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## Article

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## Challenges in Implementing Renewable Energy Sources in Azerbaijan

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### ABSTRACT

The gradual reduction of fuel resources, their depletion, as well as volatility of fuel prices led to a growing interest of countries in the use of renewable energy sources. Despite the fact that energy production in Azerbaijan currently largely depends on development of hydrocarbon reserves in the country, nevertheless, development of renewable energy sources is certainly one of the strategic priorities of the government. The main objective of the research is to study the economic problems and institutional aspects of introduction of alternative energy in Azerbaijan and develop recommendations to stimulate production of renewable energy. With the help of methods of comparative analysis and dynamic comparisons, the state of development of alternative and renewable sources in Azerbaijan was analyzed. The results of the study show that in order to increase the production of renewable energy it is necessary to take a number of measures in this area: improve legislation, introduce state incentives for consumers of alternative energy, apply a green tariff to attract investment, ensure transparency and consistency of energy policy.

**Keywords:** Alternative Energy, Renewable Energy, Energy Sources, Azerbaijan

**JEL Classifications:** O10; Q42; Q48

### 1. INTRODUCTION

Coal, oil and gas were used as the main energy carriers for a long time in the world. After the first oil crisis of 1973, countries began to make significant strides in diversifying their energy sources and using alternative sources of energy. This was especially true for energy importing countries. By the 2000s, use of renewable energy sources (RES) began to increase rapidly. Certainly, hydrocarbon resources will still play an important role in the global market. However, most experts around the world point out that hydrocarbon resources will go by the wayside in the energy market one day. As the International Energy Agency estimates, in 2030 global energy demand will increase by 50% (IEA, 2019).

According to the International Renewable Energy Agency (IRENA) report “Renewable Energy Potential Statistics for 2021”, the growth of renewable energy potential in the world in

2020 was 50% higher than in 2019. About 91% of green energy comes from investments in wind and solar energy. During this period, 127 gigawatts of solar energy and 111 gigawatts of wind energy were put into operation. As noted in the IRENA report, by 2050, renewable energy sources will satisfy 86% of the world's energy needs (IRENA, 2021). This is an extremely ambitious, but necessary goal for the future of the world. Since it is impossible to meet the growing demand with completely traditional energy resources, both in terms of quantity and efficiency, the development of alternative energy sources is of great importance.

The experience of the countries using renewable energy resources shows that the advantage of using this energy is that it does not cause any environmental problem and does not pollute nature with harmful emissions. There are several advantages of using renewable energy:

- Ensuring energy security;

- Improving the energy supply of community members and reducing poverty;
- Improvement of the environment;
- Increased investment in energy development. The International Energy Agency considers it is necessary to attract investment in the amount of \$ 568 billion on average annually in this field including energy sector by 2030 to meet the growing energy demand, half of which is accounted for developing countries) (IEA, 2019);
- Development and distribution of energy technologies;
- Expansion of energy trade.

It should be noted that countries engaged in the production of alternative types of energy accept the alternative energy production project not only as economic, but also as an environmental project.

Despite the fact that Azerbaijan has rich mineral resources, the government also pays great attention to use of renewable energy sources. This is evidenced by a number of measures to introduce green energy in Azerbaijan: adoption of the State Program on use of alternative and renewable energy sources in 2004; Azerbaijan's entry into the International Renewable Energy Agency (IRENA) in 2009; creation of the State Agency for Alternative and Renewable Energy Sources; exemption of import of equipment, installations, facilities used in alternative and renewable energy from VAT and customs duties from 2014 for 10 years (Interfax, 2014). However, despite all this, the volume of renewable energy is much less than that of conventional energy. So, about 5.5% of 25811,2 million kWh of electricity generated in Azerbaijan in 2020, that's, 1413,0 million kWh, was produced by water, wind and solar power plants (Ministry of Energy, 2020). There are a number of institutional problems in the country regarding the widespread use of alternative energy, and the necessary legal framework is lacking.

The main purpose of the study is to consider various economic problems related to the implementation and use of alternative and renewable energy sources in Azerbaijan, to offer recommendations and proposals related to the promotion of the use of renewable energy sources in the country.

## 2. BRIEF LITERATURE REVIEW

A large number of studies on renewable energy are currently published. However, there is not enough research to reveal the trends and characteristics of renewable energy in Azerbaijan from the perspective of the economy. The studies practically lack an assessment of the possibilities of using world experience in introducing renewable energy sources to develop mechanisms for development of the Azerbaijani economy, support and monitor the process of attracting foreign investment in the industry under study. The reason is the lack of a system of accumulating advanced foreign experience in the field of renewable energy.

The theoretical and methodological basis of the study was the scientific works of Azerbaijani scientists in the field of renewable energy – Hasanov, Mukhtarov, Mikayilov (2019), Vidadili et al. (2017), Mustafayev et al. (2022), Aydin (2019) as well as scientific

developments of foreign authors such as Banos et al. (2011), Akella et al. (2009), Karpenko et al. (2015).

From a methodological point of view, the recommendations, reports and papers of the United Nations, the International Energy Agency, the Organization for Economic Cooperation and Development, the European Council on Renewable Energy, the World Bank, and Renewables Global Status Report 2020 are important.

The article used theoretical and empirical, fundamental and applied research methods. The used methods are based on the results of empirical analysis and modern data obtained from reliable sources, official statistics, Azerbaijani and international databases.

## 3. RESULTS

### 3.1. Brief Analysis of the Energy Sector of Azerbaijan

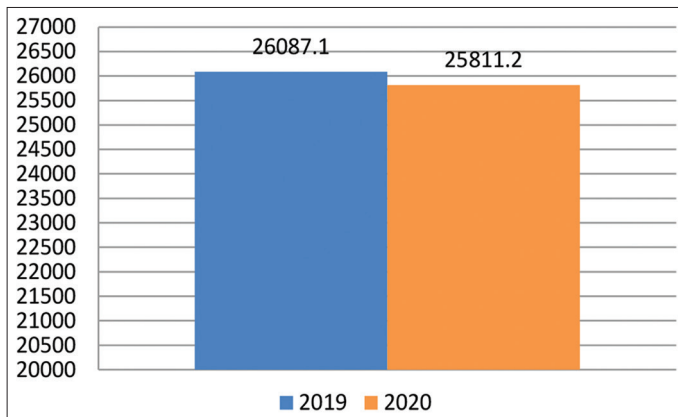
Azerbaijan is an electricity exporter. The country exports oil, natural gas and electricity. Azerbaijan currently meets its energy needs through domestic production, which is heavily dependent on the use of the country's hydrocarbon resources, more specifically oil and natural gas. Azerbaijan's proven oil reserves in the Caspian Basin, which it shares with Russia, Kazakhstan, Turkmenistan and Iran, are estimated at 7 billion barrels in 2019 and are comparable to the North Sea's reserves of several decades ago (BP, 2021).

According to the State Statistical Committee of the Republic of Azerbaijan, the production of electricity in the country amounted to 25,811.2 million kWh in 2020. During the reporting period, electricity production was 24,398.2 million kWh at thermal power plants, 1,069.5 million kilowatt-hours at thermal power plants, and 343.55 million kWh at other sources. In 2020, 96.1 million kWh of electricity was generated at wind farms, 46.9 million kWh at solar power plants, and 200.6 million kWh at the Solid Waste Incineration Plant. Electricity generated from renewable energy sources accounted for about 5.5% of total production. In this period, electricity exports amounted to 1147.8 million kWh, while imports amounted to 136.3 million kWh (The State Statistical Committee of the Republic of Azerbaijan, 2021).

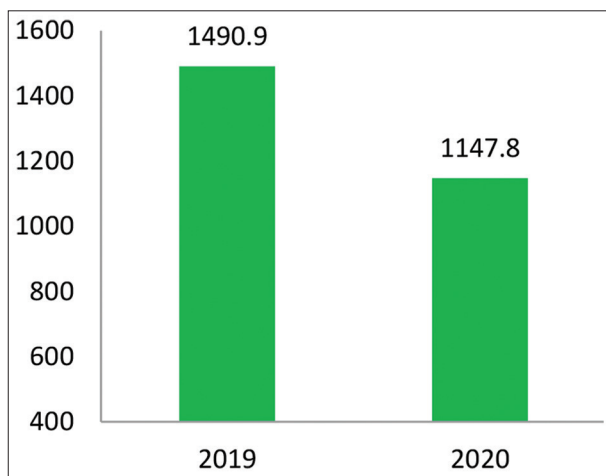
Indicators on electricity in Azerbaijan in 2019-2020 (Figures 1-3) (The State Statistical Committee of the Republic of Azerbaijan, 2021):

According to the State Statistics Committee of the Republic of Azerbaijan, since 2005, the share of renewable energy sources in Azerbaijan in the total installed energy has gradually begun to increase. The share of power plants generating electricity from renewable energy sources, which was 33% in 2005, increased to 51.7% by the end of 2020. The renewable energy support mechanism has played a key role in this growth.

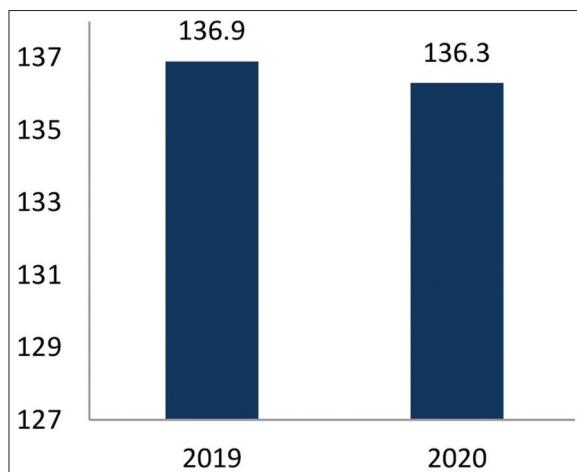
Figure 4 shows the dynamics of energy supply from renewable sources in the Republic of Azerbaijan for 2016-2020. As can be seen from the figure, in recent years, the total volume of energy supply from renewable sources has been declining. If in 2018 this indicator was at the level of 273.2 thousand TOE, then in 2020 it fell to 212.7 thousand TOE (The State Statistical Committee of the Republic of Azerbaijan, 2021).

**Figure 1:** Electricity generation (mln kWh)

Source: The State Statistical Committee of the Republic of Azerbaijan (2021)

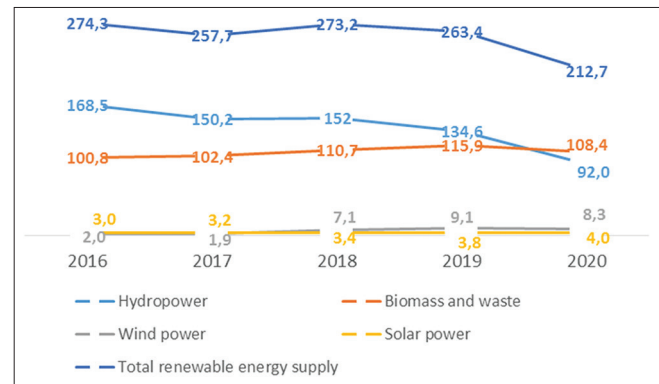
**Figure 2:** Electricity export (mln kWh)

Source: The State Statistical Committee of the Republic of Azerbaijan (2021)

**Figure 3:** Electricity import (mln kWh)

Source: The State Statistical Committee of the Republic of Azerbaijan (2021)

From renewable sources, until 2019, hydropower prevailed, and in 2020, the production of biomass and waste energy began to

**Figure 4:** Renewable energy supply, thousand TOE

Source: The State Statistical Committee of the Republic of Azerbaijan (2021)

exceed the volume of hydropower production in the country. Despite the small share of wind and solar energy, compared to 2016, their supply increased in 2020 by 4.15 times and 1.33 times, respectively.

As can be seen from the Figure 5, the share of renewable energy sources in comparison with the total energy production and consumption is declining from year to year, which indicates problems in this area.

### 3.2. Potential Available for Use of Renewable Energy Sources

It goes without saying that the use of renewable energy directly depends on the climatic conditions and characteristics of any country or region. Favorable geographical location and climatic conditions enable wide use of environmentally friendly renewable energy sources in Azerbaijan. Involvement of renewable sources of energy into the production of electricity and thermal energy, using the country's natural potential, will allow for making progressive changes in the future development directions of electric power industry.

Azerbaijan has wide reserves of renewable energy of all types: solar, wind, geothermal, hydropower and biomass. The most important and used type of renewable energy sources in Azerbaijan is hydropower obtained from small hydropower plants located on rivers. Due to its favourable location and natural conditions, there is potential for use of solar energy. The report by the International Energy Agency (IEA) states that solar radiation on the horizontal surface throughout Azerbaijan is 1,566 kWh/m<sup>2</sup> (IEA, 2020). According to the IRENA classification, this refers to the "favourable" and "very favourable" classes of energy potential. The high average annual wind speed, especially in the coastal part of the Caspian, provides an opportunity for efficient use of wind energy. The average annual wind speed throughout the Absheron Peninsula is 7.7 m/s, therefore, installation of windmill power plants in this zone is suitable (IRENA, 2020). The waste from the country's widespread agricultural production may be intended for burning biomass or gasification. There is also the potential for using geothermal energy for heat supply purposes due to the relatively low temperatures in the wells.



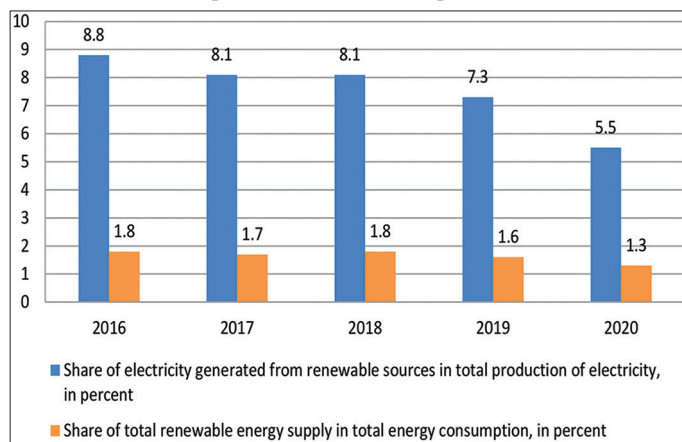
According to the Azerbaijan Ministry of Energy for 2020, the renewable energy potential in the country is estimated at 26,940 MW, including 3,000 MW – wind energy, 23,040 MW - solar energy, bioenergy - 380 MW, mountain river potential - 520 MW. Currently, the total capacity of electricity production in Azerbaijan is 7,144 MW, the capacity of renewable energy plants, including large hydropower plants, is 1,273 MW, which is 18% of the total capacity. According to 2020 data, the total power generation capacity of Azerbaijan is 7621.6 MW, the capacity of power plants on renewable energy sources, including large hydropower plants, is 1295.5 MW, which is about 17% of the total power (Ministry of Energy, 2020).

The country has 21 hydroelectric power stations with a capacity of 1149,4 MW (of which 11 are small hydroelectric power stations), a plant for disposal of municipal solid waste with a capacity of 44 MW, 4 wind farms with a total capacity of 66 MW, 7 solar power plants with a capacity of 35,1 MW and one hybrid power plant (Ministry of Energy, 2020).

Information on available stations for the production of alternative energy sources in Azerbaijan is presented in Table 1:

In addition, one hybrid power plant (in Gobustan) is equipped with 2.7 MW of wind energy, 3 MW of solar and 1 MW of bioenergy. There are 2 solar power plants with a total capacity of 27 MW in the Nakhchivan Autonomous Republic. The installed capacity of renewable energy sources, excluding large hydropower plants, in 2020 amounted to 168.3 MW, which is 2.2% of the total electricity generation capacity (PEEREA, 2020).

**Figure 5:** The share of renewable energy sources in total energy production and consumption



Source: The State Statistical Committee of the Republic of Azerbaijan (2021)

**Table 1: Types of stations for the development of alternative energy sources**

Types of stations	Power, MW	Number of stations	Number of hybrid stations
Hydropower	1149,4 MW	22	-
Wind energy	66 MW	5	1
Bioenergy	45 MW	2	1
Solar energy	35,1 MW	9	1

Source: Ministry of Energy of Azerbaijan Republic

According to the executive agreement between the Ministry of Energy of Azerbaijan and ACWA Power of Saudi Arabia, the foundation of the 240 MW Khizi – Absheron Wind Power Plant to be built in Azerbaijan on January 13, 2022 has been laid, the investment cost of the project is \$ 300 million. According to the order of the President of the Republic of Azerbaijan, it is planned to increase the share of renewable energy sources in the total investment capacity of the country to 30% by 2030 (ACWA Power, 2020). According to a report prepared by the German company VPC, in order to achieve the 30% target, new renewable energy plants with a total installed capacity of 1,500 MW must be installed in our country by 2030, which of these, 440 MW in 2020-2022, 460 MW in 2023-2025 and 600 MW in 2026-2030 were considered to be expedient to be integrated into the network in 3 stages (IEA, 2021). In order to select sites for potential solar power plants in 16 regions of Azerbaijan, preliminary research was conducted, 20 areas with a total area of 9,218 hectares and a capacity of 4,609 MW were selected in 11 regions. Power generation from these areas is projected to be 6.1 billion kWh (IEA, 2021).

### 3.3. Key Issues in the Field of Renewable Energy

In our opinion, one of the main reasons why renewable energy production in Azerbaijan is so weak is the high cost of renewable energy in our country compared to traditional types. The higher prices for alternative energy against the background of low oil prices in the world market have reduced the interest in alternative energy in many countries, especially in energy-rich countries. High costs and expenses are considered as one of the main challenges. This is also due to the high cost of technology. In addition, the tradition of using renewable energy in Azerbaijan is relatively weak compared to some developed countries. We consider that there is a need for further research on the use of renewable energy sources in Azerbaijan. In this way, along with the use of wind energy, it is also possible to effectively benefit from other alternative sources of energy and increase the volume of these sources in total energy consumption. In addition to the above, two main barriers to the spread of renewable energy can be distinguished in Azerbaijan:

- Insufficient incentives and inadequate current tariff calculation methodology;
- Insufficient regulatory framework and lack of rules for connecting to networks (IRENA, 2019).

Despite the approval of a number of important laws, legislative documents and state programs in Azerbaijan aimed at improving the environmental situation in the country, the country does not have a strategy, action plan, legislation in the field of energy efficiency. Establishment of institutional infrastructure in the field of energy efficiency is at a very early stage. A significant problem is also the low interest of the population and organizations in the use of renewable energy, due to the lack of a special strategy for development of renewable energy in the regions.

It is known that the development of the renewable energy sector in the country is possible as a result of large investments. Thus, by 2020, global investment in renewable energy potential has increased by 2%, after surviving the economic crisis from COVID-19 (Hoang et al., 2021). New global investments in

renewable energy and fuel (excluding water projects larger than 50 MW) in 2020 amounted to \$ 303.5 billion (Renewables, 2021).

However, investment in this area has varied from country to country, with investment increasing by 13% in developed countries in 2020 and declining by 7% in developing countries. Investments in renewable energy sources are mainly focused on wind and solar energy generation. Thus, in 2020, the production of these types of energy amounted to 148.6 billion US dollars (12% increase), which is about half of the total investment in renewable energy sources (Renewables, 2021). The experience of other countries (USA and China) shows that one of the main directions of increasing investment in renewable energy production is to ensure state-business cooperation in this area.

World experience also shows that the application of this model has a positive impact on the socio-economic development of the country, while creating a perfect legal framework for the development of public-private partnership. Because the legal framework determines the legal framework of the contract, such as how the state will conclude a private partnership agreement, how long it will be, and how the responsibility for the service will be distributed. In countries implementing public-private partnerships, they have created a legal framework for these models. In this regard, the law “On state-business cooperation” should be prepared in Azerbaijan.

In addition, one should take into account the fact that the energy sector in Azerbaijan remains largely state-owned. All of Azerbaijan’s electricity is controlled by one vertically integrated state-owned company, “Azenergy” OJSC. It has a monopoly in both the production and transmission, distribution, and supply of electricity. There are several small hydroelectric power plants in private ownership, which generate less than 1% of the country’s total electricity (IEA, 2020). Therefore, one of the problems is the lack of a competitive electricity market in the republic, which is unattractive for investors.

All these problems require solutions that can increase availability of renewable energy, provide necessary level of automation, interest people and organizations in the use of renewable energy through advertising and state propaganda.

### 3.4. Recommendations

The government should give high priority to improving the efficiency of use of renewable energy. Future energy policies should be supported by a detailed analysis of the economic potential of energy efficiency in all sectors of the economy, as well as an analysis of the obstacles to realization of this potential. The Ministry of Energy should develop institutional capacity to analyze and evaluate energy efficiency for development of future policies, including decisions on financing issues. Reconstruction of assets in the segments of production, transmission and distribution in the electric power industry should continue. This will maximize the efficiency of fuel combustion and minimize technical losses during transmission and distribution. Energy policies and strategies should be transparent and consistent, include long-term goals, envisage implementation of energy efficiency programs, and define

objectives for key sectors. A huge impetus to use of renewable energy can be provided by subsidizing these technologies by the state. An important factor in stimulating and attracting investments in technologies for production of renewable energy is use of the green tariff. The principle of the green tariff is that the state undertakes to buy energy produced using renewable energy sources from legal entities and individuals. Also, the green tariff enables citizens to establish mini-stations for generating energy on economically advantageous conditions.

## 4. CONCLUSIONS

Significant fuel and energy reserves are one of the main obstacles in Azerbaijan for development of renewable energy. However, the huge opportunities and resources of renewable energy can help reduce dependence on traditional sources, attract significant investment in the economy, and improve the environmental situation in the region with proper government support. If Azerbaijan succeeds in implementing all the planned measures for development of renewable energy, then the volumes of renewable energy production may be on a par with the developed countries of the world in the near future already.

While there are no strict rules for successful public-private partnerships, team approaches are a proven way to stimulate renewable energy markets. Coordination between the public and private sectors at the national or local level is challenging, but achievable. Recognition, support and encouragement of public-private cooperation, meeting common needs and participating in joint problem solving are the keys to success. Creating and maintaining an attractive business-friendly market mechanism is also essential to the successful creation and continued growth of any new industry. The government must understand the motivating factors for renewable energy companies to enter a new market and provide them with different incentives and privileges.

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In countries engaging in alternative energy production, a stable price guarantee, unauthorized production and financial incentives (VAT exemption, customs duty exemption, etc.) are used to stimulate this production. We consider that it is also important to increase the interest of private companies in the use of renewable energy. For this purpose, special incentive discounts are required as the main condition. Private companies not only will be involved in alternative energy use in this way, but also will be interested in investing in alternative energy.

We consider that it is important to work in the below mentioned areas to achieve increase in renewable energy production in Azerbaijan: achieve in the improvement of legislative base in this field; provide government incentives for renewable energy producers; achieve in the development of infrastructure areas serving this field (for ex. Panel production); provide privileges in the development of new technologies for alternative energy producers and in the transfer from foreign countries.

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