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

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Energy Sector Overview

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Enhancing Capacity for low Emission Development Strategies (EC-LEDS)/ Clean Energy Program

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May, 2016

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Presented report was developed as one of the components of the technical assistance provided by the "Enhancing Capacity for Low Emission Development Strategies (EC-LEDS)/Clean Energy Program" to the Government of Georgia in the process of preparation of the Low Emission Development Strategy. The main objective of the report is to analyze the energy consumption and emissions from the energy sector and identify the barriers for implementation of energy efficient and renewable energy measures in Georgia. The barriers and conclusions identified in the report will be the basis for elaboration of the Low Emissions Development Strategy and measures planned in the Strategy in this sector.

The report is prepared by the expert of the project, Professor Teimuraz GochitaShvili.

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1. Sectoral Overview

The energy sector of Georgia consists of practically all traditional sub-sectors of electricity generation and fuel industry such as thermal and hydropower plants, electricity and fuel networks, transport and distribution gas pipelines, transit oil pipelines, oil and natural gas extraction plants, coal mines etc. The work is in progress to enhance the existing methods and options for utilization and application of renewable energy potential including geothermal waters, bio, wind and solar resources.

Georgian national energy sector is represented by the Ministry of Energy that is responsible for energy policy elaboration and implementation, independent regulatory agencies, companies responsible for electricity and heat production, transmission and distribution and different categories of consumers.

The Ministry of Energy elaborates and implements the energy policy, defines the rules for business relations and collaboration between different parties. The Ministry is also responsible to facilitate the escalation of investment flows into the sector, also plan its rehabilitation and development, participate in the development of legal and regulatory frameworks, support elaboration of transit and import/export relations and infrastructure, and the state programs supporting energy efficiency and environment protection.

The Georgian National Energy and Water Supply Regulatory Commission (GNEWRC) independently regulates the relations between consumers and energy companies mainly based on the Georgian Law on "Electricity and Natural Gas" and the legal acts of the Commission itself. GNEWRC issues and regulates the licenses in electricity and natural gas sectors (except for exploration and extraction activities). It is also responsible to monitor and supervise the activities of licensees. GNEWRC defines and regulates electricity tariffs for generation, transmission, dispatch, import, export and consumption. The natural gas sector of Georgia is divided into regulated and deregulated segments. The tariffs for the supply of natural gas to a regulated part of residential consumers and thermal energy plants are determined by GNEWRC. For other consumers the gas tariff is regulated and gas supplied according to the price and conditions officially offered by a given supplier. For a regulated part of residential consumers the marginal tariffs for supply and consumption by distribution network are defined as well.

GNEWRC also regulates network activities within the sector and issues the licenses for network (transportation and distribution) companies, as they are obvious monopolists.

On the wholesale market of electricity generation the following actors are presented and functioning: generators, importers, and exporters of electricity, licensees of distribution (on supply side), direct customers, also service providers – transmission system operator, market operator, licensee of network transmissions services. The main actors of the retail market are: distribution licensees (on network services and supply side), small capacity power electricity plants, end-user consumers (among them so called, "qualified consumers" who have the right to select wholesale suppliers based on competitive prices).

Any entity that is registered as a qualified enterprise (licensing is not required) has the right to import and/or export the electricity. The price of export is open and not pre-defined, while in case of import GNEWRC defines the formula for price calculation.

By 2016 the energy generation of Georgia consists of 4 thermal power plants (one thermal power plant with installed capacity of 230 MW and supplied by combined cycled gas) and up to 50 hydro power plants.

Total installed capacity of the generation plants is 3 750 MW. The electricity generated by electricity power plants can be bought by a market operator, distribution companies and direct consumers based on supply agreement. The tariff for electricity generation (capacity) by thermal power plants is defined based on GNEWRC resolution.

The market operator trades balancing electricity and guaranteed capacity based on tariffs defined by the GNEWRC. The operator is responsible to ensure the stability of the network and to balance the market. Market operator buys and sells the electricity by means of long-term import/export agreements. It also acts as a reserve amount trader. GNEWRC defines the tariff for balancing electricity, which is used in the transactions by a market operator. In case of purchasing of electricity from generation plants, the tariff of operator's service depends on the status of a supplier and balancing electricity.

The electricity transmission grid of the country works on 500, 3030, 2020, 110 and 35 Kilovolt (kV) voltage. The total length of electricity transmission lines is 3 264.95 km. The total installed capacity of 92 substations is 10 212.6 Mega-volt–ampere (MVA). Transmission network operator (dispatch licensee) provides exclusive dispatch service of electricity transmission to eligible companies. Its work is guided by license conditions and fixed tariffs. The transmission licensees: JSC "Georgian State Electrosystem" (GSE), JSC "United Energy System" (SAKRUSENERGO) and Ltd "Energotrans" provide electricity transmissions with fixed tariffs according to voltage levels of the grid defined by GNEWRC.

Distribution companies and retail suppliers sell the electricity bought from an operator and/or generation companies to retail consumers. In the group of electricity distribution licensees the supply market is monopolistic since licensees themselves are exclusive providers. This is an important structural fault of the retail market of electricity and requires separation of supply from distribution.

Wholesale market relations in natural gas sector are regulated by rules of natural gas market. Those rules are developed and approved by the Ministry of Energy of Georgia. However, the monitoring of the market is conducted by GNEWRC. In addition to that, usually wholesale suppliers do retail supply as well.

Exploration and extraction of oil and gas are regulated by the National Oil and Gas Agency (NOGA) that issues the licenses. The territory of Georgia is divided into different license areas where the investor companies selected through international tender processes conduct exploitation as well as extraction. These companies have agreements with the Government (NOGA) on sharing of production. The Georgian Oil and Gas Corporation which is a national oil company (NOC) works in partnership with investor companies to plan activities, it also monitors and controls the processes on behalf of the State.

Oil and oil product market is fully regulated. Several local and international companies are actively presented on the market and coordinate import and retail network of oil products.

The coal industry in the country is represented by the Tkibuli-Shaori coal mine that is exploited by Ltd "SAKNAKHSHIRI" ("GIG"group). The share of locally mined coal in the energy balance of the country is quite low and has been changing in between of 3-5% percent.

If renewable energy resources and energy efficiency potential is effectively utilized the country will be able to decrease the dependency on imported gas and oil products, improve energy security, meet international environmental commitments, decrease greenhouse gas emissions and support job creation and employment. The renewable energy resources (biomass, hydro, geothermic, solar and wind energy) have technical and economic potential which is not currently adequately utilized. As for the share of renewables in total energy

balance of the country it looks as follows: 17% hydro resources, 10% firewood and less than 1% other renewables. The utilization of energy efficiency potential is not adequate in the country either – the reduction of this inadequacy will support energy saving and increase of competitiveness of local products. Respectively, by means of introduction of energy efficient appliances and heating systems as well as obligatory construction rules and regulations in residential and commercial sectors, a considerable share of natural gas consumption (approximately 40%) can be achieved.

The energy potential of wind is practically not utilized at all in the country. Preliminary studies show that if wind energy potential is exploited it is possible to arrange high-capacity and economically reasonable wind energy plants in the areas with high potential (Rioni and Mtkvari basins, mountain Sabueti, Pharavani Lake). Since wind energy potential is the highest in winter season, its utilization gives the possibility to substitute the deficiency of energy generated by the hydro in winter season when the demand on electricity reaches its maximum level. This way the country can economize on expensive fuel resources during the most critical period of the year.

250 natural and artificial geothermal water reservoirs (from wells) are recorded on the territory of Georgia. According to the studies, the heating value received from this geothermal source is lower than the value of the heat received from imported natural gas combustion. For today, the utilization of geothermal energy is inefficient while the water wasted in an uncontrolled way from non-licensed reservoirs contaminates the environment. It is crucial to regulate the utilization of geothermal water resources, define effective modes of operation with a minimal environmental impact and improve license conditions.

Almost at an entire territory of Georgia, annual solar light and level of radiation flactuates in between of 1800 and 2600 hours and 1250 and 800 kW.h/m^2 respectively . The utilization of solar energy is particularly cost-effective for generation of low temperature heat (<100 ^{0}C) by means of collective concentrators to be used for hot water supply in residential, industrial and recreational zones, also for thermal processing systems for agricultural products. As the result, a considerable amount of imported fuel will be saved and emissions decreased.

Biomass, more precisley the firewood is widely used in agricultural regions of the country in addition to heating and household purposes. Low calorie biogas received as the result of processing of waste biomass can be used to partially meet the heating needs of agricultural regions of the country.

By means of application of modern energy efficient technologies for biomass processing and firewood and utizliation of other non-traditional energy resources, in several years it will become possible to save appoximately 50-75 mln tons of oil equivalent (toe) of imported fuel and address ecological issues imposed by uncontrolled cutting of forest.

2. Energy Consumption and Green House Gas Emissions

In 2014 Georgia was supplied by approximately 4 478 and 4 346 tons of oil equivalent (toe) for an entire territory and territory with exception of Abkhazia respectively. This means 1.17 toe per capita[1] on the territory controlled by the Georgian Central Government.

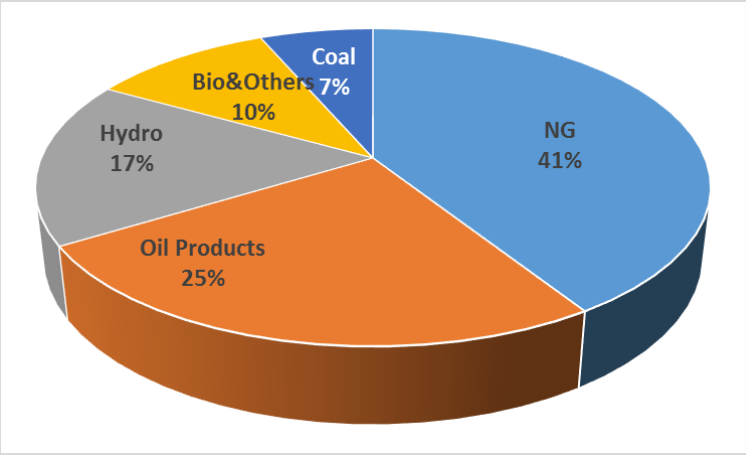

Fig. 1. Total primary energy supply, 2014

Share of the fossil fuel resources in the energy balance of Georgia is 70%. This figure is less than the global indicator (81%) due to 17% share of renewable, more precisely hydro energy resources in the energy balance of the country while an average share of renewables on the global level is only 2%. Bio energy resources (firewood) and Georgian coal are important local resources with 10% and 3% share respectively (worldwide 10% and 29% respectively). However, their total share was declined by 2% due to the increase of the share of oil products, and also increase of the share of gas up to 66% (52% worldwide).

Georgian energy sector that is oriented towards the consumption of imported fossil fuel resources (≈70%) is the source of harmful emissions and creates significant threats to the energy security of the country. In addition to that, a prudent utilization of a rich hydro potential of Georgia which implies construction of major regulating hydro power plants and efficient combined cycle gas plants, which will reduce emissions and increase energy security.

The comparative analysis shows the growth trend in consumption of primary energy in Georgia. In 2014 the total energy supply to consumers increased by 7.5% in comparison to the previous year. However, the per capita calculated value still lags behind a global average indicator which is 1.9 toe, regional indicators as well as indicators of the countries with similar climate conditions (Azerbaijan, Turkey, Romania, Bulgaria, Greece) and the countries with developed economy.[2]

[1] According to the population census conducted in 2014, the population of Georgia with exception of the population of Abkhazia is 3 713 804 inhabitants.

[2] World energy outlook, 2015, IEA and BP Statistical review of world energy, 2015

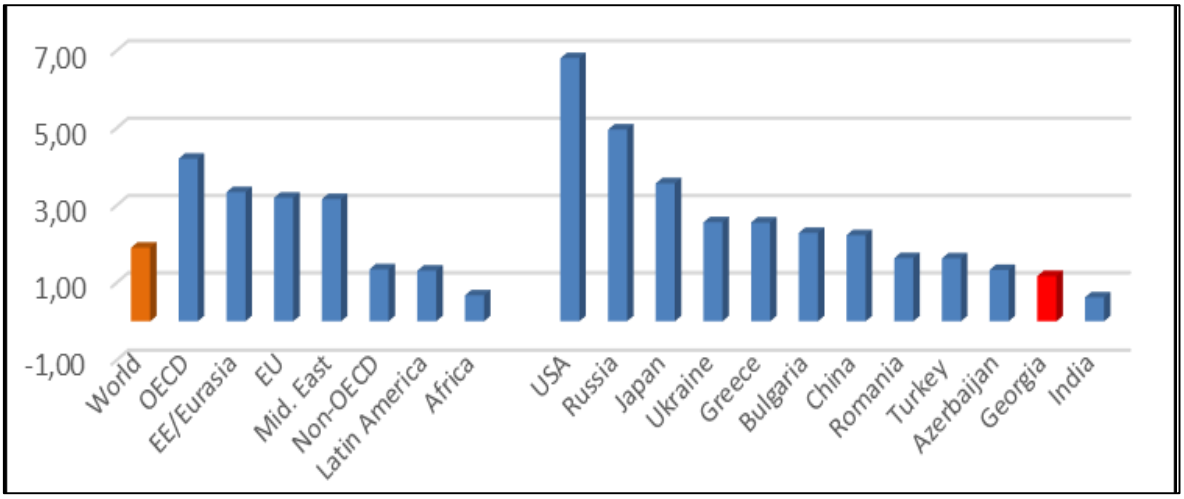

Fig. 2. Supply of primary energy resources in different regions and countries, toe/per capita (2013 and 2014)

Energy generation and consumption have been considerably increased in recent years (average annual increase has been by 3-6 %). In 2014, 10 371.2 mln kWh (733.5 toe) and 10 619.6 mln kWh (754.9 toe) of electricity was generated and supplied respectively. The consumption of the fuel is minimized in electricity generation sector of the country due to prioritized locally produced renewables, more precisely abundant hydro energy resources that are used for energy generation. The share of hydro resources is increased by 80% in comparison to the increase by 55-60% in 1990s. The shows the structure of electricity by different sectors.

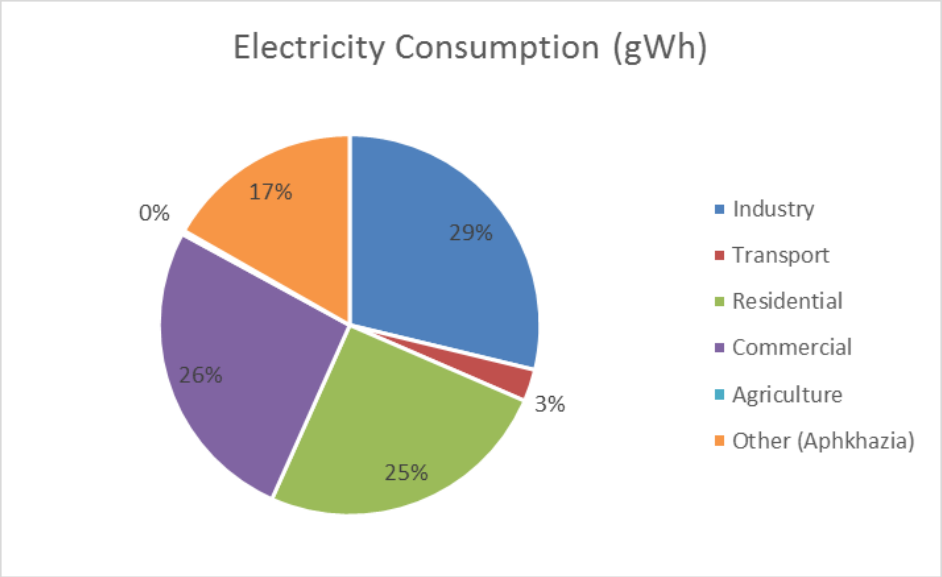

Fig. 3. The structure of electricity consumption

To meet the demand on energy from industry, commercial and residential sectors, mainly the natural gas, oil products and local bio resources (mainly firewood) are utilized. The supply trend of the natural gas has been growing since the economic revival of the last decade with the exception of the crisis of 2008-2010. 2.176 billion m^2 (approximately 1 833 toe) of natural gas was supplied in 2014. Total annual consumption of

oil products (including oil, liquefied petrolium gas (LPG), bitumen and paraffin waxes) was approximately 1.133 milliom tonnes in 2014.

In the formation of the energy balance of Georgia the local bio resources, mainly the firewood play an important role. According to experts assessments, an actual capacity of firewood together with other types of unregistered fuel resources (waste from wood processing and agricultural production, cow dung,peat and other) reach approximately 465 (in 2014)-500 thousand toe annually.

In 2014, the coal consumption in Georgia exceeded 550 thousand tonnes (290 thousand toe). In parallel to that, imported coal is considerably substituted by local production. It is expected to have an increase of coal mining up to 400 thousand tonnes per year in the coming 5 years.[3]

The highest consumption of energy resources by different sub-sectors is detected in transport and residential sub-sectors – 33 and 29.6% of total energy consumption respectively.

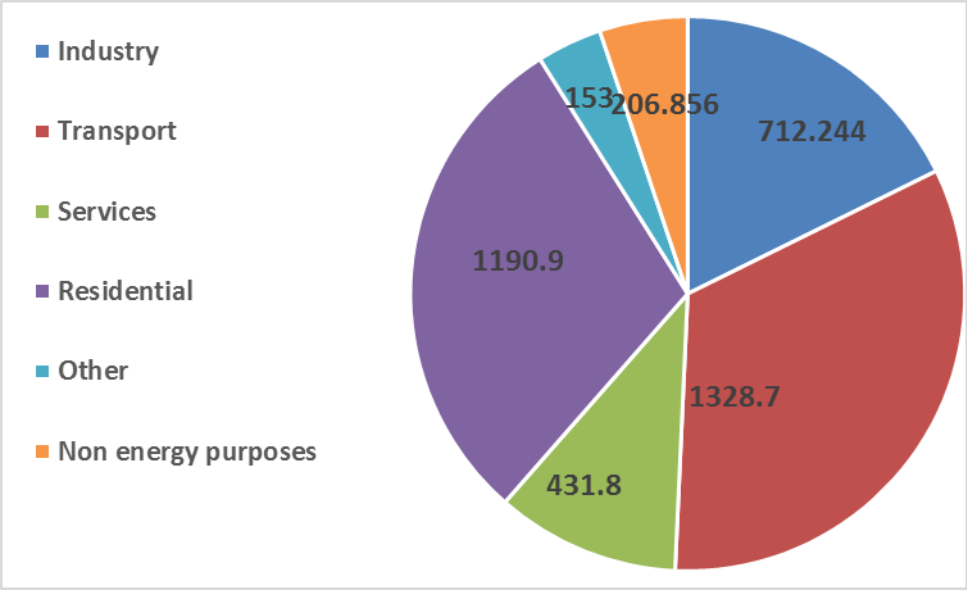

Fig. 4. Consumption of energy resources by sectors, 2014 (1000 toe) [4]

In 2014, GHG emissions from energy sector of the country was equal to 9 410 Gg of CO_2 eq. Out of this total figure, 8 098 Gg of CO_2eq (86.1%) were from fuel combustion while the rest can be characterized as fugitive emissions.

In terms of fuel combustion, in 2014 the highest amount of emissions came from transport sector (43%) that consumes mainly liquid oil products and gas. Industry sector is also a large consumer of energy resources and considerable source of emissions (2 % of direct emissions from fuel combustion). The main sources of emissions from this sub-sector are coal and coke. Residential sub-sector is also a significant emitter that consumes mainly biofuel (mainly firewood) and gas (17% of emissions). The biggest portion of fugitive emissions (93%) comes from the transportation of natural gas and gas leakage during the distribution.

[3] Source: The management of coalmining shafts of Tkibuli-Shaori coalfields

[4] The energy consumption values for industry and non-energy consumption from 2014 energy balance have been revised based on information on non-energy consumption in fertilizer industry obtained from Rustavi Azoti plant.

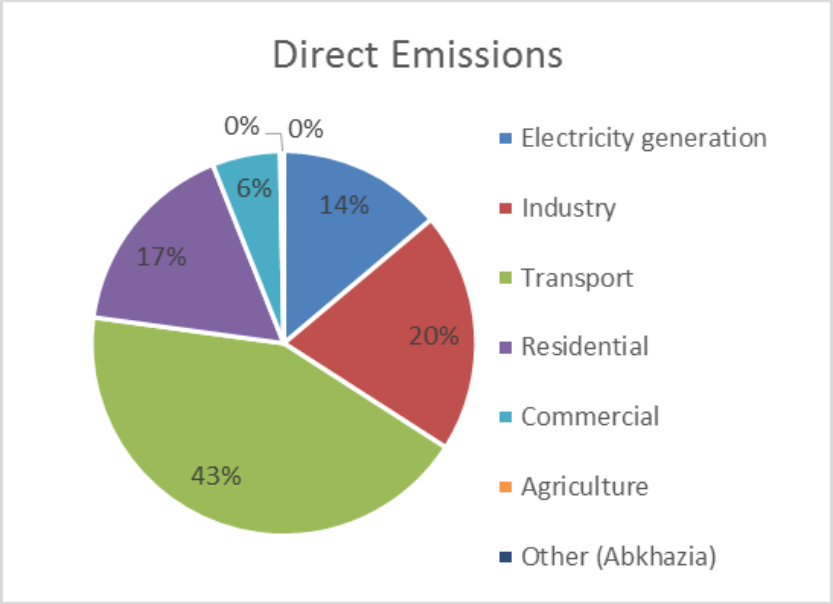

Fig. 5. GHG emissions by different sub-sectors, 2014

3. Trends of energy consumption and GHG emissions in energy sector

As it is known dynamics of consumed energy resources in the country is often correlated with the increase of production that is often being used for forecasting approximate index of energy consumption based on analysis of actual tendency during the past period but mostly, this kind of tendency is reliable for developed countries with stable economy. In case of Georgia that belongs to countries with transitional economy and where the rate of development is not stable, this approach and forecast could be made only for short period.

For example, **Error! Reference source not found.** shows connection between GDP of the country and gas consumption for the last 10 years. Analysis show that the correlative connection between the two is low – 0.41. This is linked with the economic crisis in 2008-2010 as well as an inert way of overcoming the energy crisis and this connection is not suitable for data forecasting.

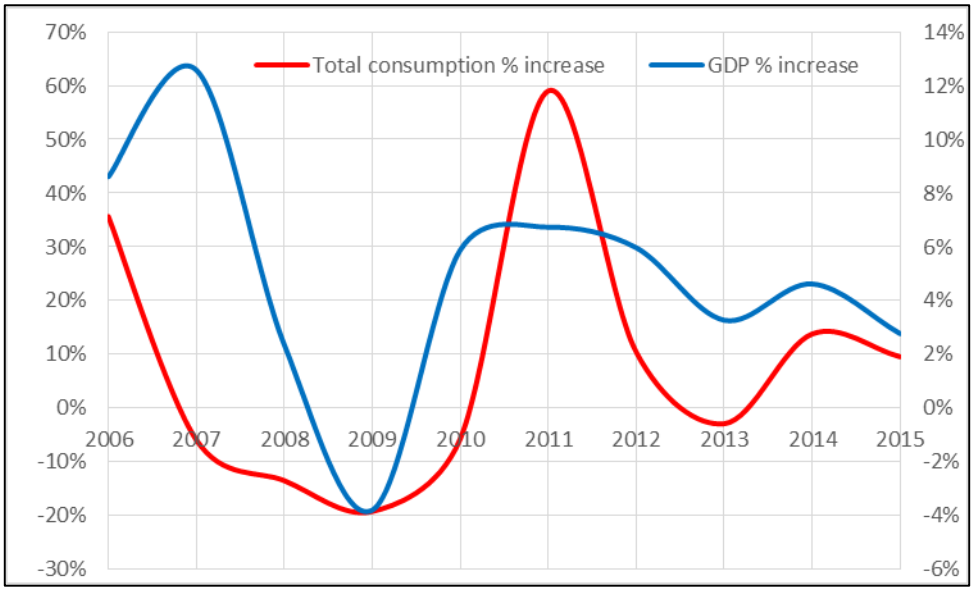

Fig. 6. Correlative connection between gas consumption and GDP, 2006-2015

Tendency is approximately the same in case of change (in percentages) of electricity consumption and GDP (see Fig. 7**Error! Reference source not found.**).

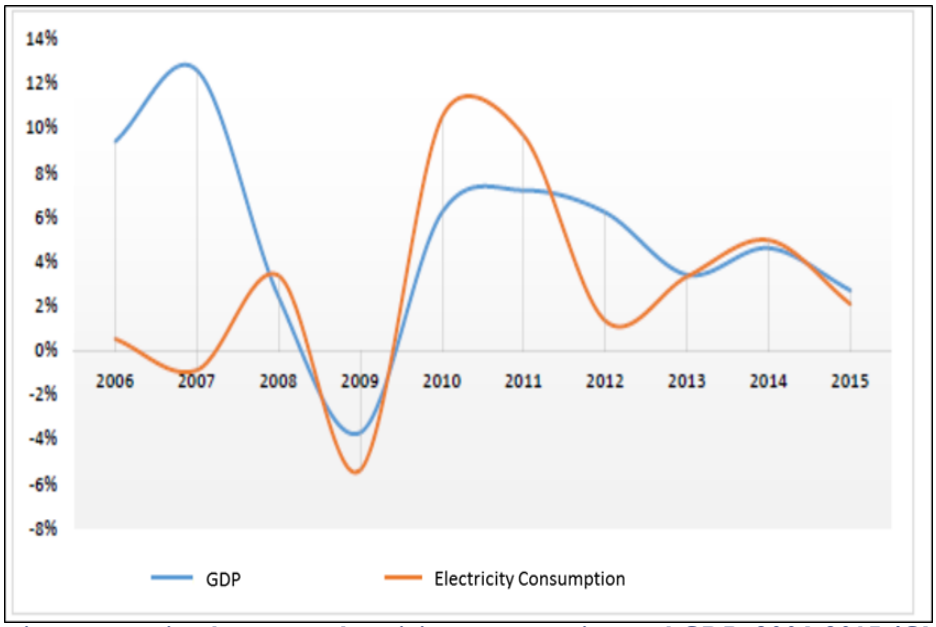

Fig. 7. Correlative connection between electricity consumption and GDP, 2006-2015 (GNEWRC data)

Correlative connection for post-crisis period (2011-2015) between the growth of consumption of energy resources and GDP is quite high (0.74) and seems reliable for forecasting (see Fig. 8). Correlative connection between the entire actual consumption (million m^3 or toe) and baseline indicators of GDP growth (million GEL according to prices in 2010) is very high (more than 0.9).

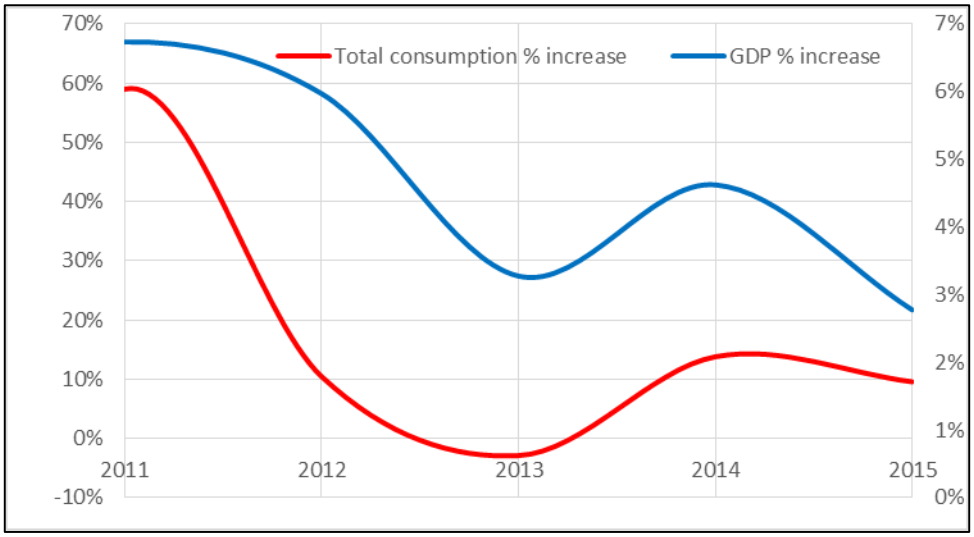

Fig. 8. Correlative connection between changes of energy consumption and GDP during the period of stable development of economics (2011-2015)

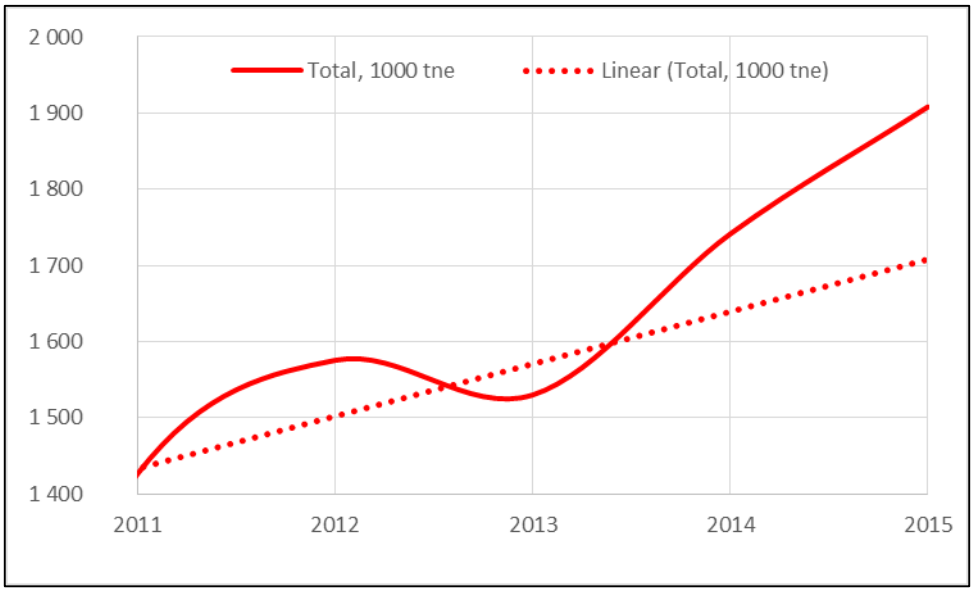

Fig. 9. Energy consumption trend, 2011-2015

The trend of change of total production with stable annual growth of consumption by 8% was one of the most important factors of the dynamics of energy resources consumption during the last 5 years, when economy of the country has been developing more stably (See Fig. 8 on the example of gas consumption).

Index of GHG emissions after the period of crisis has inconstant tendency, too (has been changing from 7 500 to 10 000 gg CO_2 eq. with average annual 6% growth during 2011-2014).

According to the analysis, trends of energy consumption and emissions change (%) do not coincide with each other. Firstly, this is caused by the change of structure of consumed primary resources, especially in electricity generation sector. **Error! Reference source not found.** shows GHG emissions trend from this sector the change of which is caused by important changeability of hydro resources utilization in different climate conditions and during different consideration period).

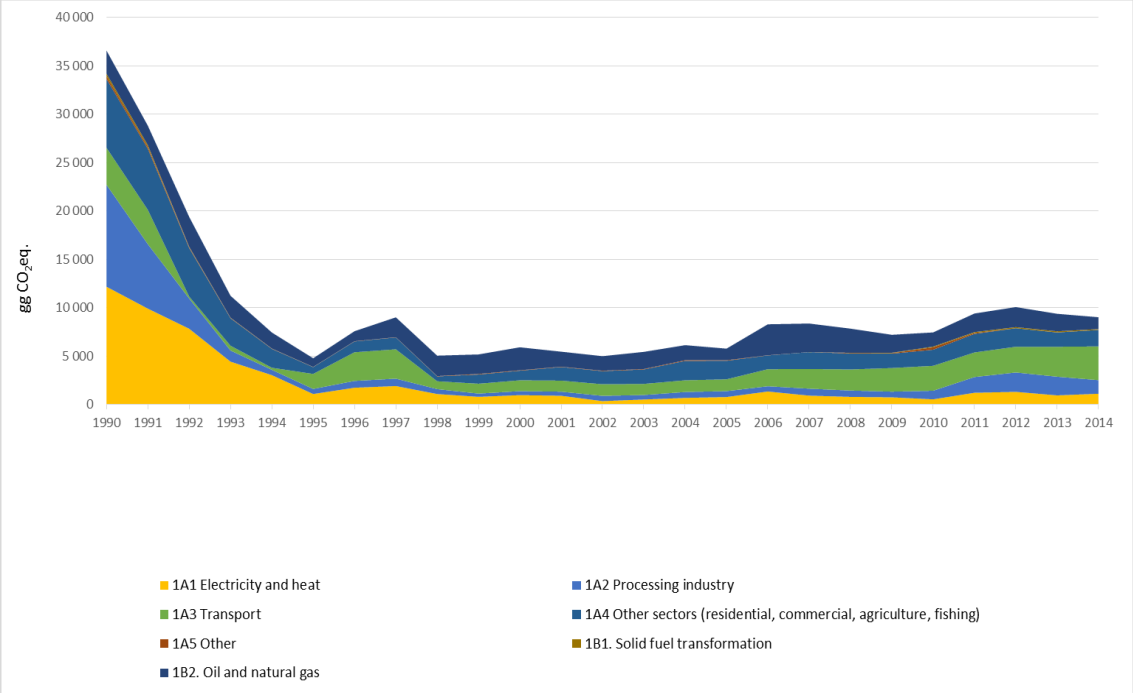

Fig. 10. GHG emissions trend in Georgia

Besides, on the one hand, increase of production and gasification of regions of the country will lead to increase of emissions and demand on energy. On the other hand, implementation of new, energy effective means and technological production lines, reduction of losses during energy transportation and distribution together with replacing solid fuel with natural gas for heat production will lead to reduction of specific emissions. So, unlike production sector, correlation of energy consumption in residential sector and GHG emissions from it with total production in the country would not be correct because of weak connections (correlation coefficient between GDP growth and fuel demand in electro generation and residential sectors is approximately 0.4). Consumption forecast for these sectors must be connected with the existing development plans significantly that basically means:

a) For the population – dominated tendency in state plan of country's gasification and international practice of gas consumption growth for improving basic living conditions (growth of heated areas, comfort).
b) For electricity generation – HPP construction plans prepared by the government of Georgia and demand on working of natural gas stations for baseline electricity.

Analysis of supply-demand forecast indicators shows that without finding additional source of natural gas, difficult situation might be created in terms of meeting total demand of the country. More precisely, for satisfying total forecast demand of the country from 2016 to 2030, additional source will be needed that can provide approximately 700 – 1 300 million m^3 (presumably by market prices), besides the gas guaranteed by the contracts. Nowadays, responsible for this kind of gas without long-term contracts and regulation-free prices is national company of Azerbaijan – Socar (or its subsidiaries), that leads to its domination on the market and high risks of monopolistic actions.

Main source of methane emissions in energy sector of Georgia is gas losses during gas transportation and distribution.

Table 1 describes dynamics of changeability of natural gas losses during 2006-2014 for transmission and the biggest distribution grids.

Table 1. Network losses of natural gas (%)

Year	Transportation	Distribution	
	GGTC	SOCAR	Kaztransgaz
2006	2.04	~30-40 (Itera)	~30-40 (Itera)
2007	1.99	~30-40 (Itera)	~30-40 (Itera)
2008	1.98	29.3	~17-25
2009	1.96	27.5	~17-22
2010	0.3	20	~16-20
2011	0.2	11.4	~16
2012	0.2	7.8	14.9
2013	0.3	5.5	13.7
2014	0.77	3.9	10.3

As a result of rehabilitation and reconstruction of transmission pipeline system and implementation of modern systems for controlling registry and unity of a system, actual gas losses are reduced significantly and are much less than normative and targeted parameter (2%) for 2030 calculated by GNEWRC. Actual losses for distribution grids are significantly reduced but they are still impermissibly high and exceed normal sizes. Disorder of the registry is the main reason for this, besides technical malfunctions of the grid according to expert estimation. Minimization of so called "commercial" losses together with grid rehabilitation-development and equipment with modern regulating, controlling and measuring tools play major role in reduction of total size of actual losses.

It must be said that losses of transporting system in 2014 was more by 0.5% than average index of the previous years that may be provoked by origination of mudflow stream and damaging (ruining) transmission pipelines that led to emergency emissions in the Devdoraki gorge in 2014.

Besides technical losses in grids, emissions are caused by natural disasters, too. During 25 years of independence, emissions of 27.9 million m^3 of natural gas (methane) has been recorded due to infrastructural accidents that is 1.12 million m^3 per year and equals to emission of 420 gg methane CO_2 eq.

Table 2 presents the list of important accidents on transmission pipelines in Georgia that includes Devdoraki disaster (2014) that led to significant additional emissions.

Table 2. Important accidents on transmission pipelines of Georgia

Accident place	Accident type	Accident result
Meneso, 224.5 km – N-S transmission pipeline, 1 200 mm	Rive caused by landslide	Emission of 5.8 million^3 natural gas, termination of supply and transit.
Meneso, 132.0 km – N-S transmission pipeline, 700 mm	Rive caused by landslide	Emission of 4.5 million^3 natural gas, termination of supply and transit.
Lemshveniera, 61 km – Kazakhi-Saguramo, 1000 mm	Fire caused by outflow	Emission of 2.8 million^3 natural gas, termination of supply and transit.
Mtskheta, 122.0 km – N-S transmission pipeline, 1 000 mm	Rive caused by landslide	Emission of 4.7 million^3 natural gas, termination of supply and transit.
Goristsikhe, 78 km - Vladikavkaz-Tbilisi, 700 mm	Rive caused by landslide	Emission of 3.5 million^3 natural gas, termination of supply

Kesalo, 55 km – Kazakhi-Saguramo, 1000 mm	Pipeline corrosion	Emission of 3.6 million^3 natural gas, termination of supply and transit.
Naniani, 233 – N-S transmission pipeline, 1 200 mm	Rive caused by landslide	Emission of 2.4 million^3 natural gas, termination of transit.
Devdoraki, 143.1 km – N-S transmission pipeline, 1 200 mm; Vladikavkaz-Tbilisi, 700 mm	Rive caused by mudflow	Emission of 0.5 million^3 natural gas, termination of transit for 5 days.

Grid losses of electricity during the calculation period has got decreasing trend that was caused by improvement of the distribution grid and registry system. According to GNEWRC, actual losses of the system were reduced by 32% from 2009 to 2014 and were 7.3% of total supply (Fig. 6**Error! Reference source not found.**). Installation of individual counters is still a problem that plays a big role in total losses of electricity.

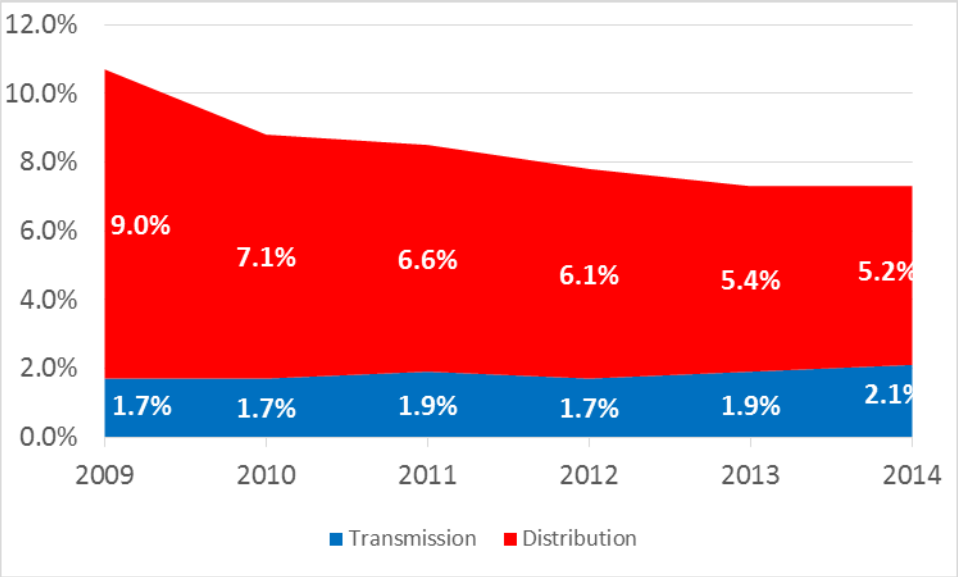

Fig. 11. Total losses of electric power system

During distribution, total losses of provided gas in the country reached 86 000 toe (103.8 million m^3) and grid losses of electric power – 60 000 toe, according to GNEWRC that is about 7% of total gas supply.

4. Existing strategic targets of the sector

Specific energy consumption per capita is significantly low in Georgia and energy intensity of produced GDP is higher when compared to the same index of countries with developed economies that creates an important barrier in intensive development and reaching product competitiveness on local as well as on international market. On the other hand, Georgia has its own energy resources – water (hydro), wind, bio, geothermal and other renewable resources together with potential of producing energy (methane of coal layer, hydrogen sulphuride, gas hydrate, etc.) untraditionally. Impediment of rational assimilation of

renewable and alternative energy potential of the country and future liberalization of the energy market, also effective integration in regional systems for utmost replacement of imported energy resources could become a serious barrier for economic development of the country and political sovereignty.

Development of energy sector of the country based on local renewable resources, especially on its huge potential of hydro resources to meet an increasing energy demand of population and different sectors of economy on guaranteed and accessible energy is very important strategic task. The most important target of energy strategy of Georgia together with the development of the sector and grown consumed energy per capita is reducing specific energy capacity of economy.

Energetics and especially hydro-electric energetics play one of the most important roles in the GDP production in the country. Though the level of its assimilation is very low and approximately just one fourth of the existing potential is assimilated nowadays.

Implementation of large-scale program of HPPs construction is planned. Medium and small HPPs are basically being built in Georgia but sometimes, big HPPs with regulating reservoirs are also built. At the same time it is obligatory to enlarge other energy resources, renewable and untraditional energy resources principally. If average annual growth by 5% of electricity production will be foreseen (actual growth during the last years was 4.5 - 6.5%), production will reach approximately 13 billion KW (17-18 billion KW according to optimistic forecast) and part of it will be exported. Nowadays, plans for constructing about 40 HPPs and 1 experimental wind turbine are being refined. Their total installed capacity is 1 872 MW and forecast annual production is 7 350 million KWh. Construction of 230 MW combined gas-cycled heat station in Gardabani is finished. Presumably, construction of other PPs (including the second combined-cycle heat station, Enguri HPP and new Rioni HPP) will begin soon.

Application of hydro energy and other local renewable resources in the electricity production will remain as a strategic direction of energy sector development of the country for safety of energy supply and minimization of electricity produced from imported fuel, expensive imported electricity and GHG emissions. At the same time it must be foreseen that energy that is based on application of potential of renewable resources, including hydro resources, depends on uncontrolled climate conditions (annual load of distributary HPPs in Georgia is approximately 50%) and needs necessary reservation by baseline capacities. Combined-cycle heating power plant that works more on ecologically safe, simple for using and accessible natural gas must be priority for baseline energy generation.

In addition to this, arrangement of trans-border energy transmitter infrastructure for reliable exchange with Turkey and united energy systems of Europe is very important. That could become one of the most effective instruments to speed up the association process with Europe.

Following priority directions for energy sector development are recommended to reach energy security, to meet growing demand of population and economy and to achieve large-scale reduction of harmful emissions of Georgia:

- Application of locally abundant hydro-energy resources, including in the conditions when eradication of negative impact on environment by means of regulating (with reservoir) HPPs is possible;
- Application of other local, renewable resources, including wind, solar, bio and geothermal resources, in different sectors of economy;

- Development of trans-border infrastructure connecting with neighboring countries for ensuring flexible connections and integration with regional systems;
- Reserving electricity generation based on using renewable resources by base thermal generation capacities working on natural gas;
- Creating strategic reserve of accumulating energy resources for guaranteed supply in crisis;
- Increase of energy effectiveness in the country for reduction of energy intensity of industrial production and for increasing competitiveness on international markets;
- Ensuring increase of component of planning in development, preparing and realizing energetic policies and strategy;
- Harmonization legal and sectoral regulations and standards with appropriate international legislation for future liberalization of the market and ensuring of healthy competitiveness during association process with the European Union.

5. Major challenges of energy sector

Georgian energy sector and country's economic security in general face serious challenges due to following factors:

- ➢ Dominant role of imported energy resources in country's energy balance, and insufficient use of national energy sources (including renewable);
- ➢ Lack of modern, resource-saving technologies, and unjustifiably low level of energy efficiency potential adoption;
- ➢ Relatively low-efficient basic heat generating means emit unjustifiably high level of GHG, and country's energy sector is oriented to utilize hydro energy resources that critically depend on climate conditions;
- ➢ Vulnerability of existing energy infrastructure to natural disasters caused either by climate and geographic characteristics, or by insufficient technological reliability of amortized systems;
- ➢ Inability to store heating resources of strategic importance;
- ➢ Increasing threat of terrorism especially on strategic objects located inside country's occupied territories;
- ➢ Insufficient number of skilled personnel to implement modern, energy efficient technologies;
- ➢ Low operational and quality standards in energy industry, and limited excess of socially vulnerable people and local industries to vital energy resources;
- ➢ Possible politicization of tariff regulations might lead to financial deficit;
- ➢ Disharmony of international and national regulations and standards in operations' technical regulations and energy infrastructure construction works.

To solve abovementioned problems, international best practices propose the following instruments:

- ✓ Make national legislation system transparent and harmonize it to the EU-legislation according to Georgia-EU Association Agreement, and form suitable investment conditions to develop competitive market;
- ✓ Integration of Georgian energy sector into regional and international structures;
- ✓ Emphasis on developing trans-border infrastructure, and providing economic, legislative and political bases for its operation;
- ✓ Maximal utilization of domestic (mainly renewable) energy sources, diversification of supply and its routes, and implementation energy efficient technologies;

- ✓ Developing production-generation, strategically important transportation and storage infrastructure;
- ✓ Accumulation strategic stock of oil products and natural gas (EU-directive[5] and approved instrument to mitigate nonstop supply risk);
- ✓ Guarantying environment protection and technical security by providing reliable infrastructure and minimizing losses;
- ✓ Depoliticize tariff regulations and licensing issues, and reaching long-term stability to gain investors' trust and attract additional investments from international financial markets;
- ✓ Finalizing energy sector's operational standards', technical regulations', service quality's and legal responsibility framework's harmonization with an international ones that is necessary precondition to attract investments and modern energy-efficient technologies.

Major risks and challenges by subsectors are given below.

Electricity generation industry[6]: market monopolization (including foreign companies); price fluctuations; supply-demand misbalance; difficulty to guarantee demand needs during pick periods; critical dependency of domestic production on climate conditions; less flexible connections with regional systems; partly absorbed infrastructure and technical impairment; energy storing capacity issues.

Timely adoption of new hydro-generation capacities and effective integration of energy-supplying systems into regional net on infrastructural (with enough transmitting capacity, quality, and synchronized work ability) and legislative levels are viable means of risk-reduction. Storage of hydro-generation potential via utilizing natural gas-run basic energy-generation means should be a priority for improving energy system's sustainability.

Natural gas sector

Transportation- and distribution infrastructure's inefficient regulative framework and an actual concentration of managing power in separate (including foreign) companies' hands. Efficient legislative separation of competition and monopolistic activities, supply diversification, market liberalization and its openness are viable means to reduce abovementioned threats.

Accidents caused by natural disasters and high probability of forming critical situations due to Georgia's geographic characteristics and low technical reliability of arterial pipelines (they are outdated). Improving infrastructure's systemic reliability using interconnectors and efficient rehabilitation/reconstruction of existing arterial pipelines are viable means for reducing abovementioned threats.

Absence of strategically important stock is a reason for system's inability to keep system in working conditions in case of supply cut. And, this is the case, when the country almost completely depends on imported heating energy-resources. Constructing gas storage capacities of strategic importance and pilling up oil products' storage are internationally approved methods for reducing abovementioned threats.

[5] Directive 2009/119/EC 14/09-2009, imposing an obligation on Member States an obligation to maintain minimumn stocks of crude oil and /or petroleum products

[6] M.Margvelashvili, Georgia's Energy Security Risks and Their Mitigation Measures. Georgian Energy Sector in the Context of EU Association, Tbilisi, 2015, pp. 48-54

Increasing demand on natural gas in Georgia and long-term contracts that limit importing volumes. Access to additional resources in following decades might be the most problematic issue for country's energy safety issue.

Guaranteeing the access to affordable and clean heating energy-sources for vulnerable consumers including those of mountainous and bordering regions. Developing autonomous energy-source-based decentralized enterprises; supplying natural gas products (LNG and CNG) or propane-butane (LPG) instead of constructing expensive and economically intolerable pipeline or cutting down the forests without control to produce firewood, is an efficient way for solving the problem. In transport sector, nontrivial environmental and economic benefits could be obtained by using compressed natural gas (CNG) instead of expensive oil products. This will reduce costs and emissions approximately by 30%.

Oil production and processing

Emission of gas while extracting oil and bad habit of burning it in flambeaus. It is necessary to supply all the extracted gas to the supply net or utilize it on the place of its production (for example, producing compressed gas), and, thus reduce GHG emissions significantly.

Almost 100% of total oil products' demand is satisfied with imported heating recourses that often do not meet standards. It is reasonable to process extracted oil in domestic high-tech plants to satisfy part of total national demand, increase country's energy security and reduce pollutants' emissions.

Coal sector

Coal bed methane (CBM) related emission due to existing extraction technologies is a serious source of GHG. It is reasonable to examine CBM and coal gasification projects' efficiency for Georgia. Country should implement them if they are profitable and burn CBM on place of its production in opposite case.

Energy efficiency and renewable recourses (legal barriers)

As energy recourses import is vital for Georgia it should take steps to improve its energy efficiency. But, at present there are not stimuli in the country to meet energy efficient construction standards and this hinders rational consumption of energy.

Energy efficient technologies are problematic issue in both, generation and energy-intensive industries. Public awareness and lack of financial recourses for implementing energy-efficient technologies is also challenging.

As a result, absence of corresponding legislative framework discourages investment in the sector and hinders energy-efficiency improvement processes.

Utilization of Georgian renewable energy sources, which are not applied enough, is vital for the country. A tariff policy imperfections and an absence of necessary legal base are the major obstacles for developing renewable energy in the country. These two are the reasons why viable governmental projects' and foreign investments' potential is not utilized fully.

Challenges in European Energy Community membership action process

Georgia has to harmonize its legal framework with European Energy Community's (EEC) framework to become its member state. This means developing market economy, increasing transparency and constructing quality legal base, which leads to efficient system, institutional and professional progress. Abovementioned processes incorporate, for example, abandoning memorandum practices, increasing competition and market transparency, advancements in professional environment, reducing corruption threats and following stabilizing policy. Reaching these goals is a necessary precondition to attract strategically important investments.

Legal harmonization, taking into account transition period, puts Georgian companies in line with European and Turkish firms and grants domestic companies with ability to operate on European-Turkish markets in full capacity. As Georgia has clear seasonal pattern in hydro-generation and lucrative geography for being a transit hub, practicing aforementioned activities is vital for the country.

Membership of EEC implies high energy-efficiency and increased renewable energy utilization, environment protection and market competitiveness that will bring Georgia's economy together with a developed ones. Given, that the country is geographically and technically isolated from EU's unite market and has binding memorandums with foreign companies, EEC membership action process is a complex challenge. Consequentially, Georgia should request to avoid energy security and energy recourse supply obligations to socially vulnerable people. In addition, it should ask for prolongation of market liberalization transition period.