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Statistical Analysis and CAPM Model for Investments in Georgia's Energy Sector

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Abstract

Various types of recent research point out the fact that Georgia's energy sector (the hydro energy one, in particular) is one of the most attractive ones when it comes to investment opportunities. Hydro power remains the cheapest and the most "eco-friendly" source of power for Georgia. An essential part of Georgia's hydro energy potential is still untapped (in fact, the current electricity generation represents just about 40% of Georgia's estimated annual hydropower output potential). At the same time, it is worth mentioning that for the last 6 years, generation capacities are falling short of growing consumption and this fact increases the attractiveness of investing in this sector. Currently, more than 20 hydro power plants are under construction/reconstruction or licensing stage and, in addition to this, the Ministry of Energy of Georgia has more than 60 HPP projects available for investment. For every potential investor, it is of vital importance to have a general knowledge about what to expect from the desired sector, what are the risks that could hurt the success of the investment and if the expected rate of return equals or exceeds his or her required rate of return. This article, based on various official data, offers introductory issues of investment analysis of small hydro power plants in Georgia and based on well known methods of Modern Portfolio Theory offers the suitable model for investments evaluation and analysis in Georgia's Energy sector.

Keywords: CAPM, energy sector, investment, statistics

JEL: C13

Introduction

Electricity Sector in Georgia – General Data on Generation and Consumption

According to Tokhnadze (2014), Giorgishvili (2012), Magradze (2013), "Among Georgia's natural riches (**coal**, oil, natural gas, etc), resources related to water come first". The country's hydro energy potential (rivers, lakes, glaciers, water reservoirs, groundwater, swamps) is one of the top in the world taken into account the total area of the country. There are around 26,060 rivers and 860 lakes in the country and the total length of the rivers is about 60,000 kms.

The official document published by the Ministry of Energy of Georgia, "Georgia Energy Strategy 2016-2025" gives the following information on the Electricity Generation in the Georgian energy sector.

Hydro Power Plants

The total installed capacity of power plants in Georgia is 3,724 MW, where the share of HPPs is 75% (2,799 MW). Currently, 67 hydroelectric power stations operate in the country. The main part of them is located in western Georgia (on the rivers Enguri and Rioni basins). Nearly half of the annual processing of the country produces by 7 regulated HPPs, with the total installed capacity of 1,991 MW and the annual production of these HPPs exceeds 5 billion kWh. The total installed capacity of existing 12 seasonal stations is 646 MW while 48 small deregulated HPPs (up to 13 MW with the total installed capacity - 162 MW) provide only 5% of the country's annual processing. The total volume of water reservoirs is 2,259 mln. m3 (useful volume - 1,425 mln m3). Most of the existing HPPs are outdated and require reconstruction/modernization to increase efficiency. Since 2010, 18 HPPs have been gradually put into operation, with total installed capacity - 174 MW.

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Thermal Power Plants

The total installed capacity of 5 TPPs in Georgia is 924 MW, which is 25% of the country's total installed capacity. Out of these, 2 TPPs (total installed capacity - 570 MW) are quite outdated. Low quality of production means the coefficient of action and the unsatisfactory technical condition reduces the reliability of the stations and increases the cost of generated electricity.

Wind Power Plants

The first wind power plant in Georgia was built in 2016, funded by the Georgian Energy Development Fund and the European Bank for Reconstruction and Development. The installed capacity of this power plant is 20.7 MW and the annual output is 88 mln. KWh / h

According to official data from the Electricity Market Operator (ESCO), (Electricity Generation and Selling Dynamics 2007-2017) the dynamics of Georgia's electricity generation on Figure 1 in 2007-2016 are as follows: production of Georgia on the territory of Georgia grew almost every year and it reached 11,573 mln. KWh/ h (2016) from 8,345 mln. KWh / h (2007), which is a 38.7% increase (3.67% compounded annual growth rate – CAGR).

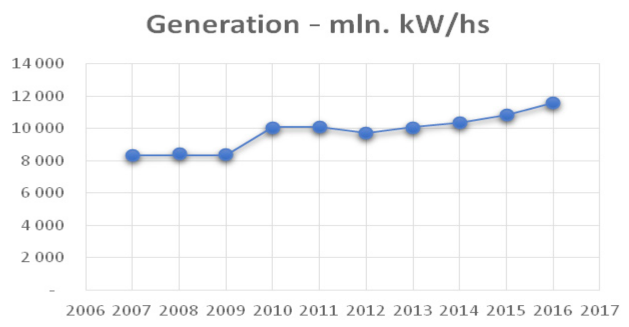

Figure 1. Generation

Consumption

According to official data from the Electricity Market Operator (ESCO), (Electricity Consumption Dynamics 2007-2017) the dynamics of electricity consumption of Georgia on Figure 2 in 2007-2016 are as follows: consumption has increased since 2007 and reached 12,693 mln. kW/hs (2016) from 8,603 mln. kW/hs (2007), which is 47.5% increase (4.42% compounded annual growth rate – CAGR).

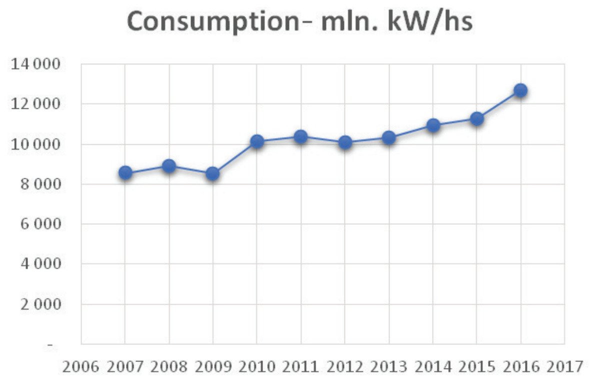

Figure 2. Consumption

Export-Import

The main power source of Georgia is hydro power plants. Therefore, electricity generation is seasonal. The abundant water flow appears in relatively warm months and production is at the peak. This fact allows electricity export to all four Georgian neighbors. At the same time, as the figure above suggests, there is a need of import.

According to the official data of the Electricity Market Operator (ESCO), the volume of electricity exported from and imported to Georgia in 2007-2016 on Figures 3 and 4 is as follows:

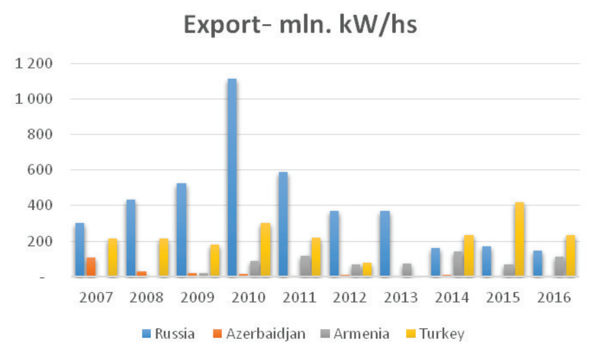

Figure 3. Exports

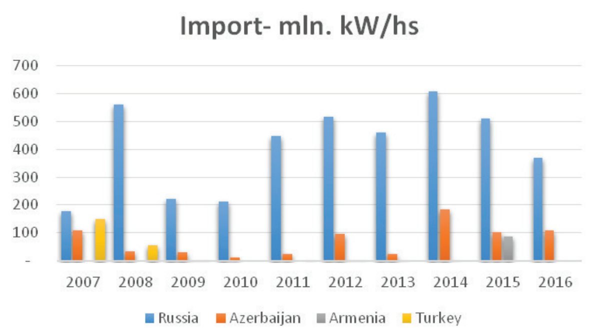

Figure 4. Imports

Electricity Market

The current model of the Georgian Electricity Market may be defined as the direct contracts market, where market participants fulfill the obligations on a monthly basis. Besides the direct contracts market, the balance market is operating, which allows participants of the power market to balance the monthly quantity of generated electricity.

Electricity market of Georgia can be divided into wholesale and retail markets. Electricity manufacturers, direct consumers, exporters, importers and distribution licensees (in the supply part) as well as service providers - transmitter system operator, market operator, transmission and distribution licensees. The main subjects of retail marketing are electricity distribution license holders. Power supply in the retail market can also be provided by small HPPs. Whatever the end-consumption segment, retail consumption is represented by household and non-household consumers.

The Purpose of the Article

It is important for any potential investor to have a general idea of what to expect from a particular sector, what risks are associated with the success of the investment and whether the expected rate of return is equal to or more than the required rate of return. Accordingly, the question arises whether it is worth investing in the Georgian hydropower sector (specifically, small HPPs) and, if not, what the reason for this is and how this sector should become attractive. The main goal of this article is to analyze the data about potential projects in the hydro energy sector and identify the "hypothetical" project. It also aims to develop the suitable model for evaluation of investments in the energy sector potential projects based on the "hypothetical" project.

Research Methodology and Obtaining of the Data

In the Prospective Projects of the Ministry of Energy of Georgia there are 52 potential HPP projects alongside with general information on each of them. Based on the objectives of the research, using various statistical techniques and research methodology, analysis of strategic investment in the hydropower sector of Georgia is made based on the example of small HPPs. "The inductive method is based on the logic of the fact that when attributes repeat the conclusion that the subject of the same attributes belongs to a particular class of subjects, consequently, the result of analyzing the subject with similar attributes may be used to evaluate the specific class of these subjects". During the first selection out of 52 potential HPP projects, 39 were taken based on HPP type and Installed Capacity. In addition, the characteristics provided for receiving the data and their short descriptions are given below:

- The type of the hydroelectric power plant is divided into two categories which are "Run-on-the-River" and "Reservoir". The Run-on-the-River HPPs do not have a dam and, therefore, the number of electricity generated by them is strongly positively correlated to the water flow in the flow of water in a particular moment. Reservoir type HPPs have sufficient capacity dams and, consequently, it is possible to increase power generation in the period when the demand is higher and, therefore, the price is higher than the average.
- Installed capacity – HPP's installed capacity demonstrates the capacity of a certain HPP. For example, if the HPP's installed capacity is 10 MW, this means that its maximum possible output is 10 MW x 24 hs x 365 days annually at 87,600 MW/hs.
- Average Annual Generation - This indicates the HPP's average annual output based on the Installed Capacity and Capacity Factor (see below).
- Capacity Factor - This indicator indicates, on average, the percentage of HPP's performance usage. For example, if two HPPs have a capacity of 5MW and 7MW, and with the capacity factors of 75% and 40%, the HPP can generate 5 X 24 X 365 X 75% 32,850 MW/hs and another 7 X 24 X 365 X 40% = 24,528 MW/hs.
- Cost of construction - reflects the total cost that will be required from the HPP construction to the stage of final operation.
- Construction period - reflects the time required for the construction of the HPP from the start of the final operation stage.

Among the types of hydroelectric power plants, Run-on-the-River HPPs and neglected by the "Reservoir" types were selected. Based on the installed capacity, the initial capacity of 30 MW with large capacity hydroelectric power was managed to be ignored, which enabled us to concentrate on a small (installed capacity of less than 13 MW) and slightly smaller HPPs.

The data obtained from the official website of the Ministry of Energy of Georgia, includes the data about 39 HPPs. Three of the above-mentioned HPP indicators (installed Capacity, Annual Generation, Cost of Construction) differ significantly from each other and require secondary selection.

These differences are clear from the following graphs (Figure 5, Figure 6, Figure 7, Figure 8):

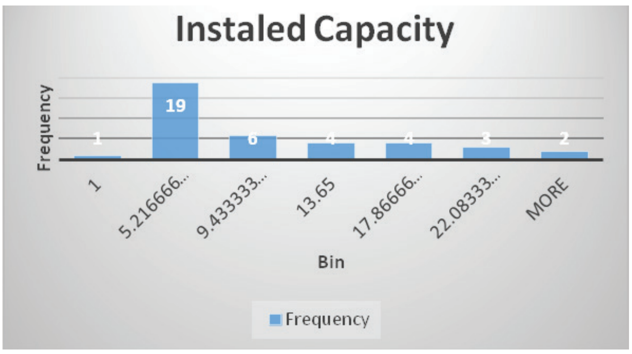

Figure 5. Distribution of Installed Capacity (in MW)

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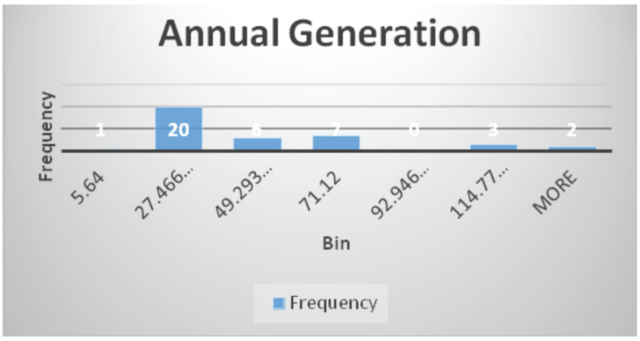

Figure 6. Distribution of Annual Generation (in GW/h)

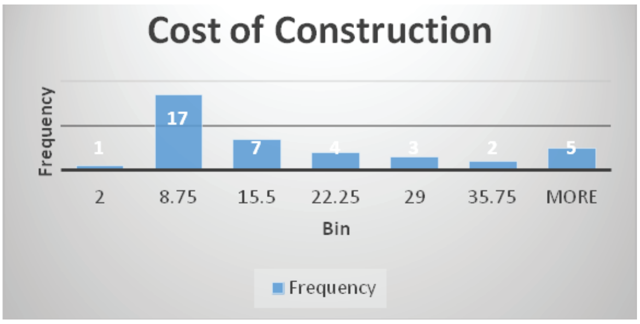

Figure 7. Distribution of Construction Costs (in $M)

Figure 8. Box and Whisker Plots

5 indicators were selected and the arithmetic average and standard deviation used for the entire population (using Evans (2016))

- Installed Capacity (MW): Arithmetic Average- 8.46; Standard Deviation - 6.54
- Average Annual Generation (GW/hs): Arithmetic Average- 40.78; Standard Deviation - 33
- Capacity Factor (%): Arithmetic Average- 55.16; Standard Deviation - 8.6
- Cost of Construction (mln $): Arithmetic Average- 15.32; Standard Deviation 12.34
- Time of Construction (years): Arithmetic Average- 2.14; Standard Deviation - 0.56

It is observed that variations are too high, especially, for Average Annual Generation. In order to have more homogeneous HPPs for the purpose of this article, calculated arithmetic means and standard deviations to select HPPs (more "typical" HPPs) have been used above which were located between upper and lower intervals based on one standard deviation.

This approach has left only 12 small HPPs out of 39, and are listed in Table 1, which we use to create a financial model for new HPP. This "hypothetical" HPP model can be used for subsequent calculations and analysis, and the conclusions made on investment can be generalized on similar types of HPPs as well.

Table 1. Sample HPPs used for determination of "Hypothetical HPP"

Name	Installed Capacity (MW)	Average Annual Generation (GW/hs)	Capacity Factor	Cost of Construction (mln $)	Time for Construction (year)
Boriti	6.4	33.75	60.20%	10.9	1.8
Cheshura	7.5	32.4	49.32%	11.25	2
Chkheri	14.8	67.95	52.41%	26.64	2.5
Juta	8.9	42.04	53.92%	15.1	2
Kobi	3.85	18.41	47%	5.7	2
Lebarde 1	4.56	19.8	49.62%	9.12	2
Medani	4.4	23.85	61.90%	8.8	1.8
Samkuristskali	4.88	25.7	60.12%	8.54	2
Stori 2	11.4	50.52	50.59%	20.5	2
Stori	11.8	56.78	54.93%	20	2
Truso	8.7	40.9	53.72%	14.8	2
Zarzma	4.3	19.8	52.60%	6.88	2
Average	7.62	35.99	54%	13.19	2.01

Based on the above mentioned information, the main indicators of the "Hypothetical HPP" are as follows:

- Installed Capacity - 7.62 MW
- Average Annual Generation - 35.99 GW/hs
- Capacity Factor - 54%
- Cost of Construction- 13.19 mln. USD
- Time of Construction – 2 years.

During the year, the expected generated electricity by months is graphically shown below in Figure 9:

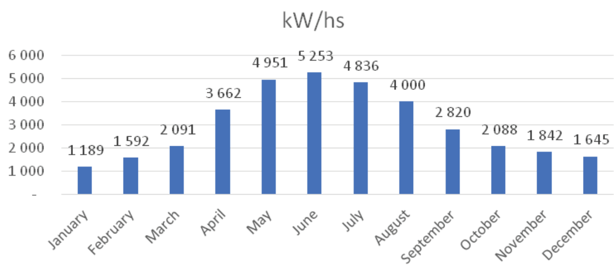

Figure 9. Generation Dynamics

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Risks that Investors Should Take in Account

During construction of HPPs and assessment of investment, it is necessary to discover different risks and write response strategies. The main risks that contribute to in small HPPs are detailed in Carnierro and Ferreira 2012, Agrall, 2012, Kuciella and others in 2012, Nicolux and others in 2011, Rangel 2008.These risks are:

The risk of completion of construction. The possibility of delay in construction and increased expenses should be analyzed in comparison with expected expenses. The risk of "failing" construction may be caused by monetary or technical reasons. Monetary reasons include poorly estimated construction costs, unexpected surplus of inflation, unexpected delays, etc. The technical reasons include incorrect designs for the first design, planning of incorrect quantities of supplies and materials, vague articles of contractual conditions etc.

The impact of these risks may be medium or high, depending on what negative consequences the project delays end up with. The delay of the project may endanger the completion of the project or expenditure may increase so that the economically undue even to the end of the project.

Technological Risk. This risk occurs when the technology used by the project is either outdated or works at a lower level, than when it was taken into account in advance. This risk is very important for the hydroelectric power plant, as even reduction in the production of turbine output can lead to large losses of HPP. It is also noteworthy that in spite of the hydro energy crisis, huge money is spent on other renewable energy sources and technological progress can make it more attractive and cheaper to use other renewable energy sources.

Geological Risk. Detailed research is required to know – gain precise geological data about the location of potential HPPs. Even the slightest inadequacy of stones and rock structure can increase colossally in the initially estimated cost of construction. The risk of seismic activity also includes geological risk.

Hydrological Risk. Hydrological risk is one of the most important factors because possible production of electricity depends on hydrology. The speed and volume of the flow must be studied in detail. If the incorrect project is based on incorrect hydrological data, it may be possible to question the success of the project.

Economic Risk. Economic risk involves reducing economic activity in the country, which could result in decrease in electricity consumption and consequently decrease prices on electricity. The decline in prices is directly related to the expected profit and if the price goes below certain predetermined point, operating HPP might become unprofitable.

Financial Risk. This risk includes problems caused by various financial external or internal factors, such as, the difficulty in borrowing, unpredictable interest rates, foreign exchange rates, etc.

Political and Legislative Risks. Political and legislative risks may arise in the existing laws of sudden changes, especially, in the energy sector, which may encourage investments in other energy sectors and not in hydropower. Because of this - Therefore, sudden changes in the legislation and the expected lucrative project might become totally loss-making.

Cost of Equity

To calculate the cost of equity, the well-known Capital Asset Pricing Model is used is based on Harry Markowitz's Diversification and Modern Portfolio Theory (1952).

Formula is the following:

$$E(R_i) = R_f + \beta_i \, (E(R_m) - R_f)$$

Where:

$E(R_i)$ - is the expected return on the capital asset

R_f - is the risk-free rate of interest such as interest arising from government bonds

β_i - is the sensitivity of the expected excess asset returns to the expected excess market returns

$E(R_m)$ - is the expected return of the market

It is necessary to specify this formula based on reality for Georgia. First of all, it is necessary to define the relevant beta coefficient. There are two types of beta coefficients - "leveraged" and "unleveraged". In the leveraged beta company's capital structure contains the loan and own capital (equity), and in case of unleveraged, the company is 100% financed by its own capital.

According to the data provided by Damodaran (2018), the unleveraged beta for companies operating in Green & Renewable Energy sector is 0.67 and is financed by 39.63% debt and 60.37% equity.

In order to calculate leveraged beta using unleveraged one, it is necessary to use the following formula:

$$\beta_l = \beta_u \, [1+(1-T)D/E]$$

Where:

β_l – is the leveraged beta coefficient

β_u – is the unleveraged beta coefficient

T – is the corporate income tax rate

D/E – Debt to Equity Ratio

The following answer will be received by inserting the appropriate values in the formula:

$$0.67*[1+(1-0.15)*(39.63/60.37)] = 1.04$$

In the above-mentioned capital asset pricing model, the need for small amendments was also observed to ensure that the risk of the premium in the country and the risk premium for companies with small market capitalization are taken into account. After these minor changes, the formula gets the following shape:

$$E(R_i) = R_f + \beta_i \, (E(R_m) - R_f) + CRP + SMCRP$$

Where:

$E(R_i)$ - is the expected return on the capital asset

R_f - is the risk-free rate of interest such as interest arising from government bonds

β_i - is the sensitivity of the expected excess asset returns to the expected excess market returns

$E(R_m)$ - is the expected return of the market

CRP – is the country risk premium

SMCRP – is the small market capitalization risk premium

The required data for the formula and their corresponding sources are as follows (table 2):

Table 2. Data for the Formula

Indicator	Value	Source
R_f	3.07%	30 year USA government bonds
β_i	1.04	Please, see above
$E(R_m)$	8.76%	Market Risk (Damodaran)
CRP	5.12%	Georgia’s Country Risk Premium
SMCRP	3.84%	Small Market Capitalization Risk Premium

The following answer will be obtained by inserting the appropriate values in the specified formula:

3.07% + 1.04*(8.76%-3.07%) + 5.12% + 3.84% = 17.96%

Cost of Debt

In order to determine the interest rate of the relevant loan, official data of the National Bank of Georgia was analyzed. Namely, loans issued in foreign currency to legal entities. The data from January to June of June 2017 was selected. As a result, relevant interest rate of 8.64% was obtained.

Weighted Average Cost of Capital

The following formula was used to calculate the weighted average cost of capital:

$WACC = E/(E+D)*R_e + D/(E+D)*R_d*(1-T)$

Where:

WACC – is the weighted average cost of capital

E – is the Market Value of Equity

D – is the Market Value of Debt

R_e – is the Cost of Equity

R_d – is the Cost of Debt

T – is the Corporate Income Tax

The following answer is obtained by inserting relevant values in this formula:

60.37%*17.96% + 39.63%*8.64% = 14.27%

Terminal Value (after 10 years)

In order to calculate IRR and NPV more precisely, it is necessary to estimate the project’s terminal value after 10 years in order to discount it to present value. To calculate this value, Gordon’s Dividend Growth Model was used, which is expressed in the following formula:

$P_0 = D0*(1+g)/(r-g)$

Where:

P_0 – is the value at the beginning of the period

D_0 – is the dividend (cash flow) which is generated at the beginning of the period

g – is the percentage growth of the dividend

r – is the relevant interest rate (in this case WACC)

Results and Conclusions for the “Hypothetical HPP”

After all the required calculations the following results have been derived/obtained for the investments on the “Hypothetical HPP” (Table 3):

Table 3. Basic indicators calculate results

Debt Finance Part	39.63%
Equity Finance Part	60.37%
Debt Finance Amount	5,225,777
Equity Finance Amount	7,960,056
Cost of Debt	8.64%
Debt Maturity (Years)	15
Cost of Equity	17.96%
Weighted Average Cost of Capital	14.27%

References

Damodaran, A. (2018). Beta, unlevered beta and other risk measures. Emerging Markets. Retrieved from http://www.stern.nyu.edu/~adamodar/New_Home_Page/data.html

ESCO. (2018). Electricity Generation and Selling Dynamics 2007-2017. Retrieved from www.esco.ge

ESCO. (2018). Electricity Consumption Dynamics 2007-2017. Retrieved from www.esco.ge

Evans, J. (2016). *Business analytics* (2nd ed.). Pearson Education.

Giorgishvili. N. (2012). *Determining mid-term energy balance structure of Georgia based on statistical reporting analysis.* (Dissertation, Georgian Technical University, Georgia).

Magradze, N. (2013). *The effectivness analysis of Georgia's electricity management and preparing optimal model for electricity market.* (Dissertation, Georgian Technical University, Georgia).

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Markowitz, H. M. (1952). Portfolio selection. *Journal of Finance,* 7(1), 77–91.

Ministry of Energy of Georgia. (n.d.). საქართველოს ენერგეტიკის განვითარების სტრატეგია 2016-2025 [Development Strategy of Georgia's Energy Sector 2016-2025]. Retrieved July 18, 2017, from http://www.energy.gov.ge/projects/pdf/pages/Sakartvelos%20Energetikis%20Ganvitarebis%20Strategia%2020162025%20Samushao%20Dokumentielektroenergetikis%20Natsili%201641%20geo.pdf

Tokhadze, N. (2014). საქართველოს ენერგობალანსი და მისი გამოწვევები [Georgia's energy balance and its challenges]. Retrieved July 15, 2017, from http://forbes.ge/news/426/saqarTvelos-energobalansi-da-misi-gamowvevebi