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ENHANCING CAPACITY FOR LOW EMISSION DEVELOPMENT STRATEGIES (EC-LEDS)/ CLEAN ENERGY PROGRAM

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Low Emission Development Strategy – Energy Sector

September 2016

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Low Emission Development Strategy-Energy Sector

September, 2016

This report was prepared under the technical assistance provided to the Government of Georgia for development of the Low Emission Development Strategy in the framework of the "Enhancing Capacity for Low Emission Development Strategy" (EC-LEDS) project.

The report presents the Energy Sector chapter of the Low Emission Development Strategy. Its Georgian version was submitted to the energy sub working group for consideration and comments on August 4, 2016. Comments were receive from the Ministry of Energy on August 31, 2016. The chapter was revised according to these comments and revised version was sent back to Ministry of Energy on September 14, 2016. No further comments have been received from Ministry by September 27, 2016.

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Abbreviations

TPS	Thermal Power Station
MW	Megawatt (10^6 Wt h)
GWh	Gigawatt hour (10^9 Wt h)
KV	Kilovolt (10^3 volt)
MVA	megavolt-ampere
PJ	Petajoule (10^{15} Joule)
TJ	Terajoule(10^{12} Joule)
RES	Renewable Energy Source
GCS	Geothermal Circulation Systems
EC-LEDS	Enhancing Capacity for Low Emission Development Strategies / Clean Energy Program

1. Energy Sector Today

Energy Sector in Georgia is represented actually with all traditional fields of electricity and fuel industry like thermal and hydro generation facilities, electric and thermal networks, transport and gas distribution pipelines, transit oil pipelines, oil and gas mining enterprises and coal mines, etc. The work for using potential and utilization of renewable energy, including geothermal waters, bio, wind and solar resources is activated in order to optimize existing methods and resources.

In 2014 about 187 397 TJ primary energy recourses have been supplied in Georgia. While excluding the electricity supplied to occupied Abkhazeti, this figure equals to 181 958 TJ of primary energy resources making up about 0.05TJ (1.17 TO eq.) per capita on the territory controlled by the central government[1]. This is significantly behind both the averaged world value – 0.08TJ (1.6TO eq.) and the analogous values of the regions with approximately similar climate conditions (Azerbaijan, Turkey, Romania, Bulgaria, Greece).

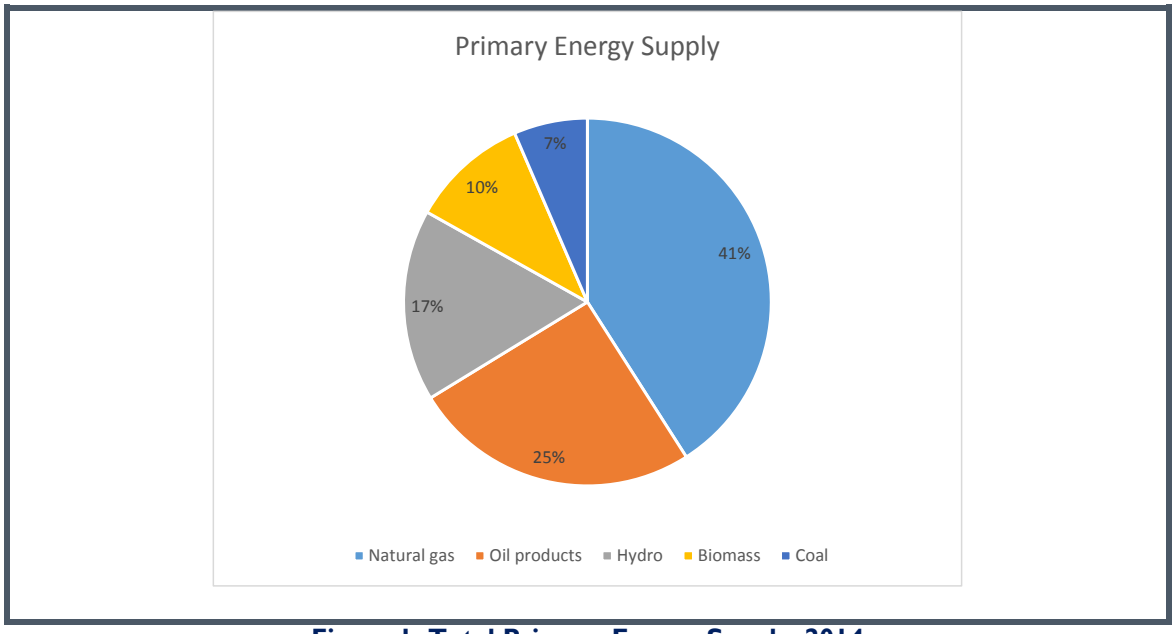

Figure 1. Total Primary Energy Supply, 2014

The share of fossil resources in primary energy consumption is about 70%, which is less than global value (81%) due to 17% share of renewable, namely hydro power resources in total balance in Georgia while the averaged world value makes up only 2%. Important local resources are bio resources (firewood) and Georgian coal, about 10% and 3% (in the world 10% and 29%) accordingly, however, their share compared with 2013 value is reduced by about 2%, basically, oil products, as well as, due to increase of gas share, by about 66%. As for other renewable resources (solar, geothermal), their share in primary consumption is less than 1%.

The power generation of the country is represented by 4 thermal power stations (among them one TPS, which is equipped with modern technologies, works on gas and has an installed capacity 230 MW) and about 50 hydro power plants. The total installed capacity of generation units equals to about 3750 MW. In 2014 the power plants of Georgia generated 10 371.2 GWh electricity, of which 19.6% was produced by

[1]According to the census conducted in 2014, the number of Georgia's population made 3 713 804 persons without the residents living in the occupied territories.

thermal power stations, and the rest – by hydro power plants. The country's power supply grid operates with 500, 330, 220, 110 and 35 kV voltages. Total length of the electricity transmission lines makes 3 350km. Total installed capacity of 92 sub-stations makes 10 212.6 MVA.

Georgia has a significant potential of renewable resources, which have not been used yet. Technical potential of hydro power is estimated as 50 billion KWh per year (only 16.5% is used)[2], wind – 4 billion KWh/yr[2] (0% is used), solar - 1.4PJ/yr[3] (solar energy is being used to heat the water in Georgia, but the rate of use is not known), and geothermal - 4.9PJ[4] (11.2% is used). Technical potential of firewood is estimated as 4.8PJ/yr[5], but actual consumption is higher (19.3PJ/yr according to Georgia's power balance). This mismatch is due to unstable use of this resource. However, Georgia is rich in agricultural residue biomass resource, the potential of which additionally is estimated as 28.7PJ per year.

Final energy consumption in 2014, at the territory of Georgia was estimated as 159 767 TJ with highest shares of natural gas (31%), oil products (27%) and electricity (22%). According to sectors consuming final energy, the highest energy expenditure is observed in buildings and transport – accordingly 42% and 35% of total consumption.

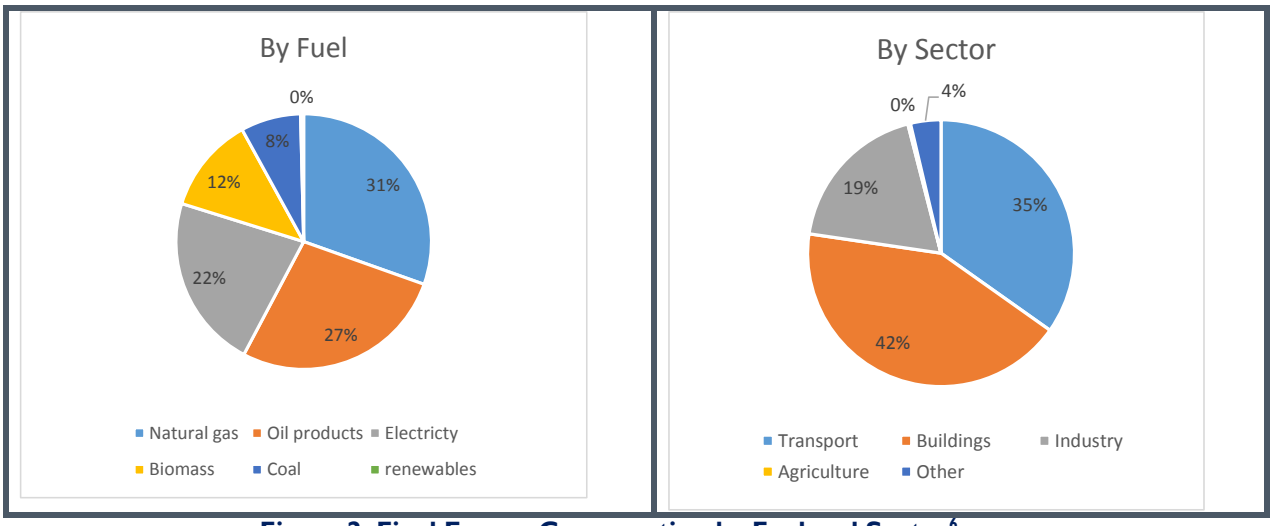

Figure 2. Final Energy Consumption by Fuel and Sector[6]

Corresponding to 2014 data, during distribution the total loss of gas consumed in the country made 3 169TJ (103.8 million m³), that equals to 6.5% of final gas expenditure, and electricity grid loss made 2 160TJ that is 6.1% of the final electricity spending.

[2] Web-page of the Ministry of Energy of Georgia: http://www.energy.gov.ge/energy.php?id_pages=60&lang=geo

[3] "Ten year Network Development Plan of Georgia, 2016-2026", Transmission System operator J/S "Georgian State Electrosystem", 2015.

[4] Geothermal Energy Potential Analysis, EC-LEDS Project Report, Sustainable Development Centre "Remissia", 2014.

[5] ASSESSMENT OF WOOD AND AGRICULTURAL RESIDUE BIOMASS ENERGY POTENTIAL IN GEORGIA, WORLD EXPERIENCE FOR GEORGIA, UNDP 2014.

6 Based on Energy Balance of Georgia 2014 in which chemical industry figures are modified according to the data provided by "Rustavi Azot"

In total, in 2014 the GHG emission from energy sector of the country made 9 410 Gg CO_2 equivalent, of which 8 098 Gg CO_2 eq. (86.1%) is emitted from fuel burning, and the rest are volatile emissions. In 2014, the highest emissions from fuel combustion were observed in transport sector (43%), which basically uses liquid oil products and gas. Industry is also one of the largest consumers of energy resources and the significant source of emissions (from fuel burning is directly emitted 20% of emissions), where the main source of emissions is consumption of coal and coke. An important source of emissions is also residential sector, where mainly bio-energy (mainly firewood) and gas (17% of emissions) are. GHG emissions from electricity generation sector leveled at 1 123.6 Gg CO_2 equivalent in 2014. Mostly use up major part of volatile emissions (93%) is emitted during transportation and distribution of natural gas due to gas losses.

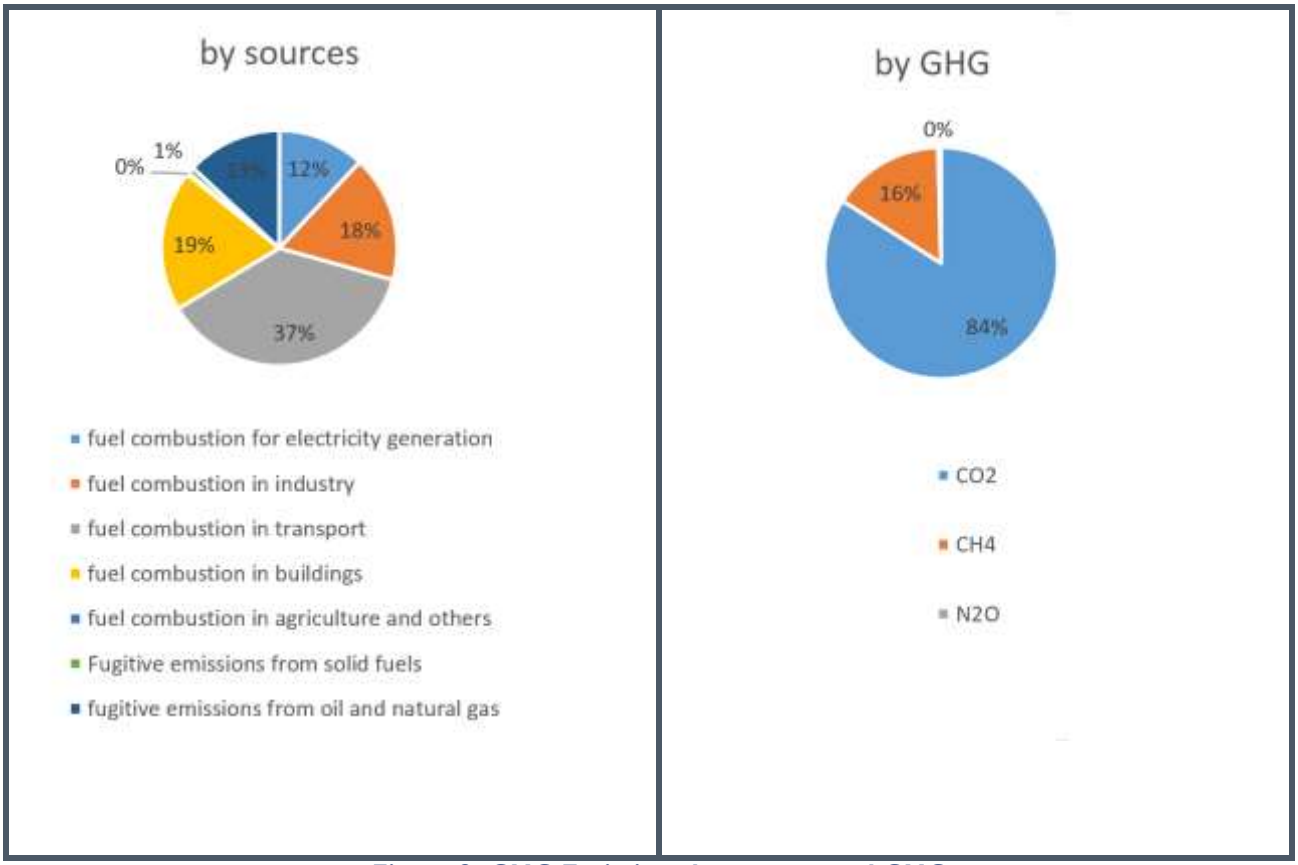

Figure 3. GHG Emissions by sources and GHGs

The energy sector of Georgia and, generally, economic security of the country face some serious challenges which are listed in the Box 1.

Box 1. Barriers to the Development of Energy Sector in Georgia

- The dominating role of imported resources in the energy balance of the country and insufficient consumption of local, including renewable energy resources;
- Lack of modern, resource-saving technologies and the unjustified low level of using the existing energy efficiency potential;
- Less efficient facilities of basic thermal generation that stipulates unjustified high level of the GHG emission, while the country's electric energy sector is basically oriented on the consumption of hydro power resources critically depending on climate conditions;
- Vulnerability of the existing energy infrastructure to natural disasters caused by climatic and geographical features and due to lack of technological reliability of the outdated systems;

- Impossibility of creating strategic thermal resource stock and reserves;
- Risks related to increasing terrorism, especially associated with the strategic facilities disposed in the occupied section of the country's territory;
- Deficit of trained personnel for introducing modern, energy efficient technologies;
- Low rate of energy enterprise activities and service level, insufficient accessibility of socially unprotected part of population and local enterprises to the energy resources of vital importance due to current tariff system and actual monopolization of supply;
- Risks of financial deficiency generated in result of politicizing tariff regulation activities;
- Non-conformity of energy infrastructure, construction and operation technical regulations and norms with the international standards.

2. Energy Sector Low Emission Development Strategic Vision by 2030

Striving for economic growth and sustainable development of the country an important role is imposed on improving efficiency of energy resource consumption, representing one of the most effective means of reducing production expenditures, rising the product's competitiveness, ensuring energy supply safety, and environment protection.

Besides reduction of specific energy resource spending, in terms of reduction of harmful emissions, it is very important to increase renewable energy share in total primary energy use up. Renewable Energy Sources (RES) can provide reduction of dependence on imported fuel, improvement of energy supply security, meeting the global terms of environment protection, and ensuring significant reduction of the GHG emissions, as well as, promotion of employment and creation of additional jobs.

Renewable sources in Georgia (hydro, geothermal, solar and wind energies) have vast technical and economic potential though the low level of their utilization for today is unjustified. This potential cannot be realized without targeted and coordinated planning of utilization of the country's renewable energy resources and will cause failing to achieve the sector development and missing the chance to get positive effect from the GHG emissions reduction.

Hence, the low emission development strategy of the country together with emissions reduction is aimed to reduce final energy consumption and increase renewable energy share in total final expenditure.

In energy sector, the increase of energy efficiency and consequently, emissions reduction strategy considers the following directions:

- Increasing the efficiency of thermal power stations and using these stations as a substitute to the climate-depended hydro generation facilities in conditions when their operation will be limited only for own consumption and for the case of urgency;
- Permanent monitoring of realization of legal norms limiting and network losses, emission of oil accompanying gas and methane emitted from coal by authoritative bodies and encouraging of gradual synchronization of the process to internationally accepted practice;
- Increasing energy efficiency in energy consuming sectors (the respective strategy and measures are discussed in the appropriate sectoral chapters).

In energy sector of Georgia the increase of renewable energy share and consequently, emissions reduction strategy considers the following directions:

- Timely launching the new hydro generation facilities and development of transmission grid (as well as, efficient integration of energy supply system with regional systems both at infrastructural and legal levels; balancing export-import with utilization of locally produced cheap hydro power for inner consumption and in the long run (2026-2030) prioritizing this process via legal regulations; etc.);
- Utmost assimilation of local renewable resources, among them wind, solar, bio and geothermal resources in different energy sectors (in the consuming sectors the programs promoting renewable energy application are discussed in the respective sectorial chapters).

Mentioned measures specify concrete strategic tasks, for performing of which it is necessary to implement the respective time-bound action plans. One of the main hampering factors to realize the GHG reduction strategy in energy sphere of Georgia is an absence of commonly shared national plans for utilization of renewable resources and the legal grounds to support their realization.

The main goals for energy sector development should be the development of laws and regulations, and working out financial mechanisms, action plan and its monitoring system. First of all, the goal of Georgia is to become the member of European Energy Community in the shortest period that will ensure adoption of market mechanisms in the country's energy sector, polishing and synchronizing with EU legal framework of transparent and non-discriminatory environment protection law and attracting investments in order to support modern resource-saving technologies, products and launching new renewable energy facilities. In compliance with the Association Agreement concluded between European Union and Georgia, Georgia has undertaken obligation to implement the directives related to energy efficiency and renewable energies. The terms and concrete performance targets will be scheduled after Georgia joins the European Energy Community.

Box 2 presents energy sector development policy implementation strategy.

Box 2. Energy Sector Low Emission Development Strategy

Short-run (2017-2020):

- Joining to the Energy Community;
- Implementation of the new model of energy market;
- Adoption of Law on Energy Efficiency;
- Developing National energy efficiency Action Plan, ensuring its implementation and monitoring;
- Developing National renewable energy utilization Action Plan, ensuring its implementation and monitoring;
- Arranging energy statistics, among them, monitoring of energy efficiency indicators to develop and carry out efficient energy policy;
- Developing subsidiary strategies (gradual switch to procurement of energy efficient technologies, products and transportation means, considering the obligatory, standard requirements and special tax order for energy efficiency – according to Procurement Law) and enforcing them.

Long-run (2020-2030):

- Perfection of the law to encourage renewable energies;
- Implementation of Energy Efficiency and Renewable Energies utilization Action Plan;

- Perfection of tariff system;
- Realization of electric energy and gas transmission network development plans.

In the respective sectoral chapters energy efficiency and renewable energy consumption increase measures in the consumption sectors are presented, and in the given chapter the measures are offered aiming the reduction of emissions in power generation and energy supply sector. In this respect, the goal of the main strategic directions is increasing the share of power generated from renewable sources in the electricity consumption, improving efficiency of thermal power stations and reducing grid losses. In the Box 3 the main strategic objectives in this direction are presented:

Box 3. Basic Strategic Goals for Power Generation and Energy Supply Sector

- Share of power produced by using hydro resources in final electricity consumption – at least 85%;
- Share of power produced by using other renewable sources in final electricity consumption - at least 2%;
- Network losses of gas – maximum 2%.

In the next chapter specific mitigation measures in electricity generation sector and in the section of energy supply are discussed and according to their estimation, derived from MARKAL-Georgia calculations, by 2030 could be saved 2 539Gg emissions. Of them, 841Gg is saved in power generation sector itself, which represents 39.6% of projected in this sector emission by 2030. The volatile emissions will be reduced by 1699 Gg, 1614 Gg of which is saved as a result IMEA4 measure, and the rest represent the reduction of volatile emissions caused due to reduction of gas consumption during other measures. This amount corresponds to 61.8% of the fugitive emissions projected by 2030. The figure below shows the forecasts of increase of electricity generation sector emissions and volatile emissions. Out of the presented projections on each diagram one represents the base growth according to BAU scenario and the other – in case of implementing measures planned in this chapter under this strategy (only).

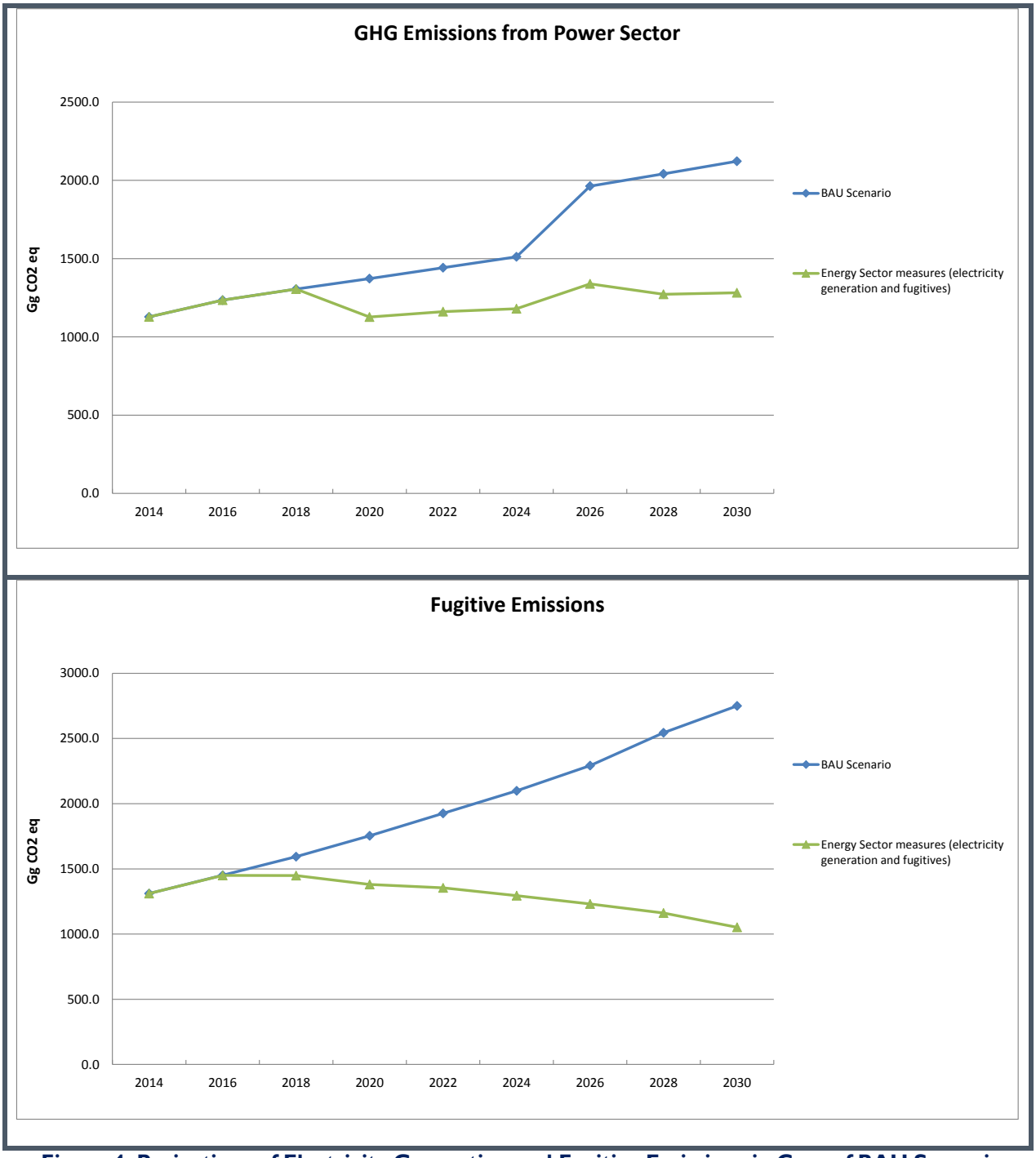

Figure 4. Projections of Electricity Generation and Fugitive Emissions in Case of BAU Scenario and Mitigation Measures Scenario (2014-2030)

The described measures compared with the baseline scenario are causing the reduction of primary energy consumption by 5, 0%, and of gas import – by 12.7%. \

3. Energy Sector Low Emission Development Pathway

In this chapter, low emission development measures in energy generation and power supply sectors are discussed. The activities cover both political and concrete technological measures.

Measure to be Implemented:	EPOL1: Membership of Energy Community and meeting the requirements of the Association
Type of the Measure:	Political
The Implementing Body:	Ministry of Energy of Georgia
Implementation years:	2016-2020
GHG:	CO_2
Reduction of Emissions by 2030:	It has not been calculated as this is the measure of policy covering the entire energy sector and its effect is considered in all the measures described in this and other chapters.
Description of the Measure:	The measure implies joining the Energy Community and considering its demands, among them, developing energy efficiency and renewable energy action plans, liberalization of market, etc., as well as working out the necessary supporting strategies.
Estimated Cost:	The measure requires technical assistance to prepare different plans or legislative amendments (the size of the assistance has not been assessed)
Assumptions and Assessments:	Has not been assessed

Measure to be Implemented:	EPOL2: Perfection of tariff policy
Type of the Measure:	Political
The Implementing Body:	Ministry of Energy of Georgia, GNERC
Implementation years:	2020-2025
GHG:	CO_2
Reduction of Emissions by 2030:	It has not been calculated yet as the measure serves removing barriers and its impact is considered in the corresponding measures
Description of the	While analyzing the barriers to the implementation of energy efficiency

Measure:	measures in Georgia (basically in buildings sector) it was identified that low tariffs on energy carriers represent one of the serious barriers, due to which the payback period of the measure is significantly increased and investment in energy efficient measures becomes less reasonable. Hence, it is very important both gas and electricity tariff policy to be perfected so that tariff should become facilitating factor to the implementation of energy efficiency measure (and not the hampering one) and to promote the optimal distribution of the capacity curve. For this purpose there may be considered seasonal, daily, quantitative, or some other types of features for tariffs.
Estimated Cost:	The measure requires technical assistance to develop reasonable tariff policy (the size of the assistance has not been assessed)
Assumptions and Assessments:	Has not been assessed

Measure to be Implemented:	EMEA1: Increase of hydro power share in energy consumption through the development of transmission grid in Georgia and improved control system.
Type of the Measure:	Technological
The Implementing Body:	Ministry of Energy of Georgia
Implementation years:	2016-2026
GHG:	CO_2
Reduction of Emissions by 2030:	389Gg
Description of the Measure:	Goal of the measure is to increase the hydro power share in energy consumption that should take place in parallels with reasonable assimilation of sustainable hydro power projects in Georgia. The hydro power share increase may occur after implementation of the following measures: • Developing and enhancing Georgia's transmission grid– priority growth of East-West directions transfer capacity; • Ensuring integration of Hydro Power Plants into regional grid and optimization of control system; • Ensuring synchronous development of transmission lines and generation/supply facilities potential.

	Share of hydro power stations in total consumption in Georgia is limited due to limited capacity of transmission lines in the direction from Western Georgia to the East. The transmission network in Georgia is disposed mostly in latitudinal direction from Western part of the country towards the Eastern part. To this, the majority of generation utilities are located in western part of the country (in the west the installed capacity of HPPs makes 2080MW), while the big part of consumption comes on East Georgia where 63.8%[7]of Georgia's population is concentrated. In Ten-Year grid Development Plan of Georgia increase the grid transmission from west to east is planned that will be positively reflected on hydro power resource balance in total consumption. The Ten-Year grid Development Plan of Georgia is the time-bound program of enhancing the country's transmission infrastructure, which considers preparation of energy system in long-run perspective to the growth of generation and loading in view of transmission grid enhancing-modernization-expanding. Together with other goals, this plan will provide sufficient carrying capacity for integration of renewable energy sources into the network. The plan also covers complete technical rearrangement of the existing generation facilities and timely building of Hydro Power Plants with water reservoirs (like the Khudon, Nenskra, Namakhvani, Tskhenistskali, Mtkvari Cascade), in order to use the water energy stock, collected during summer water abundance, during winter low-water period. It also covers increasing energy exchange potential with neighboring countries and improving electricity control system that will also make its contribution in increasing hydro power share in total consumption.
Estimated Cost:	In total, the average investment cost of the projects scheduled up to 2021 under Ten-Year grid Development Plan of Georgia reaches 814 billion EUR.
Assumptions and Assessments:	According to the projected balance under Ten-Year grid Development Plan of Georgia, the share of generation from thermal power plants in 2025-2026 varies between 14%-17% in total consumption. Within the frames of low emission development strategy an assumption was made that by 2030 thermal power stations will provide no more than 15% of the country's inner consumption.

Measure to be Implemented:	EMEA2: Substitution of the outdated thermal blocks with maneuverable and efficient combined (steam-gas turbine) thermal power stations

[7] According to the average number of population in 2015
http://geostat.ge/cms/site_images/_files/georgian/population/03%20saSualo%20wliuri%20mosaxleobis%20ricxovnoba%20TviTmmarTveli%20erTeulebis%20mixedviT.xls

Type of the Measure:	Technological
The Implementing Body:	Ministry of Energy of Georgia
Implementation years:	2020-2026
GHG:	CO_2
Reduction of Emissions by 2030:	364Gg
Description of the Measure:	The measure implies construction of two 250MW maneuverable power stations, which will be equipped with modern technologies and will be put into operation in 2020 and 2026 and will replace MTKVARI and TBILSRES Thermal Power Plants.
Estimated Cost:	The total investment cost of both thermal power stations is about 467 million USD.
Assumptions and Assessments:	The net efficiency of the new thermal power plants is 52%.

Measure to be Implemented:	EMEA3: Putting into operation the new renewable energy power plants
Type of the Measure:	Technological
The Implementing Body:	Ministry of Energy of Georgia
Implementation years:	2025
GHG:	CO_2
Reduction of Emissions by 2030:	144Gg
Description of the Measure:	The measure implies the construction of 150MW wind powered station in Eastern Georgia by 2026. The preference is given to the construction of wind power plant on the territory of East Georgia as there is more demand on electricity in East Georgia and hydro potential is less than in West Georgia. For maximum assimilation of wind energy it is also important: • To ensure grid potential to receive wind-generated energy and

	perform highly-efficient control, that will guarantee substitution of generation and import of plants thermal power; • To set up local/joint enterprises which will provide service to wind power plant and ensure its technical parameters at maximum level; • To create a legal base which will regulate pricing together with other issues, etc.
Estimated Cost:	Approximately 175 million USD
Assumptions and Assessments:	For the assessment of emissions reduction, an assumption was made that the electric energy generated by wind power station will substitute the energy generated by thermal power plant. To specify the seasonal generation of wind power plant the averaged data on the potential wind power stations disposed in Eastern Georgia (in Skra, Samgori, Yaghluja, Vaziani, Mukhrani, and Paravani areas) was used. According to these data, the average capacity factor of wind power station during the period of December-March makes 29%, in the period of April-July – 32%, August-September – 23%, and October-November – 26%[8]. Annual capacity factor is approximately 28%.

Measure to be Implemented:	EMEA4: Reduction of gas losses in distribution networks
Type of the Measure:	Technological
The Implementing Body:	Ministry of Energy of Georgia, SEMEK, Distribution Companies
Implementation years:	2016-2030
GHG:	CH_4
Reduction of Emissions by 2030:	1614 Gg CO_2 eq.
Description of the Measure:	In recent years, the actual losses in distribution networks are significantly reduced, however they are still inadmissibly high and exceed the standard values. The mentioned measure implies reduction of leaking from the distribution pipelines that includes rehabilitation and development of networks and equipping them with modern regulating, control and measuring devices.

[8]The months are divided in compliance with seasonal division by MARKAL-Georgia based on hydrological regime of rivers in Georgia.

Estimated Cost:	Approximately 5 million EUR (€5,535,000[9])
Assumptions and Assessments:	In Georgia at present technical losses in distribution companies vary between 4%-11%, and the total gas losses in distribution network make 6.4% of the energy supplied in Georgia (according to the Energy Balance of 2014). The Energy and Water Supply Regulatory Commission of Georgia analyzed available technical literature about distribution network losses and the existing state-of-the-art in other countries. It is noteworthy that technological losses in the USA vary between 0% and 1%. The obtained information about the gas distribution technological losses in percentage to the amount of consumed gas is as follows: Estonia – 1.1%, Romania – 1-2%, Azerbaijan – 2-3%, Armenia – 3-4%, Lithuania – 0.5-0.7%; Latvia – 2.3%, Poland – 2% of the consumed gas supplied through plastic and steel pipes, and 3% - through iron pipes. Considering the above-mentioned, for Georgia by 2030 it was planned to reduce the share of distribution losses down to 2% in the amount of gas received by the country.

Measure to be Implemented:	EPOL1: Ensuring/promoting geothermal resource consumption
Type of the Measure:	Information / Legislative
The Implementing Body:	Ministry of Environment and Natural Resources Protection of Georgia, Ministry of Energy of Georgia
Implementation years:	2016-2030
GHG:	CO_2
Reduction of Emissions by 2030:	Has not been calculated
Description of the Measure:	For registration of the geothermal power consumption and sustainable utilization of this energy it is significant to develop a long-run policy to ensure the geothermal resource maintenance and energy efficient consumption for that requires: • To assess the present state of geothermal resources throughout the whole territory of Georgia to reveal new deposits and specify the stocks of old deposits;

[9]Energy Efficiency Action Plan for Georgia – working version.

	• To define the efficient operation modes of deposits; • To carry out the state supervisory control on the deposits operation, to ensure their environmentally and economically justified operation run; Besides, the government should support energy efficient consumption of local resources through the following way: • Considering long-term preferential credits and promotions for those entrepreneurs who will introduce modern technologies, or carry out drilling new wells; • For the entrepreneurs working in this sphere to develop modern technological portfolios for operating thermal deposits, and to provide them with trainings; • In cooperation with the license holders, to define the most efficient modes of deposit utilization causing minimum harm to the environment. Together with the license holders to assess the prospects of maximum assimilation of the available thermal energy and to identify the role of the government in this process.
Estimated Cost:	Technical Assistance (has not been assessed)
Assumptions and Assessments:	Emissions reduction for this measure has not been calculated as for the assessment of emissions reduction it is significant to define concrete sector in which the geothermal energy will be utilized, what fuel and in what quantities it will substitute that needs the conduction of additional studies.