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**THE MAIN TRENDS IN RENEWABLE ENERGY DEVELOPMENT IN ARMENIA:
CHALLENGES FOR ENERGY TRANSITION¹**

The main trends in the development of renewable energy in Armenia are considered in the context of the challenges of sustainable development and energy transition. It is established that the development of renewable energy is one of the key directions of diversification of Armenia's energy security system. The main direction of development of the industry is identified. In particular, opportunities for the development of solar, wind, geothermal and bioenergy are analyzed. Special attention is paid to the potential of development of small hydropower in Armenia. It is shown that the full and systematic development of the mentioned industries is possible only in case of effective state-private partnership. External risks of solar and wind energy development in Armenia are considered separately.

Keywords: Armenia, renewable energy sources, energy transition, security, diversification.

One of the conditions for increasing the level of energy security and ensuring sustainable energy development of the state is the diversification of the energy system, which, first of all, involves the search and use of new sources of energy. Diversification of the energy system allows the state not only to protect itself from possible accidents and failures, but also creates conditions for reducing the sensitivity of the energy system towards external political issues. And although today it is impossible to imagine an absolutely independent energy system operating in autarchic conditions, and the concept of “energy independence” is rather of a journalistic nature, nevertheless, taking into account the geopolitical significance of energy resources, we can state that diversification allows increasing the level of energy sovereignty. This, in turn, leads to an increase in its geopolitical status.

In the case of the Republic of Armenia (RA), diversification solves a basic problem: it creates conditions for reducing the cost of produced electricity, which is one of the challenges to energy security. Reducing the cost of electricity will allow for a more flexible tariff policy, thereby stimulating economic development. Moreover, low cost may create additional conditions for the integration into the international electricity corridors in order to export the electricity generated in Armenia to foreign markets.

In order to reveal the diversification opportunities of the Armenian energy system, we will comprehensively consider the renewable energy sector (RES) in Armenia, identifying both the potential for its development and the risks that impede its formation.

Main directions of development of RES in Armenia

A necessary condition for the development of renewable energy is the presence of an appropriate regulatory and legislative framework. In Armenia, the main legislative act regulating this

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industry is the "Law on Energy Efficiency and Renewable Energy", adopted in 2004. The Law defines the principles of energy efficiency and state policy for the development of renewable energy, as well as the mechanisms for their implementation. These mechanisms are aimed at:

- strengthening the economic and energy independence of Armenia;
- increasing the degree of economic and energy security of Armenia, reliability of its energy system;
- creation of new production facilities and organization of services that stimulate energy efficiency and development of renewable energy;
- reducing the technogenic impact on the environment and human health [1].

Turning to RES in Armenia, the following sectors should be considered: solar, wind, bio-, geothermal and small hydropower.

Solar energy. During Soviet period, activity in the field of renewable energy development (without taking into account hydroenergy) began in the 1950s. Initially, that activity was of a purely research nature and, above all, related to the use of solar energy, which is quite natural, taking into account the sunshine duration in Armenia – about 2300-2500 hours per year.

The sun is the most widely used source of clean and endless energy. In the field of solar energy, Armenia has significant advantages: due to its close location to the tropical zone, a significant part of the country has favorable natural and climatic conditions that allow the widespread use of solar energy. The average annual value of solar energy in Armenia is 1720 kWh/sq.m per 1 sq.m of horizontal surface, while in Europe, it is about 1000 kWh/sq.m. During the warm period, the duration of sunshine in Armenia is 85% of the annual one, but on average, the duration of sunshine reaches 60%. These indicators allow us to confidently say that Armenia has all the necessary prerequisites for the full development of the industry [2].

In Armenia, the first photovoltaic installation with a peak power of 7.5 kW was installed in 1990 by BP (UK) in the Byron school [3].

Today, the total installed capacity of solar power plants (SPP) in Armenia is about 500 MWt (Fig. 1).

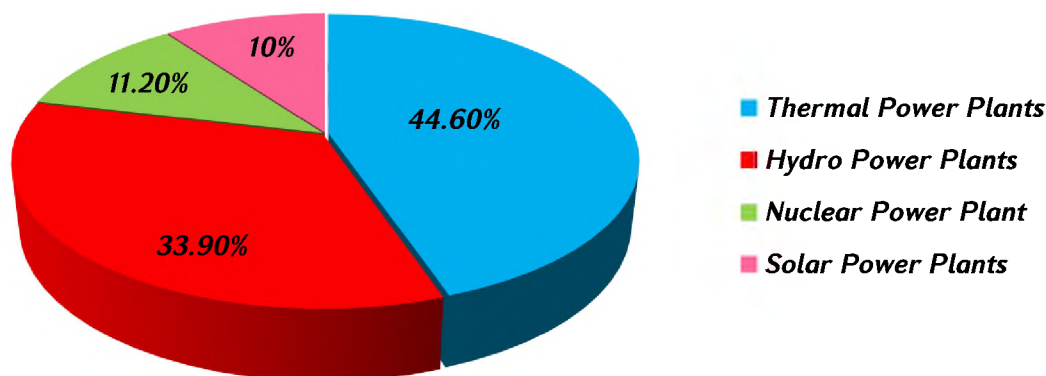


Fig. 1. Installed capacity of the Armenian energy system

In Armenia, it is planned to build the largest solar power plant in the region, "Masrik-1", with a capacity of 55 MW (commission date – 2024), which is expected to significantly change the structure of the domestic energy market. Together with the European Bank for Reconstruction and

Development (EBRD), preparatory work has also begun for the construction of 5 solar power plants in Armenia with a total capacity of 120 MW. The government approved the investment program of "Masdar" company (UAE) for the construction of a solar power plant with a total capacity of 400 MW in the Aragotsotn and Kotayk regions of Armenia. Investments in this project will exceed \$300 million. Tariff policy aimed at developing the industry is also of big importance: in the field of renewable energy, Armenia has a very competitive selling tariff for electricity - 4.19 cents per 1 kWh. This creates the necessary conditions for the implementation of new projects in the field of solar energy. Thus, the Armenian Renewable Energy and Energy Saving Fund, together with the French company "Trans Energy", received a grant from the French government for the construction of the first floating solar power plant in Armenia with a capacity of 151 kW. In general, it is expected that by 2030, the volume of planned investments in the field of solar energy in Armenia will reach 600 million US dollars, and in the field of wind energy - 500 million US dollars [4].

However, it is important to note that as a result of the war in Artsakh (Karabakh) in the fall of 2020, the prospects for the construction of some large solar power plants in Armenia became doubtful. Thus, the project of the mentioned solar power plant "Masrik-1" is planned to be implemented in the settlement of Mets Masrik in the Gegharkunik region, in close proximity to the Karvachar region that was transferred to Azerbaijan as a result of the war. The village of Mets Masrik is located 8 km from the interstate border and, as is known, was shelled by Azerbaijani drones during the war. It is obvious that repeated violations of the state border by the Azerbaijani armed forces in the same Gegharkunik region and shelling in the spring of 2021, as well as the process of including the issue of delimitation and demarcation on the official agenda of Yerevan and Baku creates quite tangible risks for business entities investing in solar energy in the region. The same problem exists in the field of wind energy, which will be discussed below.

Wind energy. In Armenia, according to available estimates, the cost of one wind power plant with a power of 1 kW is approximately 1000-1300 US dollars. To bring the total power to 100 MW. 100-130 million US dollars of investment are required. In general, the wind energy potential in Armenia is 5000 MW. Particularly noteworthy are such places of Armenia as the Pushkin Pass, Karakhachin, Semenov, Zod, Sisian, as well as the Charentsavan region.

Armenian power engineers already have some experience in the construction of wind plants. In 2005, the first wind plant in Armenia with a total capacity of 2.6 MW was put into operation. The wind power plant was built due to \$3.5 million grant from the Iranian government. The plant is located on the Pushkin Pass in the Lori region at an altitude of 2060 m above sea level and is equipped with four wind turbines. The average annual electricity generation is estimated at 5 million kWh, the service life is 20 years. It should be noted that the wind power plant installed at Pushkin Pass is the first in the South Caucasus [5].

Another important project in the field of wind energy is "Zod-Wind" - a wind power plant installed in Gegharkunik region in 2018. The station's capacity is 20 MW. Taking into account the inaccessibility of the most perspective points in terms of generation, the construction of wind power plants often runs into problems of transporting large-sized blades and other components to the station construction site [6].

Today, a number of European companies are involved in the process of monitoring the terrain and assessing the wind potential of Armenia in various regions and attracting investments for the construction of wind power plants, including the Italian company "Ar Energy", "Zod Wind", the Spanish company "Acciona Energia Global S.L." etc.

As noted above, the war in Artsakh (Karabakh) in the fall of 2020 caused serious threats to the development of RES, including the wind energy. At the end of May 2021, the "Zod-Wind" company filed a lawsuit against the Government of the Republic of Armenia demanding compensation for damages (\$5 million) incurred in November 2020, when, after the signing of a trilateral ceasefire agreement, the Azerbaijani Armed Forces invaded the territory village of Sotk, Gegharkunik region, with a threat to open fire. As a result, the company lost the opportunity to carry out economic activities on the territory transferred to it by the government until 2048 (200 hectares). The company has already built two wind turbines on 75 hectares. According to the business plan, it was planned to build 23 more [7]. Obviously, this situation creates some risks for the investment field in renewable energy in Armenia.

Bioenergy. Currently, in Armenia, the process of obtaining energy from biogas is at the initial stage of development. According to the USAID program (2007), in Armenia, the biogas potential for 2006-2020 estimated as follows: with 34.17 million US dollars of investment, 38.34 million cubic meters of biogas can be provided annually, which will prevent methane emissions into the atmosphere. In Armenia, one of the first installations for the production of biogas from farm animal manure in combination with a solar 75 water heating system was created on a small cattle farm in Aparan [5]. The largest biogas plant launched in Armenia is located at the Lusakert poultry farm where gas is mainly used to meet the needs of the poultry farm.

It is also important to dwell on the program for obtaining energy from biogas at the Nubarashen city landfill. In 2001, the Japanese company "Shamizu", together with the Government of the Republic of Armenia and the Yerevan City Hall, began developing a number of projects under the CDM (Clean Development Mechanism) scheme. One of them is a project aimed at obtaining methane from the Nubarashen landfill and its further use as an energy source. According to the document developed by the UNDP and UNFCCC in 2007, a 16-year repayment period for the targeted loan was established. Three Japanese companies were involved in the implementation of the program: "Shimizu", "Hokaido Electric Power" and "Mitsui". Investments in the program amounted to about 8 million US dollars [5]. Currently, the program is essentially frozen.

Geothermal energy. In 2009, the World Bank allocated 1.5 million US dollars to the government of Armenia to study the potential for the development of geothermal energy in the country. As a result of the research, it was revealed that in Armenia, there are perspective areas for the construction of geothermal power plants. It was revealed that electricity generation of 150-200 MW was quite realistic. Geological surveys in the central volcanic zone made it possible to discover promising geothermal and mineral deposits (Jermakhbyur, Sisian, etc.). The potential of the Jermakhbyur source is estimated at 25-30 MW. Compared to all other renewable energy resources, geothermal resources can be used for a long time, regardless of weather conditions [2].

Small hydropower. In the energy balance of Armenia, the share of hydroelectric power plants (HPPs) is more than 30%. In turn, the capacity of small hydroelectric power plants is 365 MW. At the same time, there is a noticeable decrease in the dynamics of the construction of new small hydroelectric power plants, which is, firstly, due to the unfavorable investment climate and, secondly, to the ineffective government policy in this area. Currently, the small hydropower complex demonstrates some crisis tendencies. There is a trend: most of the problems in the field of water resource management in Armenia are traditionally attributed to small hydropower plants. Obviously, this cannot but affect investment activity in the industry. The result of this policy was the government's decision (2020) to fine small hydropower plants 64 million drams for using water more than the permitted volume [8].

Obviously, preventing the withdrawal of additional water volumes is a necessary condition for effective water resource management, but several factors must be considered in this case. Most rivers in Armenia have so called high water, and in the spring, the water flow increases significantly, which creates opportunity to produce additional volumes of electricity. This water flow to Azerbaijan and Turkey, where it is used for irrigation purposes. Thus, it is necessary to avoid an average approach, especially when monitoring small hydropower plants that are located near state borders.

As for any state, diversification is one of the main challenges to ensuring energy security in Armenia. The development of renewable energy is a key condition for diversifying the energy system. Armenia has great potential for the development of renewable energy. To use this potential most effectively, it is necessary to establish a public-private partnership, since the problems in the functioning of the industry are related not only to technical or financial issues, but also to issues of market regulation and, in general, energy policy of the state.

The analysis showed that the most promising areas for the development of RES in Armenia are solar, wind, bio-, geothermal and small hydropower. In turn, small hydropower and solar energy (the energy sectors with a number of successfully implemented projects), should be particularly highlighted. As for wind, geothermal and bioenergy, the assessed potential allows us to talk about the prospects for their development in the case of a well-structured and effective state energy policy and, in particular, improving the investment climate in the energy sector and in the economy as a whole.

References

1. "Law on Energy Efficiency and Renewable Energy", November 9, 2004/
<https://www.arlis.am/DocumentView.aspx?DocID=67719>.
2. **100 years** of energy in Armenia / Ed. L.V. Yeghiazaryan and others - Yerevan: Media-Model Publishing House, 2003. - 192 p. (in Rus. And Arm.).
3. **Panosyan Zh., Marukhyan V.** New technological developments for the production of efficient and competitive solar power plants // First Congress of Renewable Energy. – Yerevan, 2003. – P. 96.
4. **First floating** solar power plant to be built in Armenia // https://finport.am/full_news.php?id=44072&lang=3.
5. **Odabashyan V., Khachatryan S.** Renewable energy in the Republic of Armenia // 21st century: Information and analytical journal. – Yerevan, 2007. – 2(6). – pp. 143-158. (in Rus.)
6. **Davtyan V., Tevosyan O.** Trends in the development of energy policy in Armenia. – Yerevan, Korad Adenauer Foundation, 2019. – 144 p. (in Arm.).
7. **Zod Wind** demands \$5 million from the Armenian government for not protecting business from Azerbaijanis // <https://ru.armeniasputnik.am/politics/20210527/27713395/Kompaniya-Zod-Wind-podala-isk-protiv-kabmina-Armenii-iz-za-proniknoveniya-azerbaydzhantsev.html>.
8. **The decision** to set a 64 million AMD compensation fee for small HPPs that use a lot of water is a direct blow to the state // <https://www.tert.am/am/news/2019/09/10/letter/3090150>.

Վ.Ս. Դավթյան

ՀԱՅԱՍՏԱՆՈՒՄ ՎԵՐԱԿԱՆՁՆՎՈՂ ԷՆԵՐԳԵՏԻԿԱՅԻ ԶԱՐԳԱՑՄԱՆ ՀԻՄՆԱԿԱՆ ՄԻՏՈՒՄՆԵՐԸ. ԷՆԵՐԳԵՏԻԿ ՎԵՐԱՓՈԽՄԱՆ ՄԱՐՏԱՀՐԱՎԵՐՆԵՐԸ

Հայաստանում վերականգնվող էներգիետիկայի զարգացման հիմնական միտումները դիտարկվել են կայուն զարգացման և էներգետիկ վերափոխման մարտահրավերների համատեքստում: Սահմանվել է, որ վերականգնվող էներգետիկայի զարգացումը Հայաստանի էներգետիկ անվտանգության համակարգի դիվերսիֆիկացման առանցքային ուղղություններից է: Վեր են հանվել ոլորտի զարգացման հիմնական ուղղությունները: Մասնավորապես, վերլուծվել են արևի, հողմային, երկրաջերմային և կենսաէներգետիկայի զարգացման հնարավորությունները: Հատուկ ուշադրություն է դարձվել Հայաստանում փոքր հիդրոէներգետիկայի զարգացման ներուժին: Ցույց է տրվել, որ նշված ճյուղերի լիարժեք և համակարգված զարգացումը հնարավոր է միայն պետության և մասնավոր հատվածի միջև արդյունավետ համագործակցության արդյունքում: Առանձին դիտարկվել են Հայաստանում արևային և հողմային էներգիետիկայի զարգացման արտաքին վրանգները:

Առանցքային բառեր. Հայաստան, վերականգնվող էներգետիկա, էներգետիկ վերափոխում, անվտանգություն, դիվերսիֆիկացում:

В.С. Давтян

ОСНОВНЫЕ ТЕНДЕНЦИИ РАЗВИТИЯ ВОЗОБНОВЛЯЕМОЙ ЭНЕРГЕТИКИ В АРМЕНИИ: ВЫЗОВЫ ЭНЕРГЕТИЧЕСКОГО ПЕРЕХОДА

Рассмотрены основные тенденции развития возобновляемой энергетики в Армении в контексте вызовов устойчивого развития и энергетического перехода. Установлено, что развитие возобновляемой энергетики является одним из ключевых направлений диверсификации системы энергетической безопасности Армении. Выявлены главные направления развития отрасли. В частности, проанализированы возможности развития солнечной, ветряной, геотермальной и биоэнергетики. Особое внимание уделено потенциалу развития малой гидроэнергетики в Армении. Показано, что полноценное и системное развитие указанных отраслей возможно лишь при наличии эффективного государственно-частного партнерства. Отдельно рассмотрены внешние риски развития солнечной и ветряной энергетики в Армении.

Ключевые слова: *Армения, возобновляемые источники энергии, энергетический переход, безопасность, диверсификация.*

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