THE EUROPEAN "GREEN AGREEMENT" AND ITS IMPACT ON GEORGIA'S ENERGY SECTOR

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Abstract

Energy is a key field of not only economic, ecological, climatic, but also political challenges and risks of modernity. Special attention is paid to the energy sector in the context of global climate change. Increasing the use of solar, wind, hydropower, geothermal energy and biomass will reduce greenhouse gas emissions and switch to fossil fuel-based economies of clean sources. The European Union- goals to replace traditional energy with renewables - are becoming more ambitious each time. The "Global Green Agreement", which should be the basis of the EU's economic vision, provides additional incentives for this.

In the paper has been conducted an energy economic analysis of Georgian energy; Have been discussed the target indicators and characteristics of the energy sector; The most important tasks of energy security, energy saving and raising the level of energy efficiency is formulated; The directions to solve these problems are outlined in this work.

Second of all, Georgia should try to engage in a series of radical, revolutionary changes known as the "4th Energy Transition." With this transition, the use of fossil fuels will be reduced to a minimum in the next 10 years, and in 2050 the correction of "carbon neutral" energies around the world is announced. The use of solar and wind energy requires backup capacities, the cheapest source of which is again hydropower. In the paper we have substantiated and analyzed the most important issues of the need to develop hydropower resources and give recommendations based on research. In our opinion, in order to deepen political and economic relations with the EU, it is important to gradually bring Georgian legislation closer to the European one, which will help establish a concrete, transparent and efficient energy market model, create an attractive and stable investment environment, develop energy resources through the development of renewable energy resources and the implementation of energy efficiency measures.

On the other perspective the Green Agreement" of Europe is a long-term path to the transition to a low-carbon economy, in accordance with the terms of the Paris Agreement. It envisions Europe as the first

carbon neutral continent by 2050. To achieve this goal, the EU plans to reduce emissions by 50% by 2030 compared to 1990. Naturally, this can only be achieved through the adoption and implementation of relevant strategic documents and decisions. Accordingly, our paper discusses the main essence of the Green Agreement, the challenges associated with its implementation and its impact on the future of the Eastern Partnership, especially Georgia.

Keywords: Energy legislation, Energy security, Emissions Reduction, Renewable Energy Resources.

Introduction

Paper presents potential, economic and forecasting reserves of alternative energy sources (hydropower, solar, wind, geothermal water, biomass and hydrogen). Based on the generalization of the results of many years of research, we have an analysis of the energy sector of Georgia, which allowed us to study the current state of the country and its development trends.

While working on the article, we got acquainted with the European Green Agreement in detail, conducted an energy economic analysis of Georgia, reviewed the target indicators and characteristics of the energy sector, formulated energy safety, energy saving and energy efficiency issues.

1. Energy resources of Georgia

Is our country ready for the implementation of the "Green Agreement" in Europe?

In 2014 Georgia undertook the obligation to harmonize with the third package of EU energy legislation under the Association Agreement. What kind of progress may this process has made in the country and to what extent is our energy sector policy in line with the requirements of the European Energy Union?

For the proper functioning of any field, it is important to have relevant laws in the country, strategic short-term and long-term action plans, existence of specific implementing bodies and definition of their functions, systematic scientific or small practical research, access to necessary technologies, awareness of target groups and more. We may wonder: What challenges the energy sector faces and what needs to be done to strengthen and develop it?

According to the document of the main directions of the State policy in the field of energy of Georgia, the goal of the energy policy of the country is to improve its energy security, which ensures the implementation of national interests by providing sufficient, high quality, continuous and affordable energy. Energy policy identifies the main directions of the field:

1. Diversification of energy supply sources, optimal utilization of Georgia's energy resources and creation of reserves;
2. Utilization of renewable energy
3. resources of Georgia;
4. Gradual integration of Georgian legislation with EU legislation;
5. Development of the Georgian energy market and improvement of the energy trade mechanism;
6. Increasing the role of Georgia as a transit country of the region;
7. Production of clean energy and becoming a regional center for trade in this energy;
8. Develop and implement a unified approach to energy efficiency;
9. Consideration of environmental components during the implementation of energy projects;
10. Improving the quality of service and protecting the interests of the customer.

Despite these areas of energy policy set in 2015, which focus on issues important for the development of the sector, the country still does not have an action plan for strategic energy development. Work has been underway on renewable energy and energy efficiency action plans, although none of the documents have been approved. The country also has not defined the share of renewable energy sources in total energy consumption by 2022, but Georgia is very rich in renewable, non-traditional energy resources, although it can not boast of its level of utilization, follow it consistently. When discussing Georgia's renewable resources, we should first of all mention hydropower, solar, wind, geothermal water, biomass and hydrogen.

2. Hydropower

Our rivers contain a huge amount of hydraulic energy and to some extent fill the shortage of fuel in the country. The existence of powerful hydropower resources in Georgia is directly related to its mountainous terrain. Water flows from the Great Caucasus Ridge and the little Caucasus Mountains create a powerful supply of hydropower due to a sharp drop in short distances. This is especially true in western Georgia.

In total, 26 thousand rivers are registered on the territory of Georgia. Their total length is about 60 thousand km.

According to the Georgian Hydroproject, 319 rivers are distinguished from the total number of rivers in terms of energy value, with a total annual potential capacity of 15.63 million kW, and an average annual energy of 135.8 billion. KWh.[1]

Favorable conditions for hydropower construction in Georgia are created by the fact that 40% of the technical hydropower resources of the 319 rivers registered here come from the eight main rivers (Mtkvari, Rioni, Enguri, Tskhenistskali, Kodori, Bzipi, Khrami and Aragvi). The distribution of economic hydropower by rivers is given in Table №1.

Table №1.Economic potential of Georgian rivers;

Name of the River	Economic potential, Billion kWh / year	Share of economic resources %
Enguri	10.7	27.4
Rioni Tskhenistskali	8.3	21.3
Kodori	5.7	14.6
Tusheti Anlazani	3.8	9.7
Mtkvari Aragvi	3.5	9.0
Bzhipi	2.5	6.4
Khrami and Paravani	2.0	5.1
Shaori and Tkhibula	0.8	2.1
Small rivers	1.7	4.4
All	39.0	100.0

[1] Chomakhidze, D., Chomakhidze, K., Chomakhidze, I., "Peculiarities and Principles of Energy Management", Tbilisi-2020.

Georgia is especially rich in relatively small rivers. According to the Scientific Research Institute of Energy and Hydraulic Structures, their technical potential is 12.3 billion annually kWh.

In recent years, the institute has developed 300 schemes for the use of small and medium rivers, including 229 small rivers. Small hydropower plants can be built on these rivers, with a unit capacity of 1 to 20 megawatts. 229 small HPPs can be located in 47 districts of the country. 155 of them can be built in 28 districts of western Georgia and 73 in 19 districts of eastern Georgia. The total capacity of small hydropower plants is 2.1 million kW. They will be able to generate 12.3 million kWh of electricity annually. Western Georgia accounts for 66.7% of capacity and 68.38% of output. The data presented here indicate that Georgia is a typical country of hydro resources. It will not only meet the country's electricity needs, but also allow us to sell some of the cheap energy to neighboring states if used wisely.[2]

3. Wind Energy

Georgia has significant wind energy potential, which is practically not used now. As special studies show, in theory, the wind energy supply in the territory of Georgia is 1.31012 kWh per year, and the wind energy supply of more than 4.0 per second speed in the depleted zone exceeds almost 4.5 billion kWh per year.

According to the Production Center of the Georgian Technical University, the average annual wind speed in the country varies from 0.5 to 0.5-0.9 meters per second. The decrease in speed is observed in places relatively protected from the wind - in deep valleys, in the lowlands of Kakheti. High speed (more than 6 m / s) is typical for high and open places of the Great Caucasus Ridge and South Georgia. In some parts of the country, wind speeds often exceed 15 meters per second. Such places are: Rioni and Mtkvari valleys. In the first case, the wind reaches its maximum speed in K. In Kutaisi, in the second case - in Tbilisi-Samgori. The average number of strong winds per year in these areas reaches 35. This indicator is equal to 88 in Kutaisi, 132 in Tbilisi, the number of strong windy days in a separate year exceeds 120, in Tbilisi - 170. High frequencies of strong winds are noted on open mountain peaks and passes. For example, the number of strong windy days in Kazbegi averages 98 per year, in Mta-Sabueti - 142; Here the maximum - 222 days was celebrated in 1954. The territory of Georgia is zoned according to the natural energy potential of wind. In particular, the whole area is divided into 5 zones. The first zone (with a working period of more than 5000 hours) includes Ninotsminda, Akhali Shahr, Oni, Kutaisi districts. Here we can effectively use wind units of all capacities. In the second zone (Kobuleti, Gardabani, Kazbegi and other districts). The total duration of active winds is 4500-5000 hours per year. Here it is advisable to operate mainly medium (several hundred kilowatt capacity) wind machines. In other zones, where a large part of the area suitable for wind use is located in Khashuri, Gori, Lanchkhuti, Tskhinvali and other districts, we can successfully use small-capacity wind engines.[3]

The existing micro-relief of the territory of Georgia is a very important factor for the wind regime. This is especially felt in the Mtkvari and Rioni valleys. The most windy area in the West Georgia is in the Poti-Supsa district and near the Surami ridge and in the East Georgia – in Gori and Tbilisi. The average annual

[2] Chomakhidze, D., "Georgian Energy in Numbers", (Economic-statistical indicators of the field development), Tbilisi, 2021.
[3] Vezirishvili-Nozadze, K., Pantskhava, E., Renewable, non-traditional energy resources management and development of their development program in Georgia ", International Scientific Conference" Science for Practice and Development ". February 22-24, 2019, Baku, Azerbaijan.

wind speed in this zone exceeds 4 m / s, while in the whole area this figure is in the range of 0.5-0.9 meters. Table #2 shows the total duration of the active wind speed by seasons.

Table №2. The total duration of the active wind speed according to the seasons of the year;

Station	Wind speed							
	Winter		Spring		Summer		Autumn	
	≥ 3	≥6	≥3	≥6	≥3	≥6	≥ 3	≥ 6
Gagra ridge	1029	445	959	356	503	87	904	312
Mamison Pass	1856	895	1605	606	1753	599	1766	751
Kazbegi (highland)	1132	872	1143	810	1085	687	1231	921
Chkhratskaro	1800	1100	1753	923	1615	791	1566	635
Rodionovka	1469	687	1373	448	1502	401	1453	412
Poti	1210	573	1222	421	1126	162	722	261
Batumi	1782	896	1382	420	1520	204	1558	533
Jvari	1066	789	884	549	467	196	1072	726
Samtredia	1121	452	1134	407	716	132	737	255
Kutaisi	1635	959	1688	1002	1323	569	1368	640
Sabueti (Mountain)	1724	1055	1871	1146	1805	958	1727	1058
Kobuleti	1037	444	1091	418	779	202	930	359
Skra	862	535	1492	834	1459	567	1204	599
Tbilisi Airport	894	663	1194	802	1396	908	954	639
Rustavi	861	513	1140	648	1237	700	893	475
Martkopi	755	521	836	568	892	670	762	531

In general, the first and second zones are especially important out of the 5 zones which are zoned according to the natural energy potential of wind. The seasonal nature of wind speeds throughout the year is evident throughout Georgia. In the mountainous zone of the Greate and Little Caucasus, as well as in the Kolkheti lowlands, the maximum value of the average monthly wind speed is observed in the winter period from November to March, and the minimum - in the summer from May to August.

The compilation of the wind energy cadastre in the Republic is of great importance for the definition of wind resources and its practical use. Intensive work was carried out in this direction in Georgia. Back in 1959, A.G. Balabuev and I.S. Meskhi theoretically assessed the wind energy supply in the country, as well

as calculated the amount of possible energy production. Later, E.M. Sukhishvili conducted surveys on wind speed and directions and compiled a map of the distribution of these meteorological parameters. Significant scientific-research and organizational work in this direction was carried out at the Transcaucasian Scientific-Research Hydrometeorological Institute, as well as at the Scientific-Research Institute of Energy and Hydraulic Structures, in Georgian Wind Energy Atlas , in various scientific-research organizations. In these organizations, in addition to the latter, similar work was carried out on other non-traditional forms of energy. Meteorological stations contributed to the study of wind energy.[4]

These materials are the basis for the assessment of existing wind energy resources in Georgia, which is given above.

4. Solar Energy

According to the Hydromedcenter, the total solar radiation capacity is 4.1023 kilowatts. From here to the earth comes about 1014 kilowatts of power, which corresponds to 1015 kWh of energy. The distribution of the sun on the earth is extremely uneven and averages 1 kW per 1 sq. M. Georgia, as a southern country, is rich in solar energy and is located in the so-called In the "sun belt of the world" (45 ° north latitude - 45 ° south latitude). The theoretical amount of solar energy that falls on our territory during the year reaches 1014 kWh, or 32.5 billion. Tons of conventional fuel, which is about 1600 times higher than the current level of consumption of the country's fuel resources.[5]

In most parts of Georgia, the annual duration of sunshine is quite long and ranges from 200 to 250 days. For a continuous duration of solar energy flow, see Table №3.

Table №3. Continuous duration of solar energy flow, in % ;

Station	Duration of working period, hours					
	≥ 4	≥ 6	≥ 8	≥ 10	≥ 12	≥ 14
Winter						
Tbilisi	9	6	1	-	-	-
Sokhumi	10	7	5	1	-	-
Jvari Pass	13	10	7	1	-	-
Rodionovka	13	10	6	1	-	-
Summer						
Tbilisi	28	24	20	14	8	1
Sokhumi	25	22	18	15	10	2
Jvari Pass	15	11	8	4	1	-
Rodionovka	28	23	18	14	9	2

[4] Vezirishvili-Nozadze, K., Pantskhava, E., "Energy efficiency - the cornerstone of modern development of the country", III International Conference, Economic, Legal and Social Problems of Modern Development. 2019, September 20-21.
[5] Vezirishvili-Nozadze, K., Pantskhava, E., "Analysis of the Development of the Electricity Sector in Georgia and Shadows (Results)", II International Scientific-Technical Conference "Modern Energy Problems and Ways to Solve Them", Tbilisi, Georgia, 2020, 10 December.

According to the representatives of the solar companies, the number of consumers of solar panels has significantly increased since 2018, and in 2019 “we have a situation where the demand is 5 times higher than in 2018. Tomorrow will raise all. This is inevitable, "said a spokesman for the Solar Systems Company. According to the data requested from GNERC, as of September 27, 2019, up to 120 micro-power stations with a total installed capacity of up to 1,300 kilowatts are included in the net metering system. Experts say that although, on the one hand, public awareness about solar systems is low and, on the other hand, it is difficult for a large part of the population to access solar e-mail. By making an initial investment in the stations, the Georgian society is generally open to new technologies. So, in their opinion, in case of increasing their awareness, the consumption practice will soon increase.

5. Thermal Waters

These resources are one of the most studied types of in-depth ground heat and are associated with groundwater thermal waters. Georgia is one of the richest countries in the world with such waters. The total forecasted supply of thermal waters (water temperature 50-110 ° C) is 250 million cubic meters. Thermal waters were used for thermal energy purposes in communal farming (Tbilisi, Zugdidi, Saberio, Rechkhi, Kindgha), in greenhouses (Okhuri, Kindgha, Anara, Vani, Kodori), for technological needs in the tea industry (Kindgha, Zugurdidi, Tbilisi) Nakalakevi, Ujarma, Menji, Simoneti, Kvareli), in pig farms (Khobi, Mtskheta) etc. The forecast supply of thermal waters on the territory of Georgia is located according to the following basins (see Table №4).[6]

Table №4. Major thermal water Pools and forecast supplies;

Pools	Million cubic meters annually	% Of the sum
The southern slope of the Caucasus	2	0,8
Apkhazeti	34	13,6
Kolkhida	81	12,4
Imereti	50	20,0
Adjara-Trialeti	36	34,4
Tbilisi suburbs	40	16,0
South Georgia	7	2,8
Georgia - Total	250	100,0

[6] Vezirishvili-Nozadze, K., Jishkariani, M., Pantskhava, E., "Energy efficiency - the most important factor in the growth of the country's energy independence", International Scientific and Practical Conference, "The World of Science and Innovation", 10-12 February 2021. London.

The highest temperature (80-106 ° C) is in Okhuri, Zugdidi, Tsaishi, Kindghi, Kvaloni wells; The number of deposits where the water temperature is around 50 degrees is also important. These are Tbilisi, Kulevi, Samtredia, Menji, Rechkhi and other wells. The temperature of Tskaltubo, Mokvi, Tsikhisjvari, Besleti, Udabno, Akhaldaba, Sulori and other ores is in the range of 30-40 ° C, and their average water temperature is about 80 ° C.

As for the mineralization rate, according to the Georgian Hydrogeology and Engineering Ecology Sector, it in most cases ranges from 0.9-2.2 grams per liter, and this rate is about 1 gram in more than half of the water received. Gas content is also low.

According to the data of 2021, there are 206 wells, 8 springs in the thermal waters of Georgia, the temperature varies in a large range and in some places reaches 105-108 ° C (Mokvi, Kindghi), the total flow is 135599 m3 / day, thermal capacity - 307.1 MW, it Can save 458.4 conventional fuels per year.

6. Bio Fuel

Alternative energy resources also include energy obtained from the biological recycling of organic waste from industry, agriculture and the communal-household sector. The biogas obtained at this time can cover a certain part of the energy load, especially in agricultural areas. It is known that the calorific value of each cubic meter of biogas varies in the range of 5500-5800 kcal. The calculation shows that using biomass in Georgia can save about 20 thousand tons of conventional fuel annually.

It is important to use firewood from biofuels in Georgia. In 2018-2021, firewood production in the country amounted to 1000 cubic meters. Quantities of different types of biomass waste The values of their energy potential and the amounts saved using it are given in Table №5.

Table №5. The amount of biomass waste and their energy potential

Biomass species	Quantity (10^3 tons)	Energy (10^9 kWh)	Saved entrails fuel	Cost (10^6 USD)
Residues of cereals and legumes	870	1.3	$112 \cdot 10^3$ tones	80
Livestock and Poultry waste	1670	6.9	$760 \cdot 10^6$ cubic meters of Natural gas	176
Household waste	900	0.6	$53 \cdot 10^6$cubic meters of Natural Gas	14
Tbilisi Canal. From water purification equipment	250	1.0	$92 \cdot 10^6$cubic meters	57
Wood and its residues	700	2.7	$200 \cdot 10^3$ tons	125
Total	4390	12.5		452

7. Hydrogen energy

Georgia is rich in the raw material needed for the development of hydrogen energy - hydrogen sulfide. It is contained in large quantities in the Black Sea. In the recent past, the State Agency for the Protection and Development of the Black Sea Resources and Development was operating in Georgia for the complex development of the Black Sea resources and the development of hydrogen energy.

According to the most important European document, the Green Agreement, we have to use this huge potential of renewable resources to turn our country into a "green" state, this applies to hydro resources (of which only 15-18% of its existing potential is used), as well as solar resources (of which only 2% used), inclusion in the wind energy system (of which 1% is used) and geothermal energy production (less than 1% is used here as well).

In our opinion, one of the strategic goals of the new energy policy should be:

1. Northern Line and Namakhvani (connection to the transmission network of power plants from Svaneti and Racha regions).
2. Guria and Kakheti (connection to the transmission network of hydropower plants from these regions).

Regarding the renewable energy sources in the draft energy strategy, it is mentioned that in order to improve the mentioned support schemes, it is planned to conduct a feasibility study to determine which support scheme is appropriate for different technologies and generation volumes, from the perspective of technological development and impact on the electricity market. In our opinion, the financial impact of support schemes should be assessed and analyzed, in terms of the expenditure part of the state budget, as well as the specific market and their participants.

Prior to the development of the new strategy, the state program - "Renewable Energy 2008" is being successfully implemented. According to the current law, the following power plants are deregulated: stations built after August 1, 2008, which are not the source of guaranteed volumes, and stations built before August 1, 2008, with an installed capacity of up to 40 MW, which also do not represent a source of guaranteed volumes. Such stations have the opportunity to choose the buyers themselves and set the cost of electricity produced.

In 2015, the Ministry of Energy of Georgia issued a strategic document prepared by the Transmission Network Operator (GSE), "Georgia Transmission Network Development Ten-Year Plan 2015 - 2025", and since then is in the process of annual renewal, the latest version is the 2020-2030 plan. This document is a time-honored program to strengthen the national transmission network infrastructure, presenting existing problems that respond to future challenges and ways to implement new opportunities. One of the key issues addressed in the document is the integration of renewable energy with the grid, which is still the biggest challenge in terms of integration into the electricity grid received from wind and solar.[7]

Conclusion

The "Green Agreement" of Europe is the most important document and is very relevant in our tense reality, especially in the context of the Russia-Ukraine war, with which Europe distances itself from the aggressively oil-rich state in agony. The transition of the developed world to alternative energy will really

[7] Vezirishvili-Nozadze, K., Jishkariani, M., Pantskhava. E., "Variable renewable and non-traditional energy sources". VIII International Scientific and Practcal Conference, „Actual Trends of Modern Scientific Research", 14-15 March, 2021. Munich.

weaken Russia, and Georgia's "green agreement" will have a chance to use a wide range of renewable resources. This is especially true of hydro resources - hydropower plants are the backbone of our country's electricity and their annual output is 80% of total generation.

Recently, there has been a view that the construction of new hydropower plants is not necessary, and that the rehabilitation of old hydropower plants will increase their productivity. Rehabilitation increases productivity, but many fail. In the case of Enguri HPP, it is 100-120 million kWh, less than 3% of its design capacity. Prior to the pandemic, the increase in electricity consumption exceeded 3% per year, and increasing the capacity of hydropower plants by a single 3% or even 5% would be just a drop in the ocean.

Many small hydropower plants cannot replace one large hydropower plant, nor wind and solar stations, but their combination will significantly increase the total generation and allow the energy-deficient country in all directions to meet its electricity needs and export.

For some reason, they think that talking about energy independence is a slogan, and they believe that there are no certain numbers behind it. Georgia is almost 70-75% dependent on energy for different countries and we are not talking about full energy independence, we can not achieve that. We are talking about improving the characteristics of energy independence.

Recommendations

In our opinion based on our research, the following measures should be taken for the development and advancement of the energy sector of Georgia:

- More full utilization of hydropower potential and construction of new hydropower plants, including small capacity ones;
- Rehabilitation or modernization-reconstruction of existing hydropower plants;
- Rational development of thermal energy, mainly at the expense of installation of air turbine blocks;
- In regions (rural settlements), for utilities and small business needs, where it is possible to build micro and mini hydropower plants, or to use solar, wind and biomass energy resources;
- Promoting the use of geothermal water in the agricultural and communal sectors;
- Minimization of losses in distribution networks, widespread introduction of energy-saving equipment in production and the household sector;
- Flexible tariff policy;
- Restoration and expansion of Georgian energy system connections with neighboring energy systems;
- Facilitation of the introduction of individual heating systems for organic fuels in the utility sector.

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