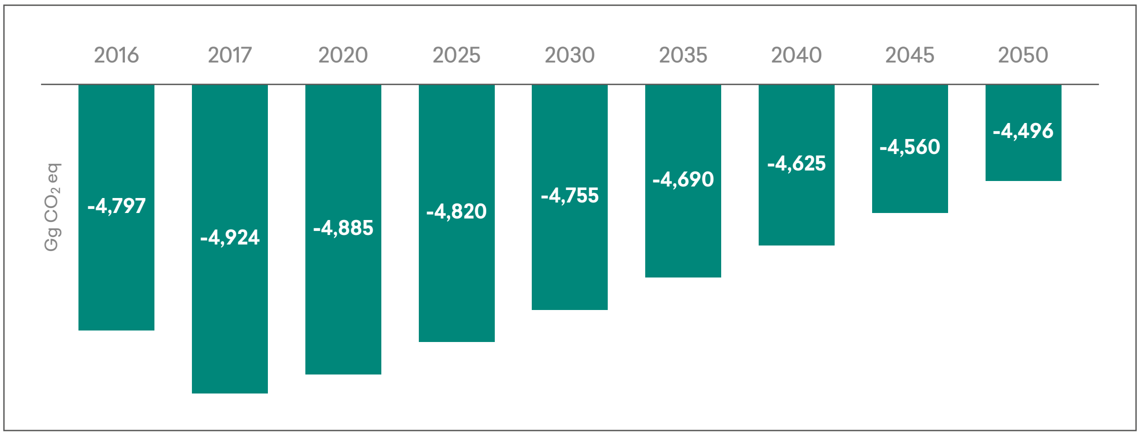
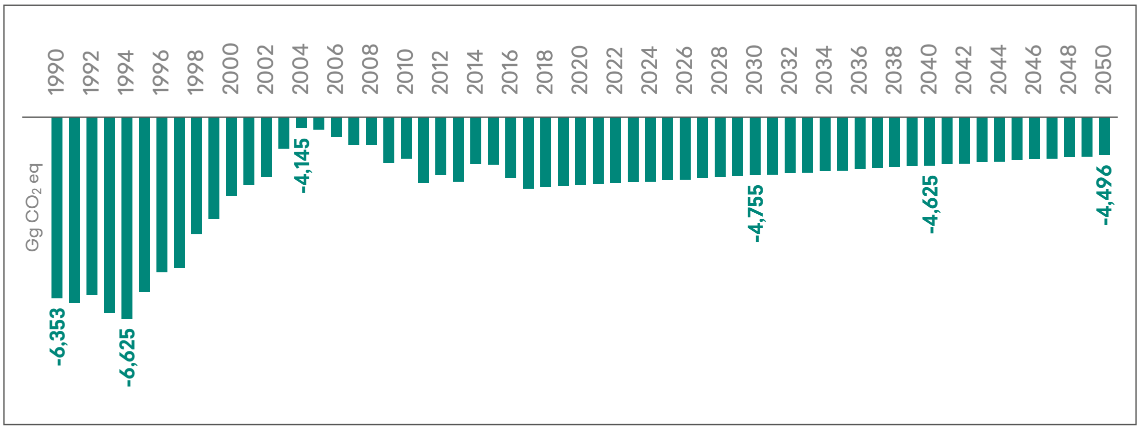


FIGURE 50. Past and Projected Emissions in the LULUCF Sector, WoM Scenario



The figure shows the results of the GHG inventory in the LULUCF sector based on the 1990-2017 data and further projections of the WoM scenario for the sector. The figure allows for analyzing how GHG removals may decrease as compared to previous years.

As seen from the figure, theremoval potential decreases under the WoM scenario and the downward trend of 1990-2004 continues, meaning that the removals will come down to the 2004 level by 2050.

Likely Range of Future GHG Emissions Trajectories (Mitigation Scenarios)

As already mentioned, the long-term (2030 and 2050) low-emission development in the LULUCF sector is projected in two scenarios:

- **WEM** - In other words, the scenario with existing measures assumes the changes that would occur by 2030 as a result of ongoing and planned measures as well as projected emission savings by 2050;
- **WAM** - The scenario includes projections for 2030 and 2050, assuming additional measures are implemented.

For the LULUCF sub-sectors where the GHG inventory was conducted, emission projections were made using the FAO EX-ACT model. Ongoing and planned activities in the sub-sectors were used for calculations and the selection of relevant assumptions for the model.

It should be noted that the model does not use general drivers (population, GDP) for projections; therefore, 'pessimistic' and 'optimistic' scenario groups are not considered for this sector.

Forest Lands

Forest lands are the main source of GHG removals/emissions in the LULUCF sector in Georgia. Despite the degradation of forest areas and the excessive consumption of timber resources, forest lands represent a carbon reservoir; i.e., a carbon sink.

The reforms planned in the sector and specifically planned measures (see Table 92) largely induce the sector's development. All three scenarios were elaborated having those in mind.

The **WeM** scenario estimates the emissions saved as a result of planned measures by 2030 and further by 2050 assuming that similar measures will logically continue (taking into account the reforms initiated in general).

By 2050, the condition of Georgia's forests will be improved and overall we will have forests that are non-degraded and fully covered with sustainable forest management. Specifically, the model assumes that Georgia's forest lands will not be degraded by 2050.

Under the **WaM** scenario, if additional resources are attracted, the state will be able to accelerate the implementation rate of new technologies and reforestation/afforestation of the areas managed with sustainable forest management principles.

According to the scenario, degraded forests will be fully restored by 2040 and Georgia's forest areas will be managed according to the principles of sustainable management.

By 2050, the pressure on forests will decrease dramatically. The country will have larger areas of fast-growing tree plantations, producing timber resources that compete with timber derived from forests.

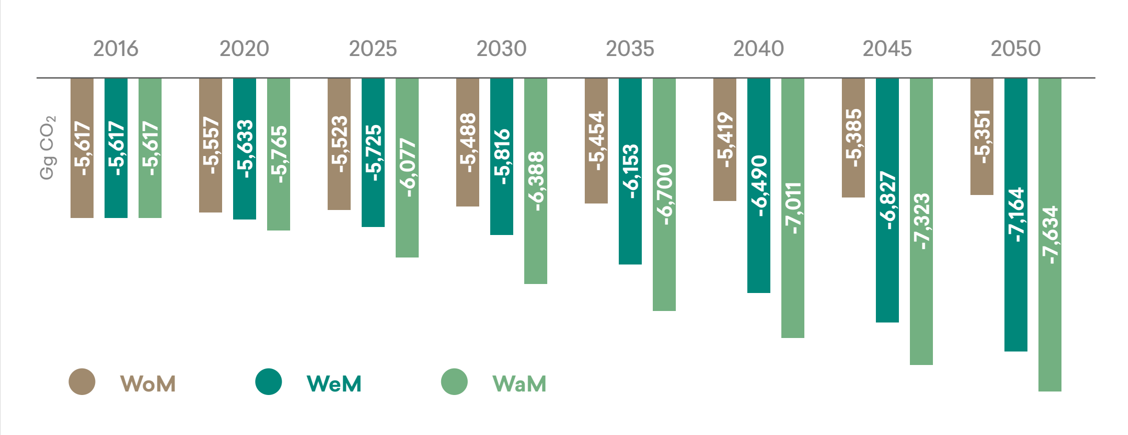
The model assumes that Georgia's forest will no longer be degraded by 2040 and the area covered by fast-growing tree species will increase by 2050, resulting in reduced emissions.

TABLE N92. Emissions Saved as a Result of Climate Change Mitigation and Adaptation Measures in the Sector (Calculations Using the EX-ACT Model)

		Start, Year	Total area, ha	Result (2050) $GgCO_2$
Restoration of 625 ha of degraded forest area (including fire-sites) through forestation in order to increase the GHG removal potential of these areas. In 2020 and 2021-2023, 250 ha and 375 ha of the degraded forest areas (including fire-sites) will be restored through forestation (125 ha per annum). The exact areas will be selected at the end of each year.		2020	250	-1.2
		2021	125	-0.6
		2022	125	-0.6
		2023	125	-0.6
		Total	**625**	**-3**
Restoration of 2,411 ha of degraded forest by supporting natural regeneration to increase the GHG removal potential of these areas.	Tbilisi City Hall restored 20 ha of degraded forest area in 2019 with support from GIZ.	2019	20	-0.02
	In 2020-2023, a total of 800 ha of degraded forests will be restored by the National Forestry Agency (200 ha per annum).	2020	200	-0.2
		2021	200	-0.2
		2022	200	-0.2
		2023	200	-0.2
	In 2019-2024, the Adjara Forestry Agency will restore 600 ha of degraded forest area (sub-alpine).	2019	100	-0.09
		2020	100	-0.09
		2021	100	-0.09
		2022	100	-0.09
		2023	100	-0.09
		2024	100	-0.09
	The Akhmeta Municipality will restore 991 ha of forest area in 2020-2024.	2020	198.2	-0.2
		2021	198.2	-0.2
		2022	198.2	-0.2
		2023	198.2	-0.2
		2024	198.2	-0.2
		Total	**2411**	**-2.36**
Introduction of sustainable forest management practices on 402,109 ha of forest area through the implementation of sustainable forest management plans developed and approved for 11 municipalities.	West Georgia	2021	162350	-130.2
	East Georgia		239759	-180.5
		Total	**402109**	-310.7

Measure	Description	Region	Protected area	Start, Year	Total area, ha	Result (2050) $GgCO_2$
Protection and/or sustainable management of forests within the expanded protected areas.	Protection and/or sustainable management of 38 ha of forest area within the expanded protected areas, including 29 ha in the expanded Javakheti Protected Areas and 9 ha in the expanded Kolkheti Protected Areas.		Kolkheti	2021	9	-0.007
			Javakheti		29	-0.02
				Total	**38**	**-0.027**
	This measure involves the protection and/or sustainable management of 16,895 ha of forest area within the new protected areas by the LEPL Agency of Protected Areas.	West Georgia	Samegrelo Protected Areas	2020	12366	-14.9
			Racha National Park		17230	-20.7
			Svaneti Protected Areas		22325	-26.8
			Racha-Lechkhumi Protected Areas		28835	-34.7
		East Georgia	Erusheti National Park		7393	-5.6
			Trialeti Protected Areas		8208	-6.2
			Ateni Protected Areas		8208	-6.2
			Dzama Protected Areas		16571	-12.5
			Aragvi Protected Landscape		41759	-31.4
				Total	**162895**	**-159**
Protection and sustainable management of the forest fund territories within the designated and nominated emerald sites.				2021	643100	**-248.4**

FIGURE 51. Dynamics of Net Removals from Forest Lands Under the Low Emission Development Scenarios (+WOM scenario)



With the WeM scenario, removals will increase and reach -5,816.0 Gg CO_2 by 2030. Subsequently, removals will increase relatively sharply and reach -7,164.0 Gg CO_2 by 2050. Under the WeM scenario, removals will increase by 22% by 2050.

Under the WaM scenario, GHG removals increase sharply already at the initial stage and will reach -6,388.0 Gg CO_2 by 2030. By 2050, removals increase by 27%, reaching -7,634 Gg CO_2.

TABLE N93. Net Removals of Forest Lands Under WoM, WeM and WaM Scenarios (2016-2050)

WOM								
	2016	2020	2025	2030	2035	2040	2045	2050
Forest lands	-5617.4	-5557.4	-5522.9	-5488.4	-5453.9	-5419.4	-5384.9	-5350.5
WEM								
	2016	2020	2025	2030	2035	2040	2045	2050
Forest lands	-5617.4	-5633	-5724.5	-5816	-6153	-6490	-6827	-7164
WAM								
	2016	2020	2025	2030	2035	2040	2045	2050
Forest lands	-5617.4	-5765	-6076.5	-6388	-6699.5	-7011	-7322.5	-7634

Croplands

According to the **WeM** scenario, the area of perennial crops increases; in particular, growth rates (see Table 4) are relevant to planned and ongoing measures, cultivated areas increase and some climate-smart agricultural practices are applied. The planned measures are included in the list of adaptation measures developed as part of the preparation of the Fourth National Communication. The scenario also includes the establishment of a biosphere reserve in the Kakheti region, particularly in the Dedoplistskaro region, with a total of 251,952 ha (core zone - 11,892, buffer zone - 28,097 and transition zone – 211,963).

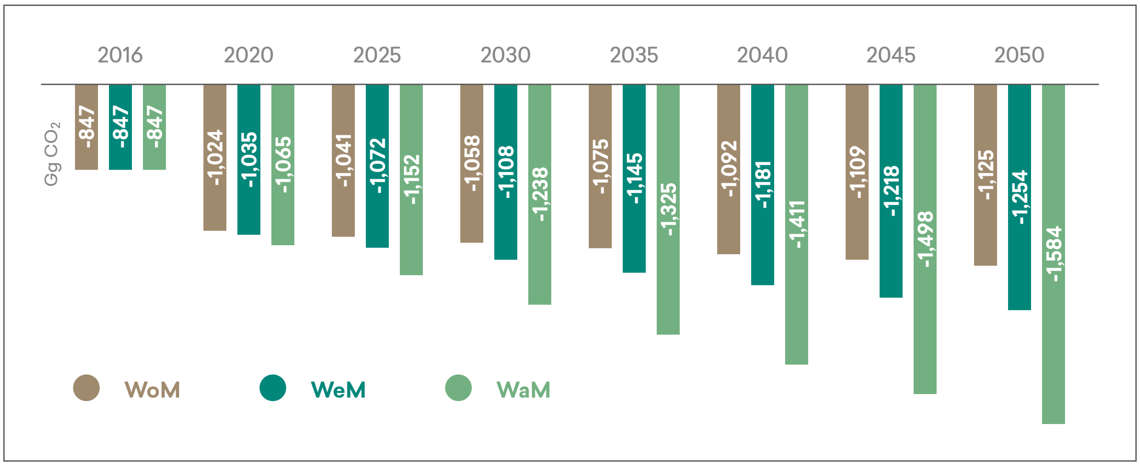
TABLE N94. Measures Implemented in the Sector

N	Measure	Period	Area, ha	Average annual carbon removal by 2050
1	Gardens and orchards created under the Implement the Future program	2016-2020	2053	-
2	Soil fertility restoration	2018-2019	100 000	267.2
3	Eradication of the practice of burning harvest residues	2015-2020	29 000	1.8

Additional measures under the **WaM** scenario include actions of good agricultural practices such as climate-smart soil management practices and favoring surface tillage over deep tillage in the context of climate change. Deep tillage causes the soil to lose moisture and organic matter. Many croplands will need to limit tillage and introduce minimum tillage practices. In other words, soil conservation methods have be used in the face of climate change.

FIGURE 52. Dynamics of Net Removals in Perennial Croplands Under the Low Emission Development Scenarios (+WoM Scenario)

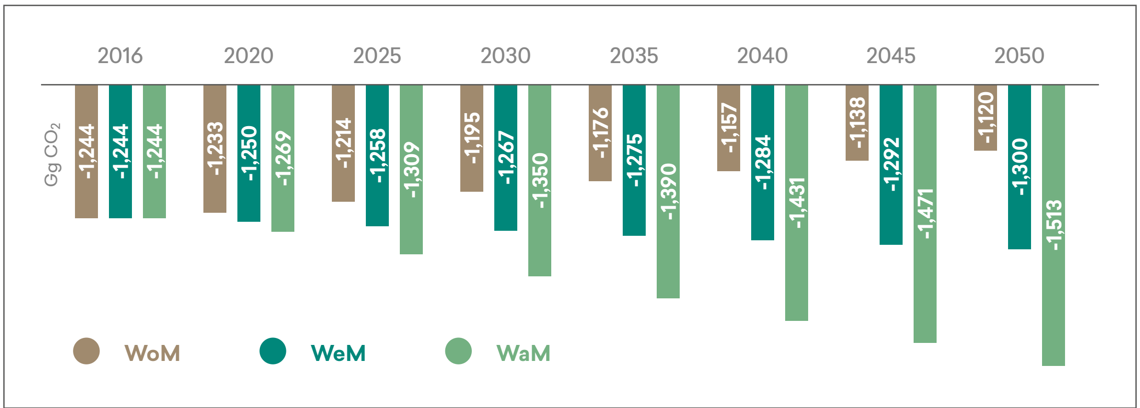
Under the WeM scenario, removals are increasing, reaching -1,108.3 Gg CO_2 by 2030 and increasing to -1,254 Gg CO_2 by 2050. Removals will be increased by 20% in 2050.



In the WaM scenario, removals already start to increase sharply at the initial stage and will reach -1,238.3 Gg CO_2 by 2030. By 2050, removals increase by 36% and reach -1,584 Gg CO_2.

FIGURE 53. Dynamics of Net Removals in Croplands Under the Low Emissions Development Scenarios (+WoM Scenario)

Under the WeM scenario, removals increase and reach -1,266.5 Gg CO_2 by 2030 and further -1,300 Gg CO_2 by 2050.



With the WaM scenario, removals start to increase sharply already at the initial stage and will reach -1,349.7 Gg CO_2 by 2030. By 2050, removals increase by 18% and reach -1,513.4 Gg CO_2.

TABLE N95. Net Removals in Croplands Under WoM, WeM and WaM Scenarios (2016-2050)

WOM								
	2016	2020	2025	2030	2035	2040	2045	2050
Croplands	-2091.4	-2256.6	-2254.6	-2252.6	-2250.6	-2248.6	-2246.6	-2245
WEM								
	2016	2020	2025	2030	2035	2040	2045	2050
Croplands	-2091.4	-2284.8	-2329.8	-2374.8	-2419.8	-2464.8	-2509.8	-2554
WAM								
	2016	2020	2025	2030	2035	2040	2045	2050
Croplands	-2091.4	-2334	-2461	-2588	-2715	-2842	-2969	-3097.4

Grasslands (Hay Lands and Pastures)

Several factors were considered when developing the scenarios for the sector: planned restoration of hay lands and pastures, frequent cases of conversion of arable lands into forests, the establishment of the planned biosphere reserve in the Kakheti region, etc. Taking this into account, it can be assumed that the extent of grassland degradation will decrease in the future; however, since soil restoration is time-consuming, the improvement and the subsequent increase of carbon storage potential is slow-paced.

The **WeM** scenario considers adaptation measures included in the Fourth National Communication and establishing the planned biosphere reserve in the Kakheti region. Projections with the existing measures were made up to 2030.

With the estimations considering the planned measures, emissions will decrease by 2030; however, the sub-sector stays a net emitter as soil restoration takes a long time; therefore, the improvement and subsequent increase of carbon storage capacity will only be visible by 2050. As the calculations show, grasslands are still an emitter, although at a minimum level, while the level of soil degradation decreases dramatically.

The calculations also consider the signs of pasture conversion into forests in high-altitude regions which contributes to the reduction of emissions.

TABLE N96. Measures Implemented in the Sub-sector

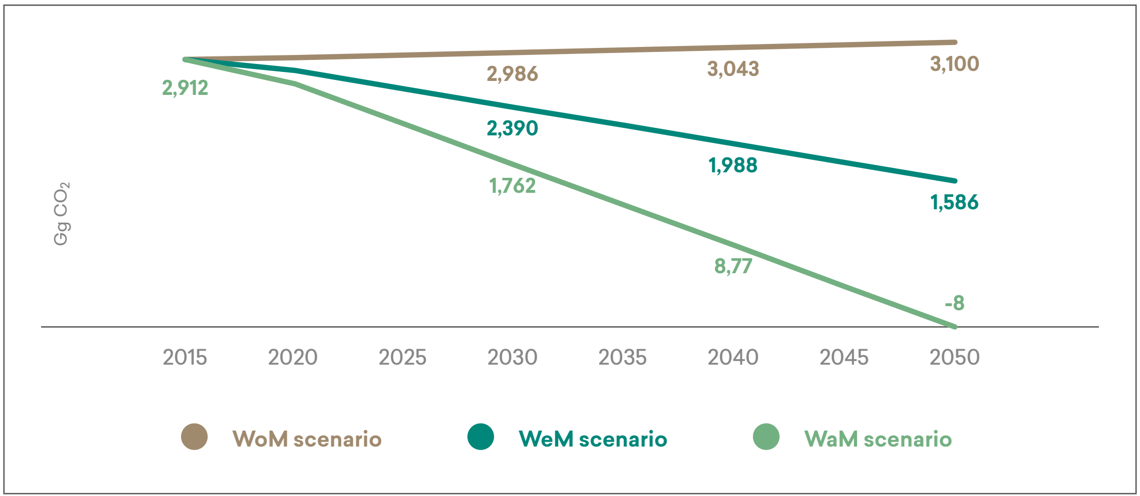
N	Measure	Period	Area, ha	Average annual removals by 2050
1	Rational use of grasslands in the highland regions	2017-19	7 649	4.4
2	Rehabilitation of degraded pastures in Vash-lovani	2014-17	4 064	10.7

The WaM scenario involves a wide range of complex measures for the rehabilitation and management of pastures, namely:

- Developing pasture management plans and sustainable management of pastures;
- Improving the surface of degraded grasslands (improving water and aeration regimes);
- Measures to combat weeds and poisonous plants;
- Fertilization of grasslands, adding seeds of edible grasses.

Specifically, it was assumed that by 2050 pastures would no longer be degraded or be a source of emissions.

FIGURE 54. Dynamics of Net Removals/Emissions from Grasslands



As the figure above illustrates, the WoM scenario of grasslands has a growing trend of annual emissions (as already mentioned, grasslands are the emitter of carbon dioxide). By 2050, emissions will increase by 187.9 Gg CO_2 as compared to 2017, reaching 3,100 Gg CO_2.

In the WeM scenario, emissions are already declining and will fall to 2,389.5 Gg CO_2 by 2030 and then continue to decline and reach 1,585.5 Gg CO_2 by 2050.

Under the WaM scenario, emissions start to decline sharply and reach 1,761.6 Gg CO_2 by 2030. By 2050, the situation reverses and the sub-sector becomes a carbon sink.

TABLE N97. Net Removals in Grasslands Under WoM, WeM and WaM Scenarios (2016-2050)

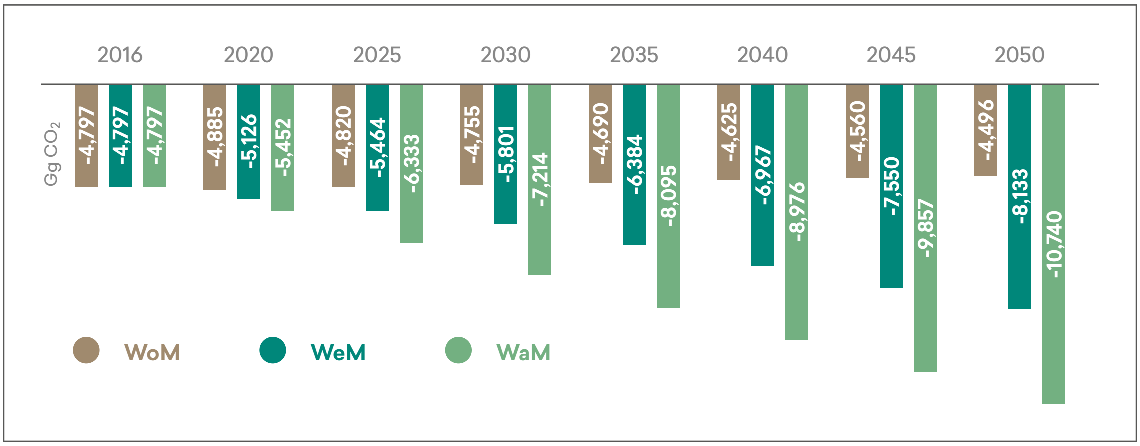
WOM								
	2016	2020	2025	2030	2035	2040	2045	2050
Grasslands	2912.1	2929.2	2957.7	2986.2	3014.7	3043.2	3071.7	3100
WEM								
	2016	2020	2025	2030	2035	2040	2045	2050
Grasslands	2912.1	2791.5	2590.5	2389.5	2188.5	1987.5	1786.5	1585.5
WAM								
	2016	2020	2025	2030	2035	2040	2045	2050
Grasslands	2912.1	2646.6	2204.1	1761.6	1319.1	876.6	434.1	-8.4

Estimation of the Sector's Share in Total GHG Emissions by 2050

TABLE N98. Net Removals in the LULUCF Sector Under WoM, WeM and WM Scenarios (2016-2050)

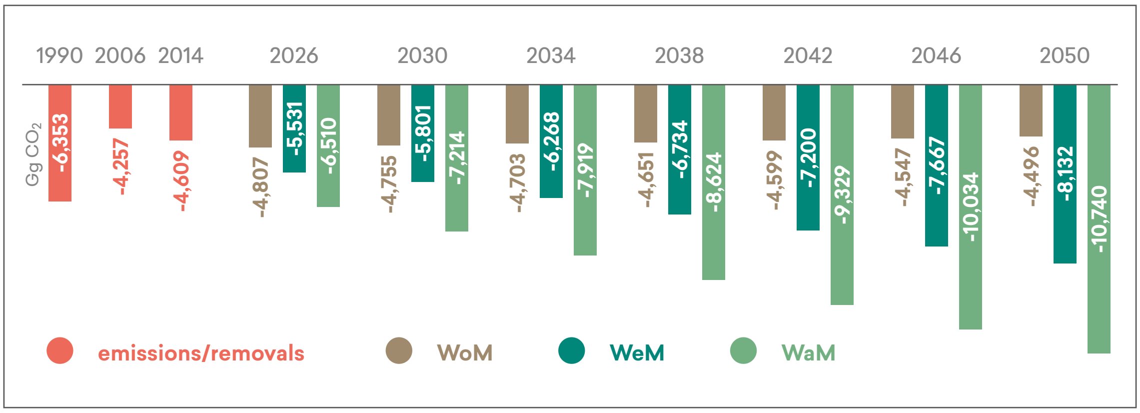
WOM								
	2016	2020	2025	2030	2035	2040	2045	2050
Forest lands	-5617.4	-5557.4	-5522.9	-5488.4	-5453.9	-5419.4	-5384.9	-5350.5
Croplands	-2091.4	-2256.6	-2254.6	-2252.6	-2250.6	-2248.6	-2246.6	-2245
Grasslands	2912.1	2929.2	2957.7	2986.2	3014.7	3043.2	3071.7	3100
LULUCF (total)	-4796.7	-4884.8	-4819.8	-4754.8	-4689.8	-4624.8	-4559.8	-4495.5
WEM								
	2016	2020	2025	2030	2035	2040	2045	2050
Forest lands	-5617.4	-5633	-5724.5	-5816	-6153	-6490	-6827	-7164
Croplands	-2091.4	-2284.8	-2329.8	-2374.8	-2419.8	-2464.8	-2509.8	-2554
Grasslands	2912.1	2791.5	2 590.5	2389.5	2188.5	1987.5	1786.5	1585.5
LULUCF (total)	-4796.7	-5126.3	-5463.8	-5801.3	-6384.3	-6967.3	-7550.3	-8132.5
WAM								
	2016	2020	2025	2030	2035	2040	2045	2050
Forest lands	-5617.4	-5765	-6076.5	-6388	-6699.5	-7011	-7322.5	-7634
Croplands	-2091.4	-2334	-2461	-2588	-2715	-2842	-2969	-3097.4
Grasslands	2912.1	2646.6	2204.1	1761.6	1319.1	876.6	434.1	-8.4
LULUCF (total)	-4796.7	-5452.4	-6333.4	-7214.4	-8095.4	-8976.4	-9857.4	-10739.8

FIGURE 55. Trends of Net Removals/Emissions in the LULUCF Sector by Different Scenarios



The table above summarizes the sub-sectors (LULUCF sector) and shows that only the WoM has a decreasing trend from all of the three scenarios; i.e., by 2050 removals decrease by -428.3 Gg CO_2 as compared to 2017 and come to 4,495.5 Gg CO_2. As for the WeM scenario, removals increase relatively slowly until 2030, then rise sharply and increase by 40% by 2050, reaching -8,132.5 Gg CO_2. Under the WaM scenario, there is a sharp increase at the beginning. By 2030, removals increase by 33% and by 2050 - 54% reaching -10,739.8 Gg CO_2.

FIGURE 56. Past and Projected Emissions in the LULUCF Sector



The figure shows the results of GHG inventory in the LULUCF sector based on the 1990-2017 data and further projections of the three scenarios for the sector. The figure allows for analyzing how GHG emissions may increase or decrease as compared to previous years.

As seen from the figure, removal potential decreases under the WoM scenario and the downward trend of 1990-2004 continues, meaning that removals will come down to the 2004 level by 2050.

Removals increase yearly in the WeM and WaM scenarios, considering low-emission development approaches. Under the WeM scenario, removals will reach 1990 levels by 2035; further, they will increase by 21% by 2050 as compared to 1990.

With the WaM scenario, removals will reach the 1990 level in 2025 and saving potential will increase by 41% by 2050. Overall, looking at the results achieved in the WeM and WaM scenarios, we can say that large-scale changes are planned in the sector which allow not only reaching the levels of the 1990s but even exceeding them.

Waste Sector

Estimated share of the sector in total greenhouse gas emissions by 2050

According to the projections under the pessimistic and the optimistic scenarios, the likely range of GHG emissions from the waste sector and its share in the total national emissions (excluding LULUCF) between pessimistic and optimistic scenarios in 2050 will be from:

- 1,980 Gg CO_2-eq (5%) to 2,779 Gg CO_2-eq (6%);
- 1,279 Gg CO_2-eq (5%) to 2,078 Gg CO_2-eq (6%), and
- 740 Gg CO_2-eq (6%) to 1,087 Gg CO_2-eq (10%) - for WoM, WeM and WaM, respectively.

These figures demonstrate that the share of the sector in the national total is increasing regardless of the mitigation actions envisaged and the efforts in these directions should be strengthened further using the additional potential for emission reduction (explored below).

Range of Likely Future Emissions Trajectory Baseline (WoM) Scenario

The baseline (without measures) scenario uses general drivers for GHG emissions projections. Pessimistic and optimistic approaches to the drivers entail corresponding WOM scenarios.

Approach to Drivers

For the baseline (WoM) scenario projection, the general drivers of population number and the GDP have been used. Based on high touristic flows into the country, the common number of the resident population and 'year-round' tourists have been used as a driver for the projection of solid waste and domestic and commercial WW generation because of their strong dependence on the number of persons generating these types of waste. For industrial WW (IWW), the GDP has been chosen as the most relevant proxy. It impacts the IWW emissions because of the direct interdependence of the whole economy and industries.

This approach is consistent with that used in the CAP/CS.

Range of Baseline Scenarios

Statistical data for population and GDP growth show a slow and fluctuating growth of the population and the GDP in recent decades. Regardless of the causes of such a trend, the country's long-term development should consider the opportunity of a breakthrough in it, aiming at a tangible increase by the mid-century. For this reason, instead of one close-to-real baseline scenario for development, a range between pessimistic and optimistic paths has been chosen for projections.

The pessimistic scenario of development is based on the assumption of the slow growth of the population and the GDP that is close to actual (recent) statistics/trends for these parameters while the optimistic scenario implies the most optimistic expectations with respect to economic and demographic upheaval.

Thus, two baseline scenarios (pessimistic and optimistic) have been elaborated based on the corresponding series of the projected main drivers, identified preliminarily, and respective coefficients of annual growth calculated and used for long-term projections.

TABLE N99. Baseline (WoM) Scenarios (Pessimistic and Optimistic) for GHG Emissions (Gg CO2eq) from the Waste Sector

	2020	2025	2030	2035	2040	2045	2050
✕ Pessimistic							
SWDL	1108.17	1131.06	1149.33	1173.27	1206.45	1252.02	1314.81
WW	444.803	470.613	498.033	530	567.476	611.741	665.285
✓ Optimistic							
SWDL	1108.17	1164.66	1164.66	1221.15	1321.74	1505.07	1847.79
WW	444.8	471.36	505.8	555.95	630.45	745.47	931.03

GHG Emissions Likely Future Emissions Trajectories

Mitigation Scenarios (WeM and WaM)

The mitigation scenarios have been created based on those presented in the draft CS 2021-2030 and CAP 2021-2023 which provide a wide range of activities for mitigating GHG emissions from the waste sector. They are two types: those already considered in the budget and included in the national plans and those not. The former has been allocated to the WeM while the latter – to the WaM scenarios due to their 'additional' character.

Both the WeM and WaM scenarios have been imposed on pessimistic and optimistic baseline scenarios making two sets of calculations: a common 'pessimistic' scenario comprising a 'pessimistic' baseline, WeM and WaM, and a common 'optimistic' scenario with the same three projections. Such a presentation of the projections enables us to view the effects of the same mitigation packages of the measures on the different baseline development trajectories.

WeM Package

The 'existing' measures for GHG mitigation in the sector, described in the CSAP/CAP, refer to two main directions ongoing in the country under the sector's reforms: those related to solid waste and wastewater treatment.

Solid waste-related measures presented in the CS/CAP are based on closing old small, unmanaged landfills and dumpsites and substituting them with larger regional landfills equipped with modern installations, including gas recovery. They are:

- Closure of all landfills in the country except three that meet the standard requirement;
- Closure of uncontrolled and unmanaged dumpsites collecting a significant amount of solid waste, avoiding official landfills;
- Construction of eight new large landfills equipped with modern installations for flaring and methane recovery, getting the MSW from the closed landfills.

Another group of activities in this direction of Solid Waste is comprised of gas recovery activities such as:

- Installation of a gas recovery system in the existing Tbilisi landfill;
- Methane Gas Recovery from five new regional landfills.

The activities considered for the wastewater comprise:

- Construction of seven new WWT plants;
- Gas recovery from two new WWTP (Zugdidi and Poti).

Composting as an emission-reducing activity from solid waste is also considered among 'existing' measures.

A common approach for gas recovery in new and modernized landfills is based on flaring the generated methane for a few years until there is enough gas to recover. Both activities are reducing emissions.

WaM Package

The WAM package consists of 'additional' activities from the CSAP/CAP including:

- Methane gas recovery from Rustavi and Kutaisi landfills;
- Construction of 14 more WWT plants;
- Gas recovery from Kobuleti and Batumi WWT plants;
- Recycling paper parts of the MSW.

Projections

Approach and assumptions: The measures included in the CS/CAP are envisaged for the 2020-2030 period of time but are quite comprehensive to encompass the main spectrum of the sectoral issues. Moreover, when thinking over the further period to 2050, the introduction of new technologies in the sector is hardly expected. This was the assumption when designing the mitigation scenarios for 2050.

Thus, both WeM and WaM scenarios have been elaborated based on the CS/CAP activities,

- Without adding new ones (for WaM);
- Projecting their effects by 'prolonging' the activities until the mid-century.

When calculating the projections, the start times for some activities have been shifted based on the actual delay of all activities due to the pandemic situation that entailed changes in the latest draft CS/CAP from the initially defined periods.

The results of the joint 'pessimistic' and 'optimistic' scenarios encompassing the baseline, WeM and WaM each are shown in the tables and charts below.

The scenarios have been elaborated separately for the solid waste and the wastewater treatment sub-sectors.

A) Solid Waste

TABLE N100. Pessimistic Scenarios: CH4 Emissions (in Gg CH4)

Scenario	2017	2020	2021	2022	2025	2030	2035	2040	2045	2050
WOM	53.19	52.77	52.78	53.36	53.86	54.73	55.87	57.45	59.62	62.61
WEM	52.75	52.28	52.28	51.66	44.96	45.32	42.22	41.08	39.71	38.96
WAM	51.90	51.15	50.06	49.36	40.26	39.25	34.87	30.57	26.56	22.40

FIGURE 57. Pessimistic Scenarios for CH4 Emissions from Solid Waste Disposal on Land (SWDL)

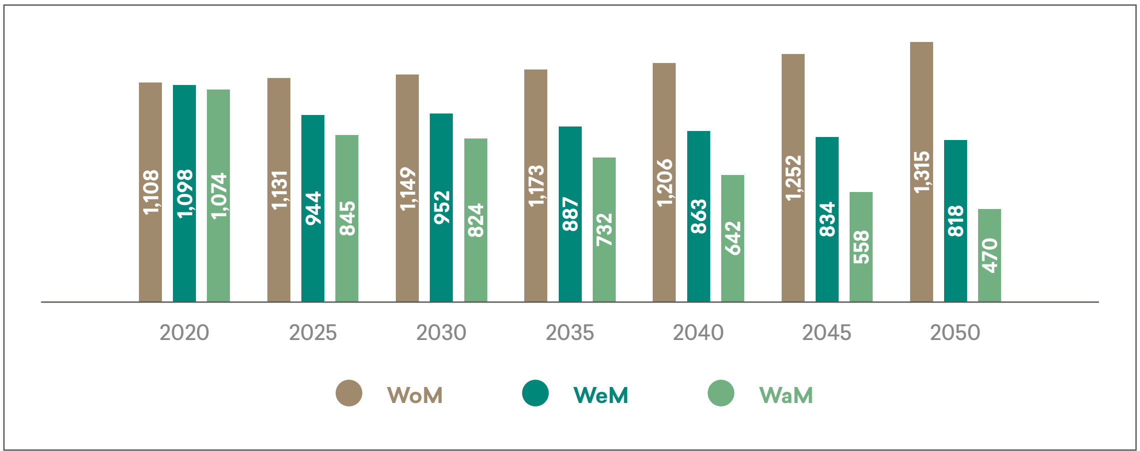
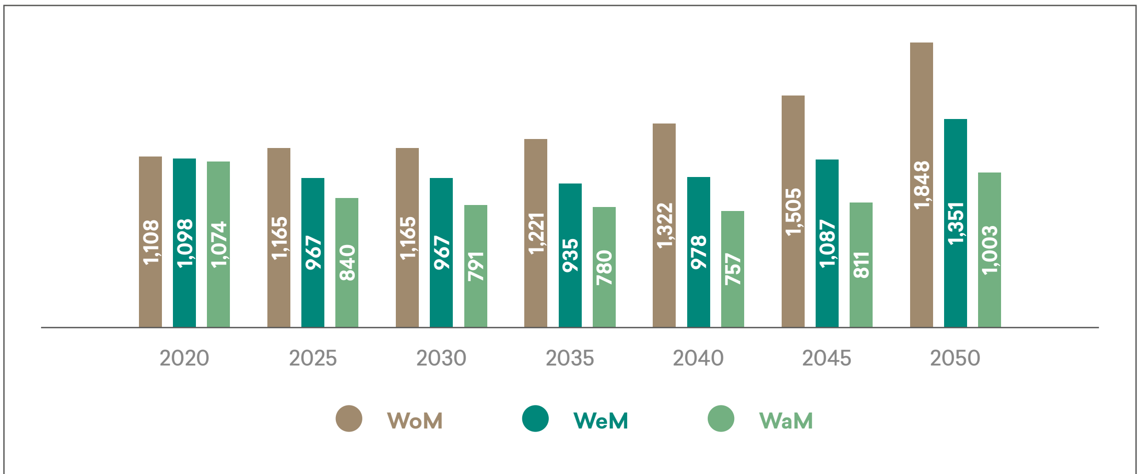


TABLE N101. Optimistic Scenarios: CH4 Emissions (in Gg CH4)

Scenario	2017	2020	2022	2025	2030	2030	2035	2040	2045	2050
WOM	53.19	52.77	53.38	53.96	55.46	55.46	58.15	62.94	71.67	87.99
WEM	52.75	52.28	51.69	45.06	46.05	46.05	44.50	46.57	51.76	64.33
WAM	51.90	51.15	49.39	40.36	39.99	37.69	37.16	36.06	38.60	47.77

FIGURE 58. Optimistic Scenarios for CH4 Emissions from Solid Waste Disposal on Land (SWDL)



As seen in the figure, in the case of the optimistic scenario development corresponding to an increase in population (with tourists) number, the measures for neither WeM nor WaM are sufficient and additional efforts seem to be needed.

Considering the fact that the fundamental reforms are undergoing in the sector just now and are expected to be completed by 2030 leading the sector to the targeted level of modernization, envisaging additional measures for emissions reduction in the sector is very unlikely and the enhancement/intensification of existing measures seems more realistic. Specifically, this would include an increase in methane recovery from every site where this measure is planned and a maximal reduction of landfilled solid waste by means of recovering some fractions (garden and park waste, market waste, paper and cardboard for composting and recycling).

B) Wastewater

The wastewater treatment (WWT) sub-sector comprises two sources of GHGs: 1) Domestic and Commercial WW (D&CWW) and 2) Industrial WW (IWW). The subsector produces two GHGs: methane (CH4) and nitrous oxide (N2O). The latter is only calculated in Georgia's GHG inventory for sewage sludge. However, the N2O and CH4 potentials are calculated by the 2006 IPCC GLs that may be applied to new WWT plants.

The reform that is ongoing in the sub-sector implies the construction of 21 new WWT plants of which seven have already been built or being built which corresponds to the WeM scenario. The construction of the remaining 14 WWTP which is recommended, although not yet planned, corresponds to the WaM scenario. Recovery of the generated methane is envisaged in some of the WWTPs.

Drivers for the projection of the emissions from the sub-sector are the population number (together with the all-year-long tourists) and the GDP (for the N2O from the WW). As mentioned above, the pessimistic and optimistic baseline scenarios (WoMs) for GHG emissions differ by the population (with tourists) and the GDP growth rate. The population growth projections have already been considered above. For the GDP, this projection is shown as follows:

TABLE N102. GDP Growth Projections for Optimistic and Pessimistic Scenarios

Years	GDP annual growth	
	✓ Optimistic scenario	✗ Pessimistic scenario
2016	2.85%	2.85%
2020	-6.10%	-6.10%
2025	5.34%	5.29%
2030	6.04%	5.71%
2035	6.74%	6.14%
2040	7.02%	6.22%
2045	7.02%	6.22%
2050	7.02%	6.22%

Using corresponding drivers, baseline emission projections have been calculated and mitigation scenarios imposed on them, resulting in WeM and WaM pessimistic and optimistic scenarios. For the starting point, the values for the sub-sector for 2017 have been taken from the National GHG Inventory included in the recently finalized 4th National Communication of Georgia.

Outcomes

WoM (Baseline) Scenarios

The WoM scenarios have been projected:

- for CH4: Using the per capita CH4 emissions, calculated based on the 2016 and 2017 values from the latest National GHGI for each Domestic and Commercial WW (D&CWW) and Industrial WW (IWW) and the population (with tourists), optimistic and pessimistic projections until 2050;
- for N2O: using N2O emissions per GDP as a coefficient, calculated from the N2O values for 2016 and 2017 from the National GHGI and GDP projections (optimistic and pessimistic) until 2050.

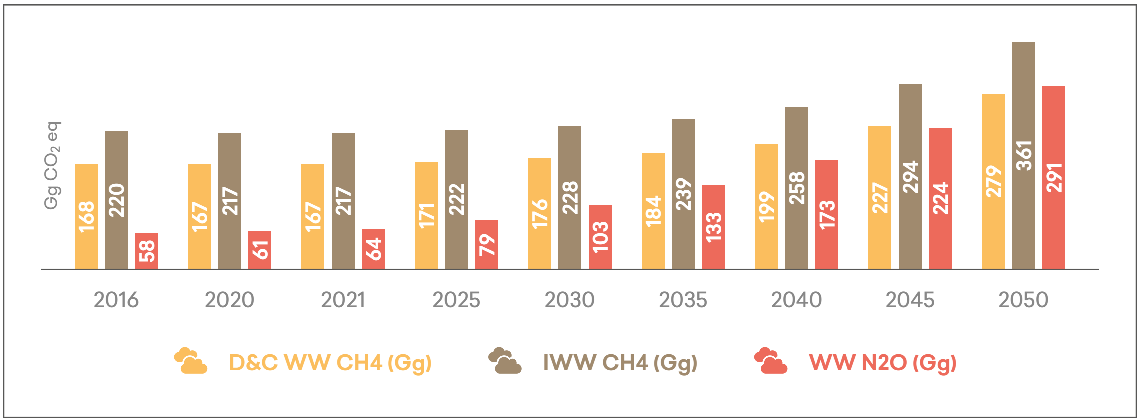
The resulting scenarios are given in the tables and corresponding charts below.

Optimistic:

TABLE N103. Optimistic WoM Scenario for CH4 and N2O Emissions from the WW (Gg CO2e)

	2017	2020	2021	2025	2030	2035	2040	2045	2050
D&C WW CH4 (Gg)	167	167.2	167.2	171	175.7	184.2	199.4	227	278.7
IWW CH4 (Gg)	219	216.5	216.5	221.5	227.6	238.7	258.3	294.1	361.1
WW N2O (Gg)	59	61.1	63.7	78.9	102.5	133.1	172.8	224.3	291.2

FIGURE 59. CH4 and N2O Emissions from the WW: Optimistic WoM Scenario

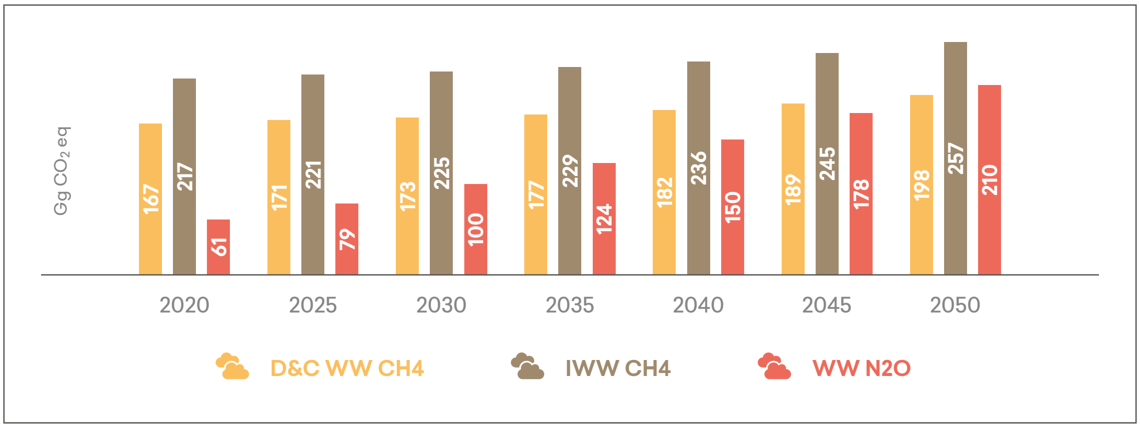


Pessimistic:

TABLE N104. Pessimistic WoM Scenario for CH4 and N2O Emissions from the WW

	2020	2025	2030	2035	2040	2045	2050
D&C WW CH4	167.2	170.6	173.4	177	182	188.9	198.4
IWW CH4	216.5	221	224.6	229.3	235.8	244.7	257
WW N2O	61.1	78.9	100.1	123.7	149.7	178.2	209.9

FIGURE 60. CH4 and N2O Emissions from the WW: Pessimistic WoM Scenario



WeM and WaM (Mitigation) Scenarios

As mentioned, the WeM scenario comprises the construction of seven WWT plants and methane recovery from two new WWT plants and CH4 recovery from two new WWT plants (Zugdidi and Poti). The conditional (WaM) scenario implies the construction of 14 additional (new) plants. Their emission reduction should be based on their possible methane recovery.

The GHG emission reduction from unconditional and conditional measures is projected for 2050 as shown in the tables below.

TABLE N105. Unconditional and Conditional Emissions Reductions from WW, Projected

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Unconditional emissions reduction	-0.499	-0.502	-0.505	-0.508	-0.511	-0.514	-0.517	-0.520	-0.524	-0.527
Conditional emissions reduction		-6.666	-6.736	-6.803	-6.838	-6.885	-6.946	-7.016	-7.097	-7.189
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Unconditional emissions reduction	-0.580	-0.673	-0.780	-0.905	-1.050	-1.218	-1.413	-1.639	-1.901	-2.205
Conditional emissions reduction	-7.275	-7.362	-7.451	-7.540	-7.631	-7.722	-7.815	-7.909	-8.004	-8.100

	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Unconditional emissions reduction	-2.558	-2.967	-3.442	-3.993	-4.632	-5.373	-6.232	-7.229	-8.386	-9.728
Conditional emissions reduction	-8.197	-8.295	-8.395	-8.495	-8.597	-8.701	-8.805	-8.911	-9.018	-9.126

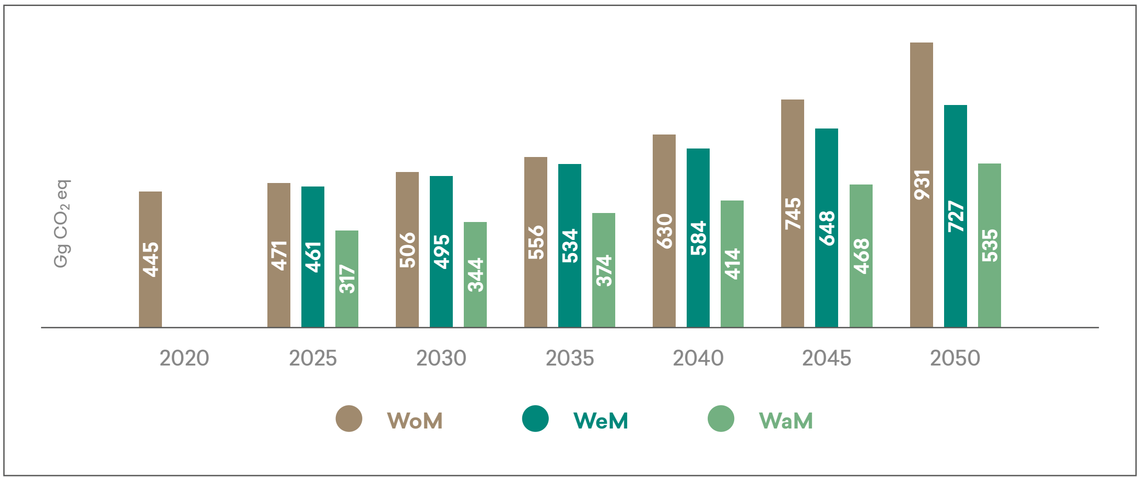
Imposed on the optimistic and pessimistic WoMs, these unconditional and conditional emissions reductions result in optimistic and pessimistic WeMs and WaMs. The tables and corresponding charts for the optimistic and the pessimistic scenarios (WoM, WeM and WaM) are presented below.

Optimistic Scenarios

TABLE N106. Optimistic Scenarios for GHG Emissions from WW

	2017	2020	2021	2025	2030	2035	2040	2045	2050
WOM	445	444.8	447.43	471.36	505.8	555.95	630.45	745.47	931.03
WEM			436.95	460.63	494.73	533.9	584.14	648.21	726.75
WAM				317.03	343.77	373.65	414.04	467.66	535.1

FIGURE 61. Optimistic Scenarios for GHG Emissions from WW

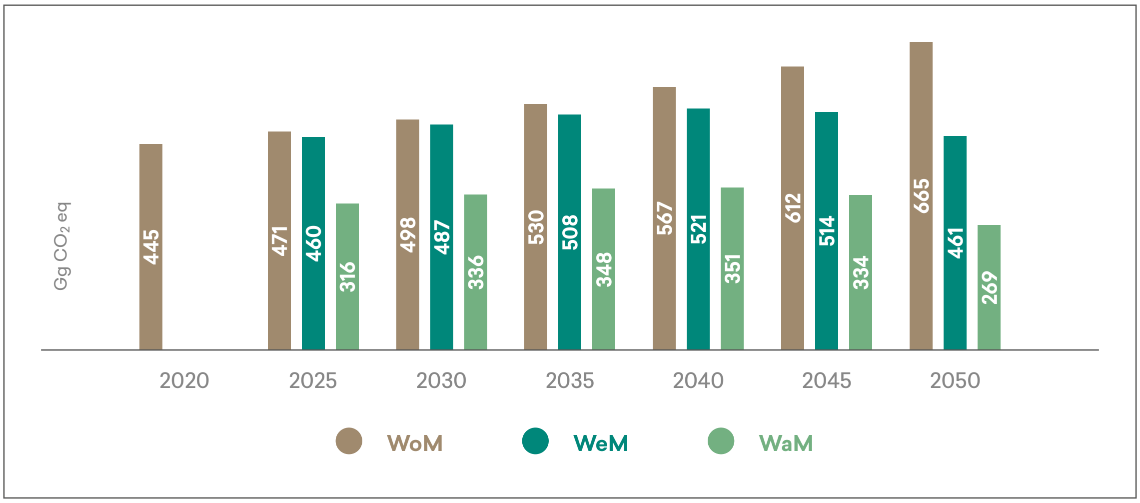


Pessimistic Scenarios

TABLE N107. Pessimistic Scenarios for GHG Emissions from WW

	2017	2020	2021	2025	2030	2035	2040	2045	2050
WOM	445	444.803	447.55	470.613	498.033	530	567.476	611.741	665.285
WEM			437.074	459.886	486.963	507.952	521.168	514.477	460.999
WAM				316.284	335.997	347.707	351.075	333.931	269.357

FIGURE 62. Pessimistic Scenarios for GHG Emissions from WW



End Notes

- CH4 recovery is envisaged only in a few WWT plants. Construction of the others will only add CH4 emissions to the baseline.
- When the 14 (additional) WWT plants are constructed, their type (not yet identified) will influence their emissions and a recalculation will be needed.
- CH4 and N2O potentials have been estimated though the estimates are only tentative (ranges are given based on potential treatment management).
- Analyzing the three scenarios, it is evident that the approaches with respect to long-term development rates need re-evaluation and the assumptions with respect to the expected effects of some of the measures – need revision.

Sectoral Projections

The whole sectoral emissions under optimistic and pessimistic scenarios until 2050 are presented in the table and the figure below:

TABLE N108. Pessimistic Emissions from the Waste Sector (Gg CO2e)

	2020	2025	2030	2035	2040	2045	2050
WOM	1552.973	1601.673	1647.363	1703.27	1773.926	1863.761	1980.095
WEM	1097.88	1404.046	1438.683	1394.572	1383.848	1348.387	1279.159
WAM	1074.15	1161.744	1160.247	1079.977	993.045	891.691	739.757

FIGURE 63. Pessimistic Emissions from the Waste Sector (Gg CO_2e)

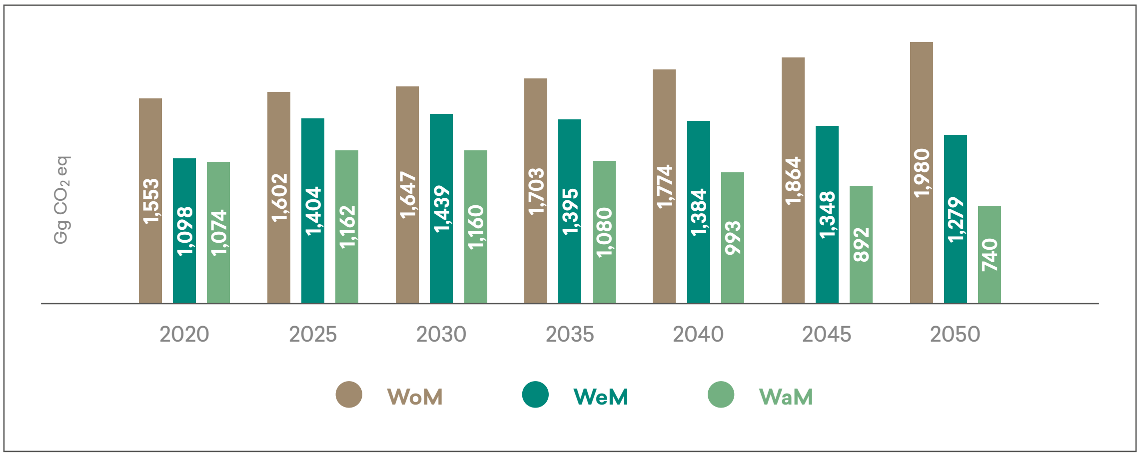
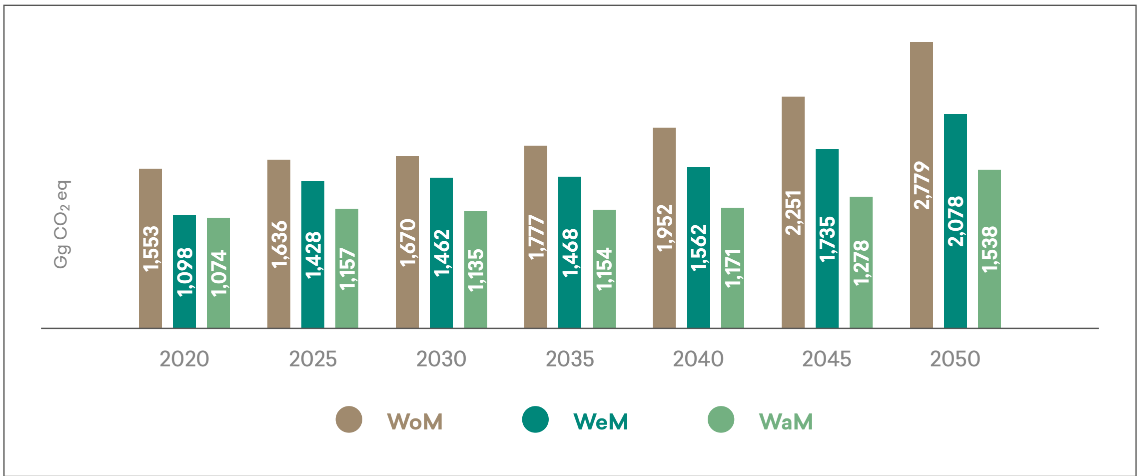


TABLE N109. Optimistic Scenario: Emissions from the Waste Sector (Gg CO_2e)

	2020	2025	2030	2035	2040	2045	2050
WOM	1552.97	1636.02	1670.46	1777.1	1952.19	2250.54	2778.82
WEM	1097.88	1427.68	1461.78	1468.4	1562.11	1735.17	2077.68
WAM	1074.15	1156.82	1135.26	1154.01	1171.3	1278.26	1538.27

FIGURE 64. Optimistic Emissions from the Waste Sector (Gg CO_2e)



In this respect, the potential of GHG emissions from some fractions of MSW has been calculated to identify the amount of CH_4 that will be reduced for the recycling or/and the composting purposes of these fractions. For WW, the total potential of methane (CH_4) and nitrous oxide (N2O) generated in new WWTPs (except the existing ones where methane recovery takes place) has been calculated to identify the amount of GHG emissions reduction in the case of the recovery of CH_4 and N_2O.

These potentials, projected to 2050, are calculated and presented in the tables below.

The total amount of paper, garden and park waste from all landfills (Tbilisi, Rustavi and new regional ones – virtually united) and their respective methane potential has been calculated to identify the **methane reduction potential from solid waste** nationwide. This potential by years is presented in the table below.

TABLE N110. Potential of CH_4 Emissions from Paper, Garden and Park Waste Fractions of all Landfills of Georgia (Tbilisi, Rustavi and all Remaining New Regional Landfills) until 2050

Years	Total methane-producing potential (Gg CH4)	
	Paper and carton	Paper, park and garden waste
2024	1.603	1.006
2025	2.401	1.101
2026	3.195	1.194
2027	3.961	1.283
2028	4.701	1.368
2029	5.416	1.449
2030	6.107	1.528
2031	6.775	1.603
2032	7.424	1.680
2033	8.026	1.750
2034	8.604	1.816
2035	9.158	1.880
2036	9.691	1.941
2037	10.201	1.999
2038	10.699	2.060
2039	11.179	2.121
2040	11.639	2.178
2041	12.080	2.233
2042	12.508	2.288
2043	12.918	2.341
2044	13.312	2.391
2045	13.689	2.439
2046	14.051	2.485
2047	14.399	2.529
2048	14.733	2.572
2049	15.053	2.612
2050	15.360	2.651

Increasing the methane recovery capacity from new regional landfills is also a very important source of emissions reduction. The existing data rely on preliminary calculations but the real potential of methane recovery depends on corresponding technical equipment and the start times of the landfill's operationalization, equipping and methane recovery practice. It may be estimated after the reforms are completed.

Methane (CH_4) and Nitrous Oxide (N_2O) Potential in Georgia's WWT Plants

CH_4 emissions from all WWTPs nationwide were calculated for the first time based on Tbilisi/Gardabani and Batumi WWTPs data and the national coefficient of BOD per capita which enabled the calculation of the potential CH4 emissions from all the new (constructed and envisaged to be constructed) WWTPs from the number of the population connected to them (using the 2006 IPCC GLs).

According to the BUR2 (published in 2019 and reflecting 2015 data) for the WWTPs under construction (Poti, Zugdidi, Gudauri, Anaklia, Ureki and Tskaltubo), collection (in gas tanks) of CH4 produced from anaerobic decay is envisaged for use as well as the mounting of flares for flaring surplus gas. However, this practice is currently only considered reasonable for Zugdidi and Poti because the rest of the WWT plants do not seem to be cost-effective for such modernization.

WWTPs emit both CH4 and N2O because the WW is rich in organic (food) matter and proteins.

Centralized aerobic treatment and an anaerobic reactor are the main types of WW treatment planned in Georgia's new WWT plants. In centralized aerobic treatment, more methane is produced when the treatment is poor and N_2O is generated. In the anaerobic reactor's case, a significant amount of methane that needs recovery or flaring is generated while N_2O is not produced. It is also possible to use deep lagoons.

Based on these, CH4 and N2O producing potential has been calculated, although emissions reduction will still depend on the concrete measure applied for each WWTP.

A) Methane Emissions Potential

Table 111 below presents potential CH4 generation in new (recently built) and planned WWTPs in Georgia in the cases of good and poor management practices (MCF=0.3 for aerobic centralized WWTPs - poor treatment and MCF=0.8 for anaerobic reactor or anaerobic lagoon) calculated based on the number of inhabitants connected to them and a country-specific BOD value (44.735 g/cap/day) calculated from real data for Tbilisi (Gardabani) and Batumi WWTPs.

TABLE N111. Annual CH4 Generation Potential in all New and Planned WWTPs in Georgia (for MCF=0.8 and MCF=0.3)

MCF=0.8		MCF=0.3	
City/town	Gg CH_4/y	City/town	kg CH_4/y
Zugdidi	0.34	Zugdidi	126.4
Poti	0.41	Poti	152.3
Gudauri	0.001	Gudauri	0.3
Telavi	0.15	Telavi	57.7
Tskaltubo	0.09	Tskaltubo	33.2
Ureki	0.01	Ureki	3.4
Anaklia	0.01	Anaklia	5
Pasanauri	0.01	Pasanauri	3.4
Kvareli	0.02	Kvareli	7.3
Khashuri	0.2	Khashuri	76.8
Martvili	0.03	Martvili	13
Tkibuli	0.1	Tkibuli	35.9
Bakhmaro*	0	Bakhmaro	0
Abastumani*	0	Abastumani	0
Mukhrani	0.06	Mukhrani	22.7
Marneuli/Bolnisi	0.29	Marneuli/Bolnisi	107.2
Mestia	0.02	Mestia	5.8
Chiatura	0.13	Chiatura	47
Kutaisi	1.45	Kutaisi	542.4
Dusheti	0.05	Dusheti	18.1
Zhinvali	0.01	Zhinvali	5.4
Total (new)	**3.381**	**Total (new)**	**1263.3**

* Resort settlements with mostly seasonal inhabitants

Assumption: The number of inhabitants connected to the collector has been left unchanged since 2019).

Thus, there is significant CH4 emissions potential from new WWTPs and its reduction value depends on the concrete type of treatment at the plants.

It is to be noted that the removed sludge contains a significant amount of degradable matter and represents a methane emission source without proper treatment. The common practice in Georgia vis-à-vis the sludge, however, (in open air on the ground) ensures its aeration and prevents methane generation. It is important to periodically remove the mass in order to ensure proper aeration.

Methane 'capture' or recovery as well as its flaring are likely practices to be used in the new WWTPs. In the case of 'capture,' the amount of the recovered methane will depend on the efficiency of the methane-collecting technique (%) and can be calculated by multiplying the relevant coefficient. In the case of flares, the amount of the CO_2 produced from the flared methane will be calculated based on the chemical reaction: $CH_4 + 2O_2 = CO_2 + 2H_2O$

B) Nitrous Oxide (N2O) Emissions Potential

N2O emissions are generated at some WWTPs because WW contains protein and nitrogen.

The calculations are based on protein consumption per capita (national value) and standard (default) coefficients from IPPC guidelines (Revised 1996 IPCC GLs and 2006 IPCC GLs).

Using the coefficients 85 g/cap/day for protein consumption per capita, taken from the latest GHG inventory, and the numbers of connected inhabitants, emissions of N2O from new WWTPs have been calculated, providing it is generated (takes place during the centralized aerobic treatment). The total potential of N_2O from new WWTPs amounts to 62.31 or 67.32 t N_2O according to Revised 1996 IPCC GL or 2006 IPCC GL, respectively.

N2O emissions are not generated in deep anaerobic lagoons but are produced in centralized aerobic treatment plants and their reduction depends on the measure applied.

Both CH4 and N2O estimates represent just maximal potentials of their generation through the real emissions reduction amount that will result from concrete mitigation measures applied to each plant and related technical parameters.

The mitigation measures envisaged in the WWT sub-sector relate to exclusive methane. However, the N2O emissions potential estimates may be useful when planning further activities (e.g., composting the de-methanized sludge for agricultural purposes).

ANNEX 2

RELATIONSHIP OF THE STRATEGY WITH OTHER POLICY AND LEGAL DOCUMENTS

Vision 2030, Development Strategy of Georgia

The long-term development vision of Georgia envisages several key political goals such as ensuring the country's sustainable economic development and social equity, strengthening security and stability and solidifying democracy, justice and the rule of law. The LT LEDS fully complies with the 14th goal of the development vision "to protect the environment and natural resources, to ensure sustainable and climate-smart management."

Association Agreement between the European Union and Georgia (From a Climate Perspective)

The Association Agreement between the European Union (EU-AA) and Georgia was signed in June 2014 and fully entered into force in July 2016. The Association Agreement aims to provide a framework for deeper political and economic relationships between the EU and Georgia, including through the increased alignment of key regulations and standards. The EU-AA commits Georgia to an ambitious reform agenda through the identification of a list of European Commission legislations for implementation in Georgia, with a timetable of implementation for each, including but not limited to directives on energy efficiency, air pollution and renewable energy which are also high priorities for climate change planning, etc.

Energy Community for Climate Policy

In 2016 in addition to the Association Agreement, Georgia acceded to the Energy Community Treaty (entry into force in April 2017) which seeks to liberalize and align energy markets with those of the EU Member States and other Energy Community Parties. The legal relationship between Georgian and the Energy Community is regulated by the Protocol concerning the Accession of Georgia to the Treaty Establishing the Energy Community. According to Georgian legislation, the protocol is a mandatory document to be executed and has a superior force in relation to domestic legislation. By signing the Energy Community Treaty, in parallel with LTS, Georgia will also be required to submit integrated National Energy and Climate Plans (NECPs) (Governance Regulation, Chapter 3) which will require elaboration on policies and measures related to the reduction of GHG emissions in all key emitting sectors to meet 2030 targets, among others.

Georgia became a party to the Energy Community Treaty. One of the parts of this Treaty concerns the current process of reforming the energy market which from its side included the adoption of a whole range of legislative documents in 2019 and 2020 which had a direct and indirect impact on the NECP.

As a full-fledged member of the Energy Community Treaty, Georgia is now implementing the EU directives and regulations and is also transposing and harmonizing the EU legislation (Acquis Communautaire) in accordance with the working program of the Energy Community. On 18 November 2015, the European Commission received the first piece of information on the State of the Energy Community which indicates that the NECPs, which integrate all five main domains of the Energy Community, is an essential tool for the implementation of the Strategy of Energy Community and for the additional strategic planning in the field of energy and climate.

As part of the 2015 Energy Community Status, the EU issued a guidance document on integrated NECPs for EU Member States. This document forms the basis for the EU member states to start elaborating national plans for 2021-2030 and defines the main pillars of the management process. The NECPs will reduce administrative burdens, improve transparency for member states and ensure investor participation in the planned processes up to 2030 and beyond. Therefore, the Energy Community Secretariat issued a policy guidance document on NECPs for contracting parties in 2018.

The NECP should cover 2021 to 2030 and provide the basis for action to transform the economy and energy systems, ensuring a largely sustainable future. This should be achieved based on the indicators that each country should have achieved in terms of the policy by 2020 (baseline) and it should include the prospects by 2050. This ensures compliance with the long-term policy objectives of the EU, the UNFCCC and the Energy Community. Integrated NECPs may rely upon the existing national energy and climate change policy strategies of EU Member States. A complex approach should be applied to reflect all the five main directions of the Energy Union in an integrated way.

Consideration of Sustainable Development Goals through Climate Policy

In 2015, all United Nations member states adopted the 2030 Agenda, including 17 Sustainable Development Goals (SDGs) and 169 targets. SDGs are not legally binding; however, each government is expected to establish an integrated national SDG strategy to implement the new sustainable development agenda by 2030. It is significant that in November 2019, the Government of Georgia adopted a decree on the National Document of Sustainable Development Goals.[37]

Georgia submitted its first Voluntary National Report on SDG implementation following the 2030 UN Sustainable Development Agenda in 2016 and the second Voluntary Report in 2020 (Transforming Our World: The 2030 Agenda for Sustainable Development: sustainable development.un.org). The Administration of the Government of Georgia coordinates Georgia's SDG implementation. The Government of Georgia has also established technical working groups since 2016 to work on different thematic elements of the SDGs. Together with various agencies within the United Nations, they also established country-specific adjusted SDG targets with indicators to enable progress tracking (*Report: Georgia National Review 2016*). Since then, the Administration of Georgia has prioritized 98 of the 169 global targets and 204 of the 244 global indicators across the 17 SDGs.

Georgia has also established an SDG council to monitor the implementation. It has signaled priorities to enhance the monitoring and evaluation of SDG targets and the increased involvement of local governments, the private sector and civil society members (Global Agenda for Sustainable Development and Georgian Path from 2015, Sustainable Development Goals and Georgia, 2020). A long-term strategy for low-emission development will fully contribute to implementing the 13th goal of the Sustainable Development Goals which specifically deals with action against climate change. Other than this, climate mitigation activities reduce emissions from transport or transition of the power sector towards higher renewable shares, deliver many non-climate related benefits such as improved air pollution, increased energy security or adding more jobs to the economy which help fulfill non-climate related SDG targets prioritized by Georgia.

37 N 2328 Decree of the Government of Georgia on the National Document of Sustainable Development Goals.

ALIGNMENT WITH OTHER RELEVANT POLICY DOCUMENTS

The alignment of the LT LEDS with other CC-related policy documents (strategies and action plans, including sectoral documents) will follow the LT LEDS updating and decade-long LEDS elaboration and monitoring processes and procedures. The policy documents, although prepared independently but falling under the LT LEDS umbrella, are:

① those related to the Paris Agreement process (updated NDCs, CSAPs/CAPs),

② those related to the EU Energy Community (NECP, NEEAP, NREAP) and

③ others indirectly linked with LT LEDS (SEAPs, SECAPs under the EU's Covenant of Mayors, sectoral strategies and action plans).

Nationally Determined Contribution (NDC)

Under its commitment to the Paris Agreement, Georgia has set and communicated a GHG emissions reduction target in 2021, limiting GHG emissions to 35% below the 1990 level in 2030. The following NDC is due to be updated again by 2025.

Climate Strategy 2030 and Action Plan 2021-2023 (CS/CAP)

The CS outlines the strategic directions and priorities for climate action in all climate-relevant sectors and their mitigation targets for 2030 to meet the NDC-determined targets for national GHG emission reduction. The CAP embraces the short-term mitigation activities with existing and additional measures for the relevant sectors for 2021-2023. Climate change strategies and their respective action plans are subject to updating at appropriate intervals.

The LT LEDS is closely related to the 2030 Climate Change Strategy as the Climate Strategy covers the first decade of the long-term implementation of the strategy. The Strategy is coordinated with them as a framework for decadal low-emission development strategies, including the 2030 Climate Change Strategy. Therefore, the mitigation scenarios of the Strategy were largely based on the 2030 strategy package of measures, although with some modifications related to their duration.

National Energy and Climate Plan (NECP)

The National Energy and Climate Plan (NECP) is a strategic planning tool initiated by the EU whose development is required in accordance with Article 3 of the Governance Regulation from Georgia. The plan should reflect the detailed vision and the ratio of planned policies and measures in five main areas: decarbonization, energy efficiency, energy security, internal energy market, research, innovation and competitiveness. Therefore, Georgia is finalizing its NECP as recommended as part of its commitment to the Energy Community Treaty membership. In line with the abovementioned recommendations and the Governance Regulation set by the Ministerial Council of the Energy Community, Georgia's NECP should cover the period from 2025 to 2030, including targets and actions for improving energy security, strengthening the energy market, improving energy efficiency, decarbonizing the economy and promoting research and innovation (in five main areas). The Integrated plan is aligned with the Climate Change Strategy and Action Plan and will continue to do so in subsequent cycles of their renewal. The integrated plan and the working process are fully compatible with the LT LEDS and the second document defined by the Governance Regulation.

Sustainable Energy (and Climate) Action Plans (SEAPs and SECAPs)

By 2022, 24 subnational authorities in Georgia were signatories to the Covenant of Mayors, committing themselves to developing and implementing Sustainable Energy Action Plans (SEAPs) or Sustainable Energy and Climate Action Plans (SECAPs). The SECAPs include actions for reducing energy demand and increasing energy efficiency by 2030. SECAPs have an indirect overlap with national action plans. However, vertical coordination between the national and municipal level plans is expected in the climate change field in the near future. In this view, municipal plans are connected to the LT LEDS and other strategies.

OTHER RELEVANT STRATEGIC DOCUMENTS AND LAWS

In addition to the climate- and energy-related strategies and action plans identified above, there are various national and sub-national action plans and strategic documents related to climate change and the LT LEDS.

Rural and Agricultural Development Strategy of Georgia – 2021-2027

The strategy outlines three major goals to be achieved in the sector by 2027. Concerning climate change, the strategy focuses mostly on responding to the risks of climate change through adaptation. However, some of the measures in the strategy would also have relevance for climate change mitigation targets.

Forest Code of Georgia (2020) and National Forest Concept (2013)

The Forest Code aims to protect the biodiversity of the forest of Georgia, including preserving and improving the forest's characteristics and the quantity and quality of its resources. The national forestry concept defines the principles of sustainable forest management. Concerning climate change, this Concept refers to measures for responding to risks through adaptation to climate change. However, sustainable forest management and related measures largely determine the degree of GHG removal which is linked directly to the reduction of these gas emissions and the climate neutrality of the country.

2015 Waste Management Code, 2016-2030 National Waste Management Strategy and 2016-2020 Action Plan

The Waste Management Code establishes a legal framework in waste management to implement measures to facilitate waste prevention and increased reuse in line with environmentally safe treatment. To improve the waste management system, the Waste Management Strategy and Action Plan define the goals and the objectives for waste collection and transportation, ensuring safe landfilling of waste and waste prevention, amongst others. As the waste sector is one of the serious sources of greenhouse gases, its sectoral policies are closely related to climate change mitigation policies and mitigation measures in this sector. Currently, the Action Plan has been updated for the next period.

2020 Energy Efficiency Law and 2020 Energy Performance of Buildings Law

The Energy Efficiency Law aims to determine the legal basis for the measures necessary to promote and implement energy efficiency in the country, establish a procedure for developing national energy efficiency targets and implement, coordinate, control, supervise and monitor Georgia's energy efficiency policy. The Energy Performance of Buildings Law aims to promote the rational use of energy resources and improve the energy efficiency of buildings, considering the external climatic and local conditions of buildings. The law establishes the methodology for calculating the energy consumption of buildings. As the buildings sector is one of the serious GHG emitters, its sectoral policies are linked closely to the climate change mitigation policies and mitigation measures in this sector.

Law of Georgia on Promotion of Production and Utilization of Energy from Renewable Sources (2019)

The law aims to establish the legal basis for promoting energy use from renewable sources, a mandatory national common target indicator for the total final energy consumption and the total share of energy from renewable sources in energy consumption by transport, and determines its share in total final energy consumption (27.4% by 2030). As renewable energies are one of the fundamental sources for reducing greenhouse gas emissions, the policy of this sector is closely related to the climate change mitigation policy and mitigation measures in this sector.

ANNEX 3

ENERGY EFFICIENT MEASURES

TABLE 1. Energy Efficient Measures

Energy Efficiency Measure	Description
Insulation of the roof (attic floor) and basement	External (preferred) or internal insulation such as rock wool or mineral wool, Perlite powder, other breathable materials or XPS, EPS.
Insulation of the walls	Mineral or rock wool insulation, Perlite block/powder, other “breathable” materials, composite facade systems, EPS and XPS systems.
Installation of new EE windows and doors	Double or triple-glazed PVC, aluminum or wooden doors/windows with air sealing.
Ventilation	Installation of Prana type, channel type or equivalent heat recovery ventilation units.
Heating	Replacement of boilers, redesign of the system to low-temperature heat carrier to allow condensation boilers to work in a maximum efficiency mode, replacement of inefficient wooden stoves with high-performance ones, insulation of pipes, use of inverter type water circulation pumps, application of whole building heating/cooling or district systems.
Cooling	Use efficient individual cooling units, application of building or district chillers, application of low-tech solutions such as solar shaders and plant trees.
Lighting	Substitute incandescent and fluorescent light emitters with LEDs, optimize interior and exterior lighting design and reduce light pollution (removal of excess lighting).
Various/other	Upgrade of elevators and other process-related energy consumers.
Renewables	Application of PV, DHW systems, ground heat pumps, biomass boilers (where applicable).

MEASURES/APPLICABILITY BY BUILDING TYPE

The table below describes the applicability of measures by building type.

TABLE 2. Measures by Building Type

Type/Scenario/ Level	Measures to Satisfy Minimum Requirements and Predicted Solutions	Additional Measures for “Good”	Additional Measures for “Excellent”
Multi-story buildings			
Ancient (including up to 1921)	**INSULATION OF THE ROOF (ATTIC FLOOR) AND BASEMENT** - External (preferred) or internal insulation such as rock wool or mineral wool, Perlite powder, other breathable materials, or EXPS, EPS. **INSULATION OF THE WALLS (MAINLY FROM THE INTERNAL SIDE)** - Mineral or rock wool insulation, other “breathable” materials, composite façade systems, EPS and XPS systems. **INSTALLATION OF THE EE WINDOWS AND DOORS** - Double or triple-glazed PVC, aluminum, or wooden doors/windows with air sealing. **VENTILATION** - Installation of Prana type or equivalent heat recovery ventilation units (where applicable). **HEATING** - Replacement of boilers, redesign of the system to low temperature heat carrier to allow condensation boilers, replacement of inefficient wooden stoves, insulation of pipes, use of inverter type water circulation pumps. **COOLING** - Use of efficient individual cooling units. **LIGHTING** - Substitution of incandescent and fluorescent light emitters with LEDs. **VARIOUS/OTHER** - Upgrade of process energy consumers. **RENEWABLES** - Application of PV, DHW systems.	Enhanced measures (e.g., more wall or attic insulation or more efficient boiler) Optimization of interior and exterior lighting design	Reduction of light pollution Ground heat pumps, biomass (where applicable) Application of whole building heating/cooling or district systems

Early Soviet period: 1921-1937	**INSULATION OF THE ROOF (ATTIC FLOOR) AND BASEMENT** - External (preferred) or internal insulation such as rock wool or mineral wool, Perlite powder, other breathable materials, or EXPS, EPS. **INSULATION OF THE WALLS** - Mineral or rock wool insulation, other "breathable" materials, composite facade systems, EPS and XPS systems. *Note: in many cases, only internal insulation can be applied due to decorative facade elements* **INSTALLATION OF THE EE WINDOWS AND DOORS** - Double or triple-glazed PVC, aluminum, or wooden doors/windows with air sealing. **VENTILATION** - Installation of Prana type or equivalent heat recovery ventilation units. **HEATING** - Replacement of boilers, redesign of the system to low temperature heat carrier to allow condensation boilers, replacement of inefficient wooden stoves, insulation of pipes, use of inverter type water circulation pumps. **COOLING** - Use of efficient individual cooling units. **LIGHTING** - Substitution of incandescent and fluorescent light emitters with LEDs. **VARIOUS/OTHER** - Upgrade of elevators and other process energy consumers. **RENEWABLES** - Application of PV, DHW systems.	Enhanced measures (e.g., more wall or attic insulation or more efficient boiler) Optimization of interior and exterior lighting design	Reduction of light pollution Ground heat pumps, biomass (where applicable) Application of whole building heating/cooling or district systems

Stalin period: 1937-1956	**INSULATION OF THE ROOF (ATTIC FLOOR) AND BASEMENT** - External (preferred) or internal insulation such as rock wool or mineral wool, Perlite powder, other breathable materials, or EXPS, EPS. **INSULATION OF THE WALLS** - Mineral or rock wool insulation, other "breathable" materials, composite facade systems, EPS and XPS systems. *Note: In most cases, facade wall insulation will be installed from the interior side due to facade decorations.* **INSTALLATION OF NEW EE WINDOWS AND DOORS** - Double or triple-glazed PVC, aluminum, or wooden doors/windows with air sealing. **VENTILATION** - Installation of Prana type or equivalent heat recovery ventilation units. **HEATING** - Replacement of boilers, redesign of the system to low temperature heat carrier to allow condensation boilers, replacement of inefficient wooden stoves, insulation of pipes, use of inverter type water circulation pumps, application of whole building or district systems. **COOLING** - Use of efficient individual cooling units, application of building or district chillers. **LIGHTING** - Substitution of incandescent and fluorescent light emitters with LEDs, light pollution. **VARIOUS/OTHER** - Upgrade of elevators and other process energy consumers. **RENEWABLES** - Application of PV, DHW systems.	Enhanced measures (e.g., more wall or attic insulation or more efficient boiler) Enhanced measures (e.g., more wall or attic insulation or more efficient boiler) Optimization of interior and exterior lighting design	Reduction of light pollution Ground heat pumps, biomass (where applicable) Application of whole building heating/cooling or district systems

So-called Khrushchev period (1956-1969) Developed socialism period: 1969-1990 Current (post-soviet) period	**INSULATION OF THE ROOF (ATTIC FLOOR) AND BASEMENT** - External (preferred) or internal insulation such as rock wool or mineral wool, Perlite powder, other breathable materials, or EXPS, EPS. **INSULATION OF THE WALLS** - Mineral or rock wool insulation, other "breathable" materials, composite facade systems, EPS and XPS systems. *Note: In most cases, facade wall insulation will be installed from the interior side due to facade decorations.* **INSTALLATION OF THE EE WINDOWS AND DOORS** - Double or triple-glazed PVC, aluminum, or wooden doors/windows with air sealing. **VENTILATION** - Installation of Prana type or equivalent heat recovery ventilation units. **HEATING** - Replacement of boilers, redesign of the system to low temperature heat carrier to allow condensation boilers, replacement of inefficient wooden stoves, insulation of pipes, use of inverter type water circulation pumps, application of whole building or district systems. **COOLING** - Use of efficient individual cooling units, application of building or district chillers. **LIGHTING** - Substituting incandescent and fluorescent light emitters with LEDs, light pollution. **VARIOUS/OTHER** - Upgrade of elevators and other process energy consumers. **RENEWABLES** - Application of PV, DHW systems.	Enhanced measures (e.g., more wall or attic insulation or more efficient boiler) Enhanced measures (e.g., more wall or attic insulation or more efficient boiler) Optimization of interior and exterior lighting design	Reduction of light pollution Ground heat pumps, biomass (where applicable) Application of whole building heating/cooling or district systems

Traditional Houses (homes)			
All types: Timber, Brick, Stone, Other or Complex type	**INSULATION OF THE ROOF (ATTIC FLOOR) AND BASEMENT** - External (preferred) or internal insulation such as rock wool or mineral wool, Perlite powder, other breathable materials, or EXPS, EPS. **INSULATION OF THE WALLS** - Mineral or rock wool insulation, other "breathable" materials, composite facade systems, EPS and XPS systems. *Note: In most cases, facade wall insulation will be installed from the interior side due to facade decorations* **INSTALLATION OF NEW EE WINDOWS AND DOORS** - Double or triple-glazed PVC, aluminum, or wooden doors/windows with air sealing. **VENTILATION** - Installation of Prana type or equivalent heat recovery ventilation units. **HEATING** - Replacement of boilers, redesign of the system to low temperature heat carrier to allow condensation boilers, replacement of inefficient wooden stoves, insulation of pipes, use of inverter type water circulation pumps, application of whole building or district systems. **COOLING** - Use of efficient individual cooling units, application of building or district chillers. **LIGHTING** - Substitution of incandescent and fluorescent light emitters with LEDs, light pollution. **VARIOUS/OTHER** - Upgrade of elevators and other process energy consumers. **RENEWABLES** - Application of PV, DHW systems.	Enhanced measures (e.g., more wall or attic insulation or more efficient boiler) Enhanced measures (e.g., more wall or attic insulation or more efficient boiler) Optimization of interior and exterior lighting design	Reduction of light pollution. Ground heat pumps, biomass (where applicable) Application of whole building heating/cooling or district systems

The summary of changes planned by the transposition of EPBD to Georgia is as follows:

TABLE 3.

Existing buildings	New buildings over 50 m^2 (heated area)
▸ All buildings sold or rented out will have an energy performance certificate. ▸ All advertisements will declare the building's energy performance class. ▸ Building owners will periodically inspect building systems (mostly boilers) to keep installed equipment's rated efficiency parameters. ▸ At least 1% of existing public buildings will be renovated according to new energy performance norms. ▸ Buildings going under major renovation will comply with energy performance norms.	▸ Will have minimum energy performance (KWh/m^2 of heated area). ▸ Will conform to minimum requirements of separate building systems and building fabric (boiler, envelope, renewables, heat pump, etc.).

The planned transposition of EPBD will be possible by improving or wider application of existing and new building technologies. From the long list of existing technologies that will be improved or more widely used, the major role will be played by the following ones:

Technology/measure	Content
Improvement of the building envelope properties: insulation of the roof (attic) facade walls and basement, installation of new EE windows and doors:	This implies the application of thicker insulation layers or layers with better thermal insulative materials, external (preferred) or internal insulation such as rock wool or mineral wool, perlite block or powder, other breathable materials or XPS, EPS, composite facade systems, double or triple glazed PVC, aluminum or wooden doors/windows with air sealing. For existing buildings renovation cases, it can be the application of additional thermal insulation on the facade or, if the building is listed as a monument – from the interior side.
Ventilation system:	It can be installing additional units for exhausted air heat recovery and application of mechanical or mixed-mode ventilation systems instead of natural ones where feasible. Also, in existing ventilation system cases, the fans, heat exchangers or calorifiers can be substituted with modern and more efficient ones, keeping the general design of the system unchanged.
Heating/cooling:	Replacement of boilers, redesign of the system to low temperature heat carrier to allow condensation boilers, replacement of inefficient wooden stoves, insulation of pipes, use of invertor-type water circulation pumps, application of whole building heating/cooling or district systems, use of efficient individual cooling units, application of building or district chillers. In addition, if the whole system is not redesigned, separate components can be changed with more efficient ones.

	Lighting:	Substitution of incandescent and fluorescent light emitters with LEDs, optimization of interior and exterior lighting design, and reduction of light pollution.
	Process energy-consuming systems:	Upgrade of elevators, cookers, dryers, washing machines, fridges, dish-washers, and other process energy consumers.
	On-site generation of energy from renewables:	Application of PV, DHW systems, ground heat pumps, biomass (where applicable).

ANNEX 4

POTENTIAL MEASURES OF LT LEDS WITH PLANNED AND ADDITIONAL ACTIONS

Energy Generation - Energy Industry

Existing Mitigation Measures (WeM)

The WeM scenario considers all the technologies considered in the WoM (except for the two existing low-efficiency thermal power plants) and the technologies used due to implementing policies and measures. In order to satisfy the growing electricity demand, the following climate-friendly sources of electricity are being employed:

- HPPs with a total capacity of 3,200 MW;
- Wind stations with a total capacity of 765 MW;
- Solar stations with a total capacity of 37 MW;
- High-efficiency thermal power plants with a total capacity of 460 MW.

The WeM scenario envisages the ending of operations of two existing low-efficiency thermal power plants.

Additional Mitigation Measures (WaM)

The WaM scenario is constructed based on providing additional mitigating measures to WeM that are possible through the policies and measures currently adopted and planned in the country. This definition implies that all technologies covered by WeM are also considered in WaM, along with additional technologies.

In order to satisfy the growing electricity demand, additional climate-friendly sources of electricity will be put into operation:

- HPPs with a total capacity of 2,305 MW;
- Wind stations with a total capacity of 325 MW;
- Solar plants with a total capacity of 1,105 MW.

Fugitive Emissions

WeM Scenario

- Rehabilitation and development of distribution networks and equipping them with modern regulation, control, and accounting technologies;
- Train staff of distribution companies;
- Review of current and planned regulatory or other measures regarding the control of fugitive emissions and reduce losses to the applicable standards;
- Energy efficiency measures in economy sectors (reported in relevant sections) reduce the demand for natural gas and consequently reduce the amount of distrusted natural gas.

WaM Scenario

- Replacement of existing low pressure iron pipes with plastic ones. Due to corrosion, the low-pressure iron pipes of the distribution network are in poor condition. Plastic (Polyethylene) pipes in service do not suffer from corrosion-related defects. The reliable working lifetime of plastic pipes exceeds 100 years;
- The introduction of a Supervisory Control and Data Acquisition (SCADA) system and Production Information Management System (PIMS) for transmission networks can significantly contribute to reducing natural gas losses;
- Methane extraction from coal mines;
- The South Caucasus Pipeline is owned by a consortium led by BP and SOCAR. BP declared: "We've set a new ambition to become a Net zero company by 2050 or sooner and to help the world get to Net zero."

Buildings Sector

Existing Mitigation Measures (WeM)

The mitigation scenario (WeM) is built upon the baseline scenario (WoM) considering the effects of policies and measures adopted and planned in the country. There are 37 measures considered which, if implemented, will reduce GHG emissions under the WeM scenario by 1,461 gg of CO_2 equivalent (from 7,935 gg CO_2 equivalent to 6,474 gg CO_2 equivalent) as compared to the WoM scenario.

Additional Mitigation Measures (WaM)

The WaM scenario is built upon the WeM. Given the policies and measures currently adopted and planned, it includes the effects of additional mitigation actions feasible for the country. This definition implies that all the technologies included in the WoM and WeM scenarios are also considered in WaM along with additional technologies. There are 30 measures considered which, if implemented, will reduce the GHG emissions under the WeM scenario by 5,812 gg of CO_2 equivalent (from 7,935 gg of CO_2 equivalent to 2,123 gg of CO_2 equivalent) as compared to the WoM scenario.

Transport Sector

WeM Scenario

- Make public transit faster, more reliable, more comfortable and safer as compared to private vehicles; improve the capacity, ridership, and efficiency of municipal public transport;
- Change in roadway infrastructure and operations: green light priority for busses, queue jumping at intersections, the conversion of shared road space to dedicated bus lanes, placement of stops so that busses can easily re-enter traffic, reduce traffic delays and increase travel speeds;
- Improvements in pedestrian and bicycle networks to attract more people to walk, bicycle, and ride public transportation;
- Incorporate sustainable public transport development activities, walking/ cycling/ moped travel measures and parking policy and other restrictive measures in the CoM signatory cities;
- Removing least efficient vehicles from the vehicle fleet and upgrading the fleet, improving average fleet efficiency;

- Decrease imports of old, inefficient vehicles with greater market penetration for new models as well as hybrids and electric vehicles;
- Improving fuel quality - the adoption of Euro 6 standard (by 2030) and Euro 7 standard (by 2040) for fuels;
- Provide a substantial tax credit for new electric and plug-in hybrid electric vehicles;
- Creating additional incentives through cash back, discount rate plans and other credits;
- Provide household and commercial electric vehicles charger installation grants;
- Non-cash incentives for electric vehicles, such as carpool lane access and free municipal parking;
- Creating alternatives to charging at home: public charging, workplace charging;
- Improving the quality of intercity passenger transport - improving the service and the quality of intercity public road transport;
- Increase the share of the railway in freight turnover using the relevant tariffs policy;
- Improve intercity passenger rail;
- Working out a nationwide sustainable urban transport development policy;
- Development of a national strategy for supporting municipal efforts.

WaM Scenario

- Use Bus Rapid Transit: dedicated lanes, segregated bus ways, traffic signal priority, off-board fare collection, etc.;
- Avoid unnecessary travel activity through more effective spatial, logistical and communication systems;
- Making private vehicle use more expensive or inconvenient: introduce road pricing schemes that charge drivers for using their cars in city centers; introduce measures to make parking more difficult in target areas by turning parking spaces into cycle lanes or pedestrian areas or increasing parking fees and use demand-based parking fees that increase when demand is high;
- Renewal of passenger railway infrastructure and increasing train fleet towards strategic directions;
- Promote freight transport shift from heavy truck to rail;
- Expanded capacity and ridership of the metro;
- Encourage cableway installation;
- Ban the import of vehicles older than 10 years;
- Encourage biodiesel production from canola oil/increase canola production.

Industry

The WeM scenario includes the following (planned and adopted) measures for mitigation as listed below:

- Non-metallic minerals – standard process heating with primary solid biofuels (fuel switch);
- Non-metallic minerals - Improved process heating with natural gas;
- Chemical and petrochemical - improved process heating with electricity;
- Chemical and petrochemical - improved machine driving with electricity;

- Chemical and petrochemical - improved facilities;
- Chemical and petrochemical -N_2O abatement;
- Metal - standard process heat – electricity (fuel switch);
- F-gases – HFC/PFC abatement.

The WaM scenario includes the following measures for mitigation as listed below:

- Iron and steel - improved machine drive - electricity (EE);
- Iron and steel - improved facilities/other with fuel oil, natural gas, and electricity;
- Iron and steel - improved process heat with natural gas and electricity;
- Chemical and petrochemical - improved facilities with natural gas and electricity;
- Chemical and petrochemical -improved process heat with natural gas and electricity;
- Chemical and petrochemical - improved feedstock with natural gas;
- Non-metallic minerals - improved machine drive with electricity;
- Non-metallic minerals -improved facilities with electricity;
- Food and tobacco - improved machine drive with electricity;
- Food and tobacco - improved process heat with electricity;
- Food and tobacco - improved facilities with diesel.

Agriculture

The WeM scenario considers measures that are approved worldwide and available in Georgia:

- Use high-quality forage - forage quality affects the production of CH_4. High-quality forage, such as young plants, can reduce CH_4 generation;
- Increasing the proportions of concentrates (low-fiber, high-energy forage) in the cattle diet reduces CH_4 generation;
- Replace grass silage with maize silage - silage from maize or other cereals has a higher content of dry nutrients with easily digestible carbohydrates, resulting in lower CH_4 generation by animals as opposed to grass silage;
- Replace low-productive animals with high-productive animals with less CH_4 emissions per production unit.

The WaM scenario involves methane emission reduction measures that are now being introduced worldwide and may become commercially available in Georgia:

- Add organic acids to forage for reducing CH_4 generation;
- Add fats to the diets of high-yield dairy livestock;
- Add sunflower and canola seeds to the livestock diet - methane generation can be reduced by 10-16%. A precondition is the production of canola in Georgia;
- Add soybean oil - methane generation can be reduced by up to 40%. A precondition is to increase soybean production or import in Georgia;
- Use of methane inhibitors as a feed additive - this significantly reduces methane generation.

Methane emissions reductions from manure management. Manure can be an alternative energy source for livestock farmers. In anaerobic conditions; i.e., in the absence of oxygen, manure will be partially converted to energy in the form of biogas. One of the most common practices for storing manure is using storage structures such as anaerobic (covered) lagoon. Anaerobic lagoons involve placing an impermeable floating cover; e.g., a plastic cover over the lagoon's surface to capture methane. In a covered lagoon digester, anaerobic digestion of organic matter occurs.

In the case of the WeM scenario, mitigation measures are envisaged which are tested and available in Georgia:

- Usage of biogas appliances on small farms;
- Aeration and composting of manure storage.

In the case of the WaM scenario, there are mitigation measures envisaged which have been tested in the world but are not employed in Georgia:

- Methane removal/recovery from covered anaerobic lagoons in large cattle and hog farms.

Reduction of direct and indirect emissions of nitrogen dioxide from agricultural soils. Nitrogen fertilizers and manures applied to soils (N fertilizers and manures) are not always used efficiently by plants. Improved efficiency will result in the reduction of N_2O emissions that are produced by soil microbes, mainly from excess nitrogen.

The WeM scenario considers measures that increase soil productivity and, therefore, limit the use of nitrogen fertilizers:

- Reduce/prevent soil erosion: mulching of soil surface, crop rotation, conservation plowing, contour and terrace tillage, strip-till soil cultivation, arranging grassed channels, derivative structures and windbreaks;
- Crop selection: growing less nitrogen-demanding crops that can significantly reduce N_2O emissions;
- Improved irrigation management: using drip irrigation instead of sprinkler irrigation can reduce N_2O emissions;
- Reduced soil tillage - can reduce N_2O emissions by up to 50% in the long run;
- Application of biochar/biocarbon as soil additives reduces nitrogen losses;
- Promote the development of organic agriculture.

The WaM scenario considers introducing on the large-scale a practice that improves the efficiency of nitrogen fertilizer application:

- Adjust application rates based on precise estimation of crop needs (e.g., precision farming);
- Avoid time delays between N fertilizer application and plant N uptake (improved timing of application);
- Use slow-release fertilizer forms or nitrification inhibitors (which slow the microbial processes leading to N2O formation);
- Place the N fertilizer more precisely into the soil to make it more accessible to crops roots;
- Avoid excess N applications or eliminate N fertilizer application where possible, etc.;
- Create windbreaks to minimize soil erosion.

Land Use, Land Use Change and Forestry Sector (LULUCF)

Existing Mitigation Measures (WeM)

According to the WeM scenario, Georgia's forests will improve and be fully managed by sustainable principles by 2050. Specifically, there was an assumption made in the model that Georgia's forest massifs will not be degraded by 2050. In the WeM scenario, the removal rate will increase by 22% by 2050 as compared to the WoM scenario.

Under the WeM scenario, the areas covered by perennial crops on agricultural land are increasing; specifically, the growth rates are based on planned and ongoing measures, the cultivated areas are also growing and some climate-smart farming practices are used in management. By 2050, the removal rate will increase by 20%.

Additional Mitigation Measures (WaM)

According to the WaM scenario, the pressure on forests will be drastically reduced by 2050. The country has grown plantations of fast-growing trees and plants and the produced timber resources compete with those obtained from the forest. In the WaM scenario, the removal rate will increase by 27% by 2050 as compared to the WoM scenario.

Under the WaM scenario, additional measures on agricultural land include actions that include good agricultural practices, including climate-smart soil management practices. For example, under climate change conditions, surface tillage is preferred over deep tillage. By 2050, the removal rate will increase by 36%.

Waste Sector

Existing Mitigation Measures (WeM)

The 'existing' measures for GHG mitigation in the sector, described in the CS/CAP, refer to two main directions ongoing in the country under the sector's reforms: those related to solid waste and those related to wastewater treatment.

Solid waste-related measures, presented in the CS/CAP, are based on closing old small, unmanaged landfills and dumpsites and substituting them with new larger regional landfills equipped with modern installations, including for gas recovery. They are:

- Closure of all landfills in the country except three that meet the standard requirement;
- Closure of uncontrolled and unmanaged dumpsites collecting significant amounts of solid waste, avoiding official landfills;
- Construction of eight new large landfills equipped with modern installations for flaring and methane recovery, getting the MSW from the closed landfills.

Another group of activities in this direction of Solid Waste is comprised of gas recovery activities such as:

- Installation of gas recovery system in the existing Tbilisi landfill;
- Methane gas recovery from five new regional landfills.

The activities related to the wastewater comprise:

- Construction of seven new WWT plants;
- Gas recovery from two new WWTP (Zugdidi and Poti).

Composting as an emission-reducing activity from solid waste is also considered among 'existing' measures.

The common approach for gas recovery in new and modernized landfills is based on flaring the generated methane for a few years until there is enough gas to recover. Both activities are reducing emissions.

WaM Package

The WaM package consists of 'additional' activities from the CS/CAP consisting of:

- Methane gas recovery from Rustavi and Kutaisi landfills;
- Construction of 14 more WWT plants;
- Gas recovery of Kobuleti and Batumi WWT plants;
- Recycling paper parts of the MSW.

In the case of the optimistic scenario development corresponding to an increase in population (with tourists), the measures for neither WeM nor WaM are sufficient and additional efforts are needed.

As seen from the projections, optimistic scenarios for the sector do not demonstrate emissions reduction by mid-century. However, the pessimistic projection shows a slight decrease in emissions.

However, the sector has the potential for more reduction of emissions. This potential can be utilized in upscaling/extending and intensifying already identified actions and realizing additional potential not yet reflected in the actions.

Namely, the GHG emissions reduction potential from already identified measures lies in:

- Increase of methane recovery from every site where this measure is planned (regional landfills, new WW treatment plants);
- Recycling of different fractions of MSW (paper and carton waste);
- Composting of some fraction of MSW (garden and park waste, market waste);
- Nitrogen removal from WW sludge;
- Use of MSW for energy use (for the cement production industry).

ANNEX 5

Non-technical Summary

INTRODUCTION

After joining the Paris Agreement,[1] Georgia made significant commitments to develop its climate change policy and reduce Greenhouse Gas (GHG) emissions. Georgia submitted its Nationally Determined Contribution (NDC)[2] to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) in 2021, unconditionally committed to limiting its domestic total GHG emissions to 35% below the 1990 level by 2030 and 50-57% in case of international support. Succeeding this, the Georgian Government adopted the Climate Change Strategy 2030 and the Climate Action Plan (CAP 2021-2023) the same year. As the promising process towards climate change mitigation had started, Georgia also prepared and adopted the **Long-Term Low Emission Development Strategy (further LT LEDS) in April 2023**[3]**. Georgia has an aim to become a "green" country by mid-century. It plans to implement robust climate measures and fundamental technological changes by 2050 to achieve its ultimate goal – carbon neutrality.**

LT LEDS is a framework document defining Georgia's long-term vision of low-emission development. It shapes and formulates a GHG emissions reduction vision and principles for the carbon-neutral development of the country by 2050. LT LEDS defines a range of estimated national (GHG) emissions and removals from the following sectors - energy[4], industrial processes, product use (IPPU), agriculture, land use, land-use change, and forestry (LULUCF), and waste.

MANDATE

The TL LEDS is a national policy document approved by the Government of Georgia. It was prepared in accordance with Resolution No. 629 of the Government of Georgia on "Approval of the Rules for the Development, Monitoring, and Evaluation of Policy Documents (December 20, 2019)."

The development of the LT LEDS is mandated, and it is aligned with the Paris Agreement (Article 4, Paragraph 19) adopted at the UNFCCC Conference of Parties (COP21) in December 2015, the EU-Georgia Association Agreement signed in 2014[5], and the Regulation on the Governance of the

1 The Paris Agreement, adopted at COP21 in December 2015, stipulates its objective to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels and for this purpose achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases (worldwide carbon neutrality) in the second half of this century

2 Approved according to Resolution No. 167 of the Government of Georgia "On the approval of the Updated Nationally Determined Contribution (NDC) of Georgia, the 2030 Climate Change Strategy of Georgia and the 2021-2023 Action Plan" provided by the Paris Agreement (UNFCCC), 18 April 2021

3 The Resolution No. 160 of the Government of Georgia "On the Approval of the Long Term Low Emission Development Concept of Georgia," April 24, 2023

4 The energy sector considers GHG emissions from fuel combustion which includes the power industry (electricity generation and transmission), energy consumption from stationary sources (buildings) and mobile sources (transportation), and fugitive emissions from fuels

5 In June 2014, the EU and Georgia signed an Association Agreement, which entered into force on July 1, 2016

Energy Union and Climate Action (the Governance Regulation)[6] of the Energy Community. It also follows the UN 2030 Agenda on Sustainable Development Goals and other commitments as part of Georgia's international obligations.

LT LEDS will be followed by ten-year low-emission development strategies, along with Georgia's updating NDC and corresponding short-term action plans. The LT LEDS will also serve as a framework for planning and developing sectorial policy documents linked to climate change. However, LT LEDS may become a subject of further review and update as suggested by changing international circumstances and commitments.

The implementation of the LT LEDS will be overseen and coordinated by the inter-governmental agency - Climate Change Council, the consultative body established by the Government of Georgia in January 2020[7] to coordinate the effective implementation of the national climate policy, the Paris Agreement, and Georgia's other international commitments.

SCOPE AND METHODOLOGY

The elaboration of LT LEDS began in September 2020. Many stakeholders were involved in drafting the document, including representatives from the public, sectoral governmental agencies, scientific and civil organizations, and experts. As part of this engagement, various events, such as interviews, stakeholder meetings, and public consultations, were held to discuss the document and consider proposed comments in the preparation process. The methodology and approach for the document were elaborated in consultation with relevant stakeholders and presented at the inception workshop.

As part of the LT LEDS preparation methodology, the data collection and policy analysis have been conducted for each sector, and proper drivers, e.g., population size, the gross domestic product, and other economic and demographic factors, etc., have been selected and used to elaborate baseline scenarios. Furthermore, various sector-relevant methods and models of GHG emission projection, e.g., TIMES-Georgia, Ex-Ante Carbon-balance Tool (EX-ACT), IPCC Waste Model, etc., were applied for building long-term low-emission development scenarios of the LT LEDS.

Two baseline scenarios - pessimistic and optimistic, and WoM (Without Measures), WeM (With Existing Measures), and WaM (With Additional Measures) scenarios have been elaborated, showing the tentative range of GHG emissions up to 2050. By analyzing the projected emission trends for each scenario, the possibility of carbon neutrality has been additionally discussed, and the areas for additional mitigation potential have been identified. Furthermore, additional calculations revealed the conditions and measures (extent of additional efforts) sufficient for achieving Georgia's carbon neutrality by 2050.

6 Regulation (EU) 2018/1999 of the European Parliament and of the Council of December 11, 2018, on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council, Decision 2021/13/MC-EnC passed by the Council of Ministers on November 30, 2021

7 Resolution No. 54 of the Government of Georgia on the Establishment of the Climate Change Council, 23 January 2020

CONTENT

The preparation of the LT LEDS is based on the overview of the current situation and climate change impacts in the country, entailing the need to elaborate a long-term low-emission development strategy. This initial part of the LT LEDS, among others, describes the emission sources and the GHG emissions trends in the sectors and analysis GHG emissions in individual sectors. Generally, each sector-specific section contains detailed information about the sector, including its description, current situation, and historical GHG emissions.

For the mid-century low-emission vision, the LT LEDS analyzes tentative ranges and targets between pessimistic and optimistic development paths for each climate-relevant sector to reduce GHG emissions. It also identifies corresponding sets of mitigation actions. It envisages mitigation activities to be implemented in the correlated economic sectors to be reflected in the respective strategy and action plans following the LT LEDS.

Consideration of gender aspects plays a significant role in LT LEDS development and its entire operation process. The section on gender identifies the gender-related element and provides recommendations that should be adequately reflected in the LT LEDS implementation process. LT LEDS takes a promising step to promote women's professional development and proper integration into the entire LEDS operation according to equity principles.

Georgia's LT LEDS pays critical attention to the technological transformation and modernization of economic sectors, exceptionally energy-efficient technologies and renewables, as the basis for low-emissions development. Innovative technologies, in general, and among them climate technologies, are the keys to economic development and decarbonization by 2050. Georgia plans to combine low-emission development and economic growth by introducing innovative approaches and technologies that reduce GHG emissions.

From the financial and practical point of view, the climate finance vision as part of the LT LEDS Climate Finance Strategy (CFS) considers the factors needed to raise public, private, and international funds to implement the LT LEDS successfully. The climate finance scheme includes mobilizing local, national, and international finances supporting climate mitigation, adaptation, and low-carbon development. It is crucial to develop funding policies and procedures that align with Georgia's LT LEDS and fulfill the investment requirements to achieve its main objectives. This issue is significant because, like other developing countries, Georgia is characterized by high capital costs that are a considerable barrier to attracting funds and the development process in general.

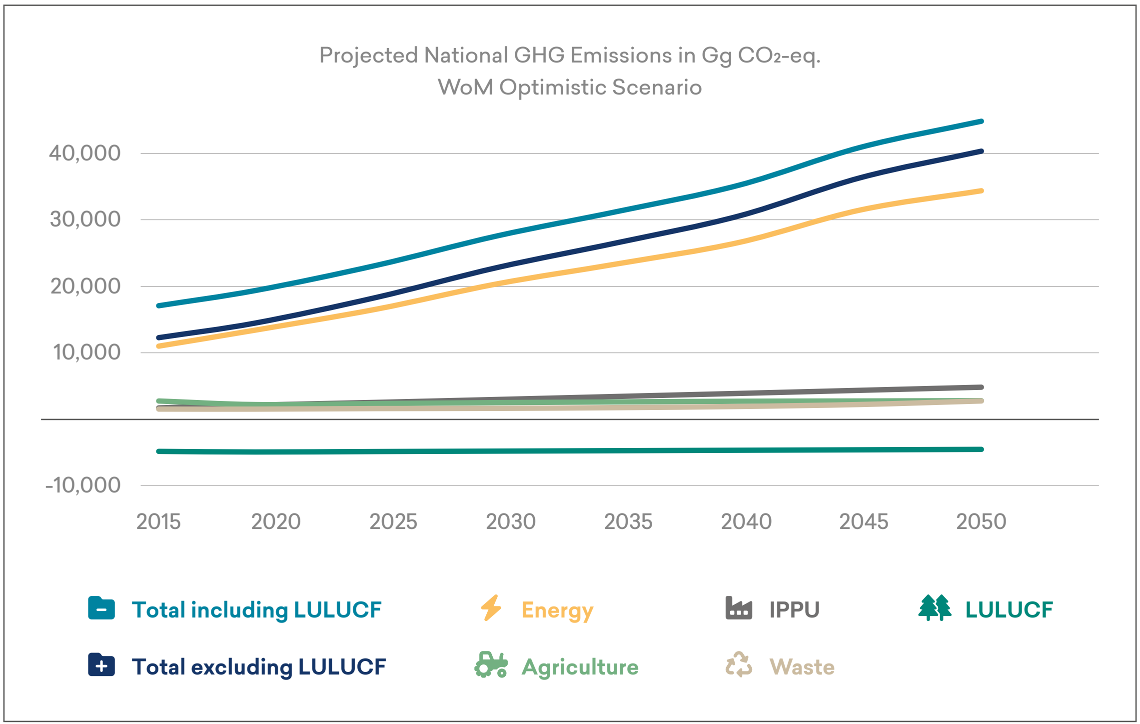
KEY CONCLUSIONS

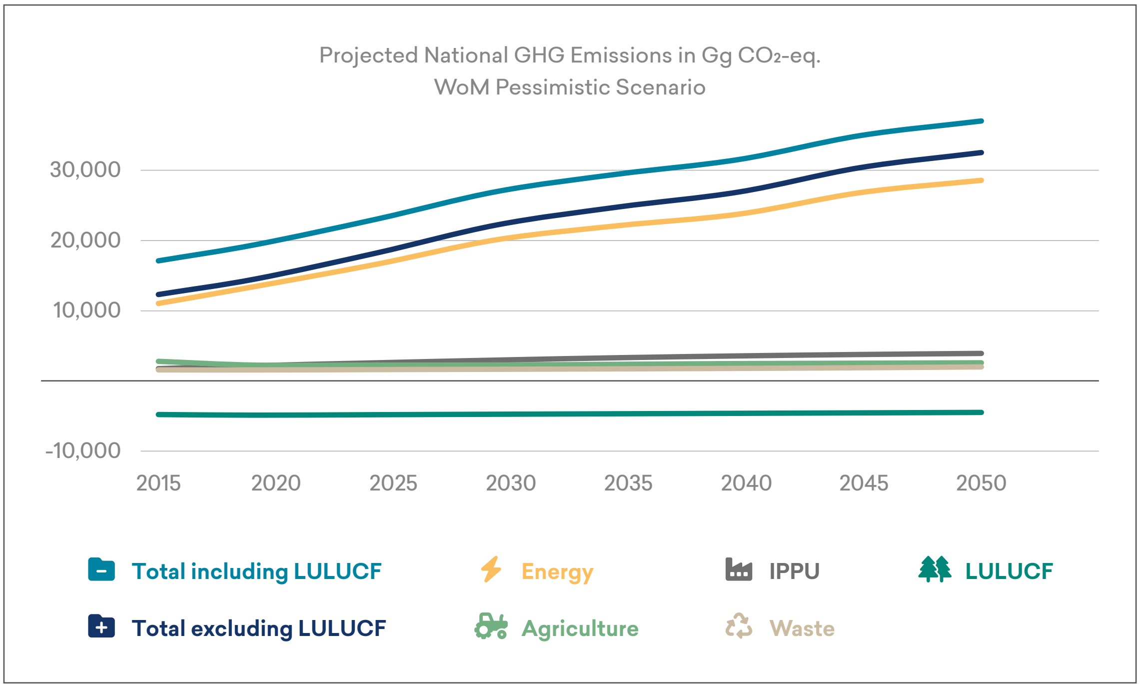
Overall, LT LEDS defines the range of projected GHG emissions by 2050 between optimistic and pessimistic development and proposes trajectories for three emission reduction scenarios for Georgia. Based on these analyses, these key conclusions are driven as follows:

WoM Scenario (the baseline scenario)

In the case of the baseline scenario (WoM) and optimistic development, the projected national GHG emissions (including LULUCF) by 2050 will reach 40,313 Gg CO_2-eq and 32,499 Gg CO_2-eq in the case of the WoM pessimistic scenarios. Similarly, GHG emissions (excluding LULUCF) by 2050 will reach 44,808 Gg CO_2-eq in the case of the WoM optimistic and 36,995 Gg CO_2-eq in the case of the WoM pessimistic scenarios.

Projected GHG Emissions in Gg CO_2-eq. WoM Optimistic and WoM Pessimistic Scenarios





As for sectors, the share of GHG emissions in national GHG emissions is presented in Table 1.

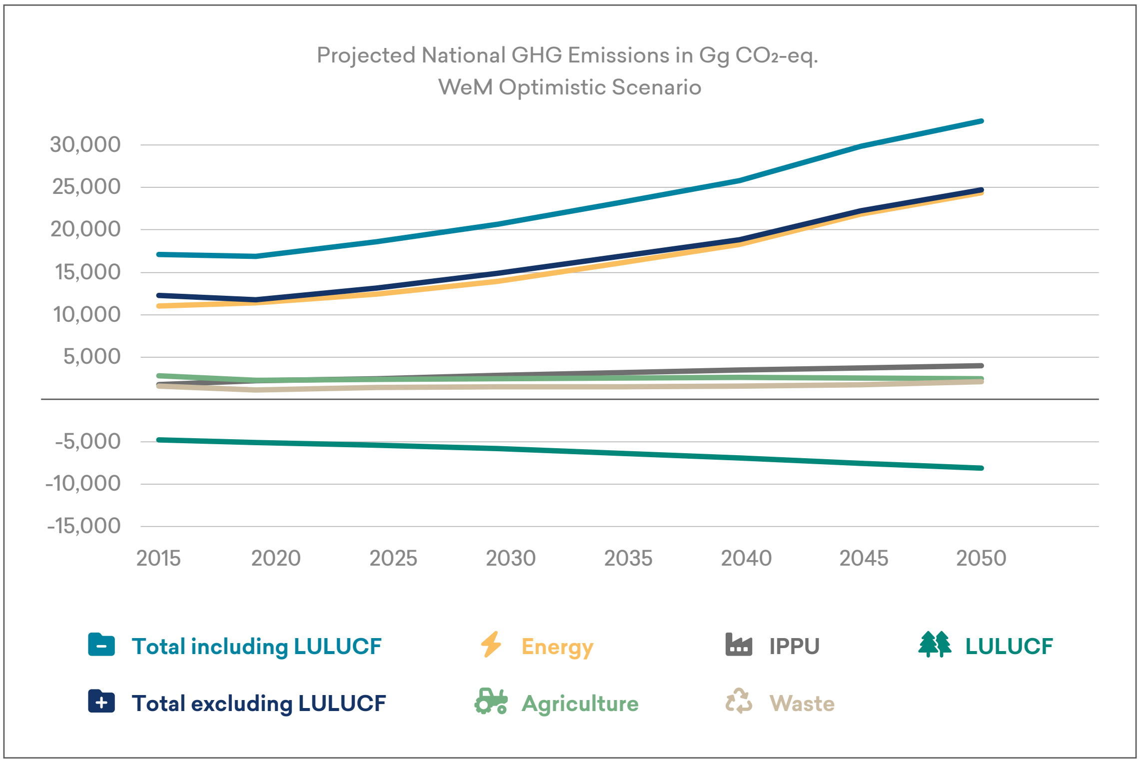
TABLE 1. Share of Sectoral GHG Emissions in National GHG Emissions

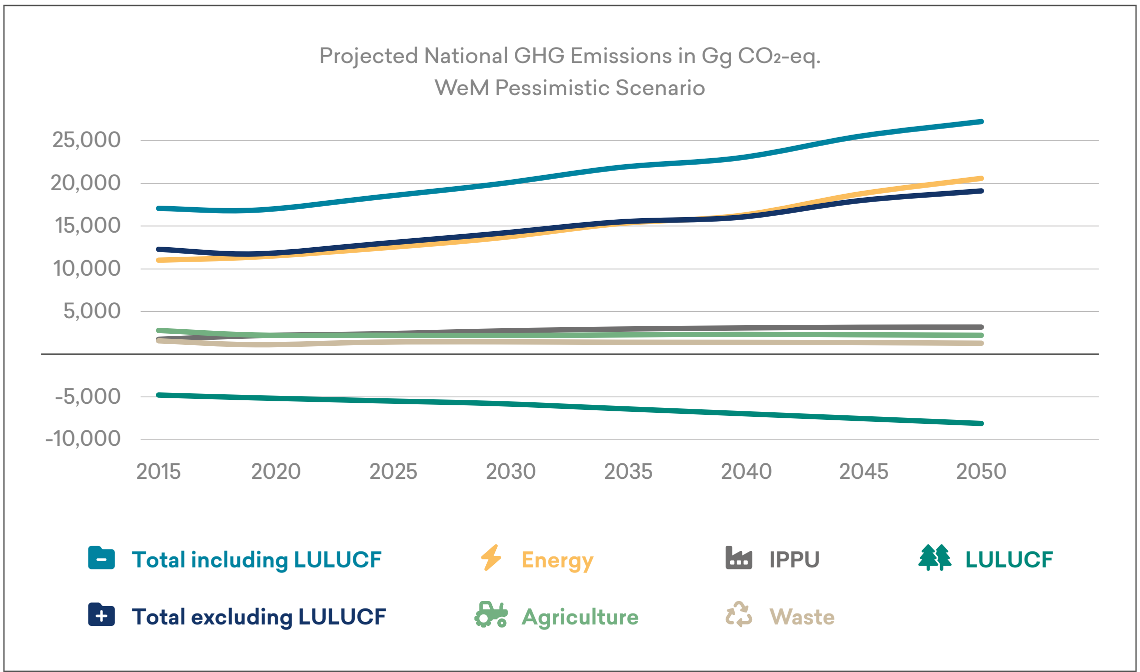
Sector	WoM Optimistic scenario				WoM Pessimistic scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Energy	69%	74%	76%	77%	69%	75%	76%	77%
IPPU	11%	11%	11%	11%	11%	11%	11%	11%
Agriculture	12%	9%	8%	6%	12%	8%	8%	7%
Waste	8%	6%	6%	6%	8%	6%	6%	5%
Total excluding LULUCF	100%	100%	100%	100%	100%	100%	100%	100%
LULUCF	-25%	-17%	-13%	-10%	-25%	-18%	-15%	-12%
Total including LULUCF	75%	83%	87%	90%	75%	82%	85%	88%

WeM Scenario (with Existing and Planned Measures)

Expected GHG emissions (including LULUCF) by 2050 will be 24,736 Gg CO_2-eq in the case of the WeM optimistic and 19,134 Gg CO_2-eq in the case of the WeM pessimistic scenarios and GHG emissions (excluding LULUCF) by 2050 will be 32,868 Gg CO_2-eq in the case of the WeM optimistic and 27,267 Gg CO_2-eq in the case of the WeM pessimistic scenarios.

Projected GHG Emissions in Gg CO_2-eq. WeM Optimistic and WeM Pessimistic Scenarios





As for sectors, the share of GHG emissions in national GHG emissions is presented in Table 2.

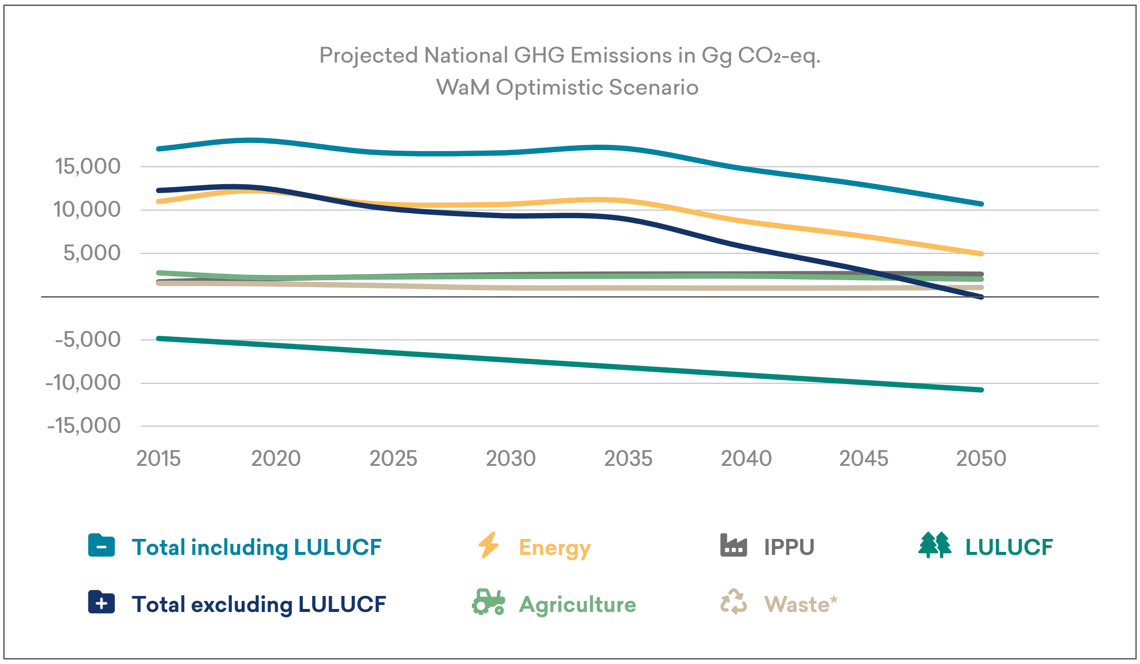
TABLE 2. Share of Sectoral GHG Emissions in National GHG Emissions

Sector	WeM Optimistic scenario				WeM Pessimistic scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Energy	68%	67%	71%	74%	66%	69%	70%	74%
IPPU	13%	14%	13%	12%	13%	14%	13%	12%
Agriculture	13%	12%	10%	7%	13%	11%	10%	8%
Waste	7%	7%	6%	6%	7%	7%	6%	5%
Total excluding LULUCF	100%	100%	100%	100%	100%	100%	100%	100%
LULUCF	-30%	-28%	-27%	-25%	-30%	-29%	-30%	-29%
Total including LULUCF	70%	72%	73%	75%	70%	71%	70%	71%

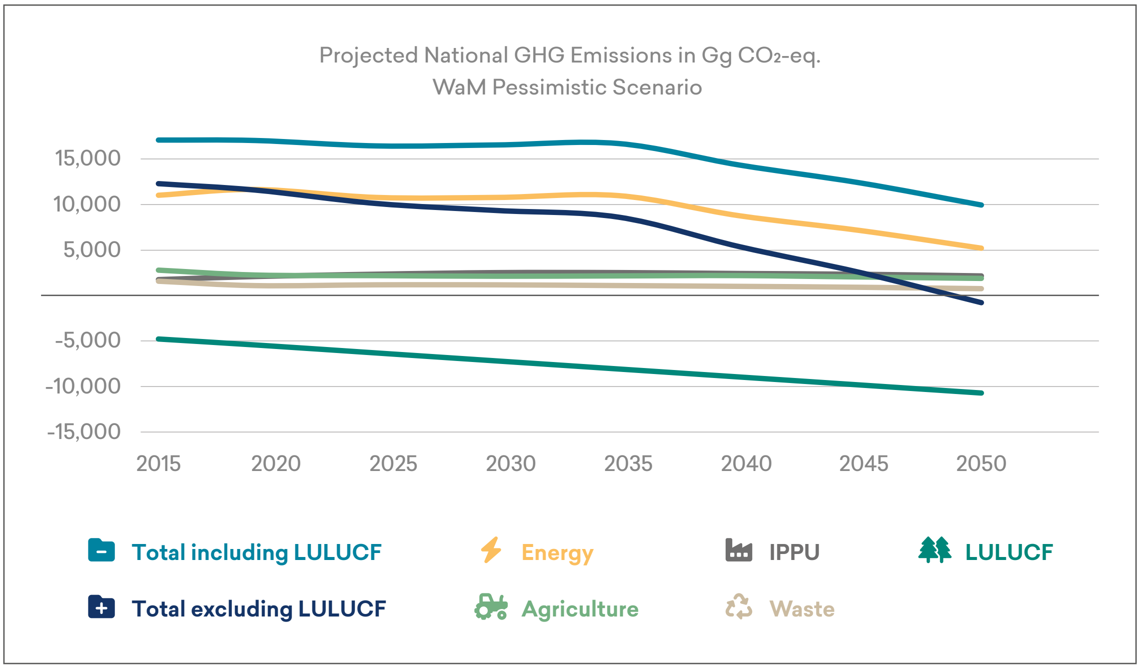
WaM scenario (with additional measures)

Expected GHG emissions (including LULUCF) by 2050 will be -20 Gg CO_2-eq in the case of the WaM optimistic and -801 Gg CO_2-eq in the case of the WaM pessimistic scenarios and GHG emissions (excluding LULUCF) by 2050 will be 10,720 Gg CO_2-eq in the case of the WaM optimistic and 9,939 Gg CO_2-eq in the case of the WaM pessimistic scenarios.

Projected GHG Emissions in Gg CO_2-eq. WaM Optimistic and WaM Pessimistic Scenarios



* Additional CH_4 recovery potential has been accounted for.



As for sectors, the share of GHG emissions in national GHG emissions is presented in Table 3.

TABLE 3. Share of Sectoral GHG Emissions in National GHG Emissions. WaM Optimistic and WaM Pessimistic Scenarios

Sector	WaM Optimistic scenario				WaM Pessimistic scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Energy	68%	64%	59%	46%	67%	66%	61%	50%
IPPU	12%	15%	18%	25%	12%	15%	17%	21%
Agriculture	12%	14%	16%	19%	13%	13%	15%	18%
Waste	8%	6%	7%	10%	6%	7%	7%	6%
Total excluding LULUCF	100%	100%	100%	100%	100%	100%	100%	100%
LULUCF	-30%	-44%	-61%	-101%	-31%	-44%	-63%	-105%
Total including LULUCF	70%	57%	40%	-1%	69%	56%	37%	-5%

Carbon neutrality by mid-century will be the ultimate goal for Georgia's long-term low-emissions development. However, achieving this with the baseline – the WoM scenario and with the existing measures – the WeM scenarios seems impossible. Instead, it can only be reached in the case of additional measures – the WaM scenario.

Thus, by 2050, Georgia will be able to become carbon-neutral in the case of both the pessimistic and the optimistic WaM scenarios.

LT LEDS demonstrates the crucial importance of introducing an innovative policy and new technologies requiring outer (international) technical, technological, and financial assistance to realize the ultimate goal – carbon neutrality by the mid-century.

Besides, the climate change mitigation policy should be implemented in compliance with the principles of social justice and the just transition principles. The measures implemented within the climate change mitigation policy framework provide opportunities for creating new decent jobs, which, along with the reduction of GHG emissions, contribute to the development of the regional and national economy. Therefore, low-emission development is turning into a tool not only for reducing GHG emissions but also for achieving social welfare goals.

PARADIGM SHIFT TOWARD CARBON-NEUTRAL DEVELOPMENT PATHWAYS

Social-economic impact - key messages[8]

Implementing the LT LEDS will create opportunities for new investments and technological innovations that can benefit the overall economic prospect of the country. This process will promote technological development, create additional jobs, and increase national revenues. However, implementing

8 This part of the Non-technical Summary summarizes the key messages of the Socio-Economic Impacts of Georgia's Decarbonization Pathway conducted by McKinsey & Company, Inc in January 2023 with support of the NDC Partnership. The study is based on comparing WoM and WaM scenarios of Georgia's LT LEDS.

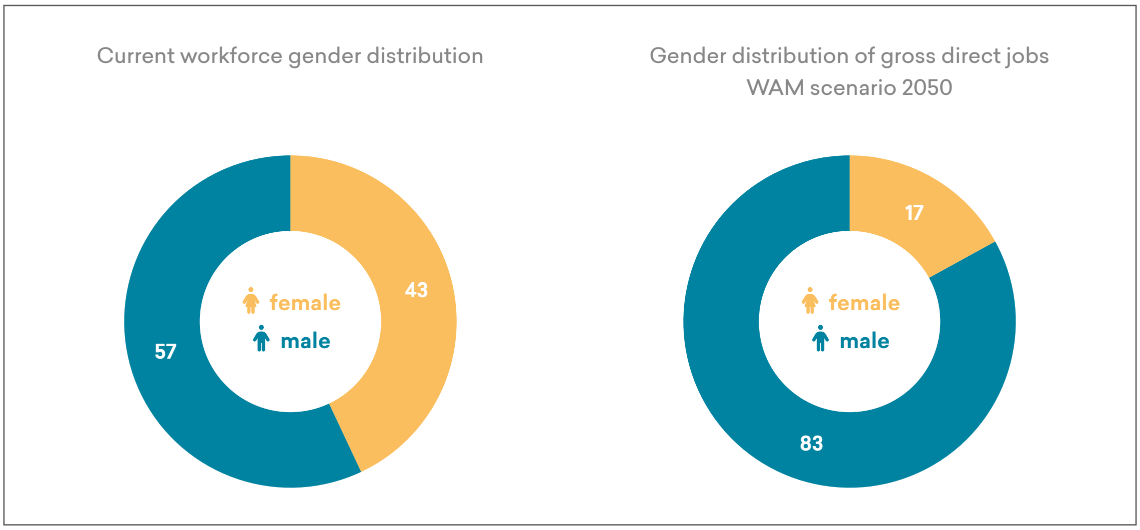
climate action, especially long-term, is hard work and requires considerable technical, human, and financial resources for Georgia to achieve the desired goal.

Georgia will need $78 bn more *capital expenditure* for implementing the scenario with climate measures (WaM) compared to a scenario without climate measures (WoM). However, setting up infrastructure for climate measures will save approximately $56 bn in *operational expenditure*, meaning that between now and 2050, Georgia will need to mobilize about $22 bn in extra finances to achieve carbon neutrality. From 2022 to 2050, implementing climate measures will require an average additional expenditure of around USD 760M per year, equivalent to 1.9% of GDP, compared to a 'business as usual' scenario. Investment in infrastructure for climate measures is crucial, and financial resources are necessary to make it happen. This includes long-term energy storage, hydrogen infrastructure, EV charging infrastructure, and electricity grid upgrades and expansion.

However, the investment to support climate measures is expected to increase GDP and employment compared to a scenario with no climate measures and sustain a long-term economic outlook for Georgia. By investing in climate measures, Georgia can create a more resilient system that relies less on imports, especially for energy sources. As a result of reducing energy consumption for heating and transportation in businesses and households, new opportunities for investing in innovative technologies will arise. Over time, Georgia will be able to recoup the initial capital investment made toward climate measures.

In addition, implementing climate measures is projected to result in an extra $1 bn of Gross Value Added (GVA) and the creation of 200,000 more jobs by 2050 compared to a scenario without climate measures. It is anticipated that roughly 80% of the total GVA generated by investments in the WaM scenario will come from low-carbon technologies.

In the WAM scenario, employment consistently remains higher compared to the WOM scenario. Furthermore, it has been estimated that low-carbon technologies will support 90% of the total jobs in the WaM scenario. As for the sectors, from WaM investments, the transport sector will generate 30% of employment, while the industry, power, and building sectors will each support roughly 15% of jobs by 2050. New jobs will create demand for mid and low-skill workers with a technical background, leaving potential occupational gaps for skilled agricultural and craft workers. However, this gap creates new opportunities for educational institutions in Georgia to enhance professional education in these directions to sustain professional demand. Nevertheless, it is essential to note that the transition will impact female workers. An increase in jobs for this transition will be seen in sectors traditionally dominated by men, posing a challenge to inclusive growth.



Finally, Georgia can benefit from the transition by exploring new areas of low-carbon development and leveraging strategic opportunities in the global technology market; one example is liquid hydrogen technology, which is expected to reach a $50 billion global market annually by 2027.

It needs to be admitted that Georgia's goal to become carbon-neutral will boost opportunities for new and innovative low-carbon technologies and require transformative changes in the country's economic and social systems in compliance with just transition principles. Although this transformation will require significant financial investments with well-managed processes and robust climate measures, it will sustain a long-term positive impact on the country.

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