Economic Potential for the Development of Renewable Energy Sources in Azerbaijan

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Abstract

Even though the oil and gas complex is a leading part of the Azerbaijani economy, other areas of the economy also influence the country's socio-economic development. In this case, renewable energy sources are no exception. Favorable natural conditions and the country's geographical location are among the factors for the effective use of this type of energy supply. In the current conditions, when the period of accelerated growth in oil and gas production in Azerbaijan has ended, the continuation of the most influential and productive development of the country should be provided based on the large-scale application of an innovative method of managing available resources and the systematic introduction of incentive mechanisms that will ensure further progress towards innovation. For these purposes, it is of particular interest to the scientific study of the accumulated experience in the formation of organizational and economic development mechanisms in these industries, the implementation of appropriate generalizations in the realities of reforming the oil and gas industries, and the systematic improvement of mechanisms for ensuring sustainable development. The main goal of this study is to assess the economic potential of green energy development in Azerbaijan. The efficiency of this sector was also analyzed, and the hypothesis about the impact of market prices for gas and oil on the renewable energy supply was tested.

Keywords: Sustainable Development, Decarbonization, Low-carbon Energy, Energy Transition, Energy Policy.

Introduction

Azerbaijan's ambitious goals are to reduce greenhouse gas emissions by 35 percent by 2030 and 40 percent by 2050 from 1990 levels. The country's energy policy prioritizes the development of green energy and its export to world markets to achieve a 30 percent share of renewable energy sources in total electricity production by 2030.

The unanimous decision to host such a prestigious event in Azerbaijan as the 29th session of the Conference of the Parties to the UN Framework Convention on Climate Change–COP29–is a clear example of the great respect and trust in Azerbaijan from the international community, as well as approval of our country's contribution to environmental protection and preventing climate change at the national, regional, and global levels.

Guided by paragraph 32 of Article 109 of the Constitution of the Republic of Azerbaijan, in order to strengthen international solidarity in the global fight against climate change, the head of state decided to declare 2024 in the Republic of Azerbaijan the "Year of Solidarity for the Green World."

Thus, the prospects for developing the alternative energy market in Azerbaijan potentially open up opportunities for many companies with relevant competencies to implement various projects in wind energy and solar generation, hydropower, and other areas of the "green" energy agenda.

Conceptual Aspects of the Use of Traditional Resources and Renewable Energy Sources in Azerbaijan

The Republic of Azerbaijan is a state that has achieved unexpected economic development results, both due to its successful domestic policies and because Azerbaijan is rich in valuable resources and minerals. After the Republic of Azerbaijan gained independence from the USSR, Azerbaijan pursued a successful social policy. The transition to a market economy was the only option, and Azerbaijan achieved this. Azerbaijan has large deposits of oil and gas, which helps to develop the oil and gas, petrochemical, and oil refining industries of Azerbaijan.

In order to successfully study the characteristics of using renewable energy sources and traditional resources such as oil and gas, you first need to understand what energy resources are and what types of energy resources exist. Energy resources are available for Azerbaijan's domestic and industrial development. Energy is divided into renewable and non-renewable energy, as well as nuclear. By type of origin, energy resources are divided into renewable and non-renewable fuels, energy from natural processes, and nuclear energy. Humanity exploits such types of energy as nuclear, thermal, chemical, and mechanical. The Republic of Azerbaijan's traditional energy sources include gas, oil, and electricity. These three industrial sectors create the country's fuel and energy complex.

Renewable energy sources, called "green" energy, are inexhaustible, such as solar energy. The most crucial principle of why renewable energy is used is that it is obtained from natural processes that occur constantly. Renewable energy is extracted from natural resources, such as sunlight, water flows, and wind, which are renewable and replenished naturally through natural processes.

Some researchers point out that analysis of the development trend of renewable energy has shown that in many countries, solar energy is gradually taking first place as the cleanest energy generator, followed by wind turbines (Hyginus et al., 2023). Still, it depends on the country's geographical location. For example, wind energy is in the lead in Moldova, and solar energy is in second place (Gutium, 2021). The transition of part of the energy sector to renewable energy sources has several positive effects: economic growth of the national economy (Candra et al., 2023) (Jie et al., 2023) (Yongjun Lv, 2023), sustainable development (Adamowicz, 2022) (Bogdanov et al., 2021), cost-effective electricity generation (Ang et al., 2022), increased employment, reduction of poverty (Rutskiy & Filippov, 2022) (Gutium et al., 2023), and limit global temperature rise (Osman et al., 2022) (Rahman et al., 2022).

The Aim and Approaches Used In Economic Impact Assessment

On July 16, 2009, by the decree of the President of the Republic of Azerbaijan, the Agency for Alternative and Renewable Energy Sources of the Republic of Azerbaijan was created under the Ministry of Industry and Energy. The Agency's main goals were to provide the country with alternative energy sources. Before the creation of the Agency, there was a "State Program for Alternative and Renewable Energy Sources in the Republic of Azerbaijan," approved by decree of the President of the Republic of Azerbaijan in October 2004.

In 2015, a wind farm called Yeni Yashma was built. Its power reaches 50 MW. This power plant was put into operation in 2018. Azerbaijan plans to use the windy Caspian Sea to expand its alternative energy potential. Wind power plants will be built on the shelf in an area characterized by strong winds.

During this period, the total electricity generation capacity in the country is 7,200 megawatts. Azerbaijan can produce about 24 billion kilowatt-hours and export 2.1 billion kilowatt-hours of electricity annually. Azerbaijan has alternative electricity tariffs, depending on the region.

Direct impact

When the "Contract of the Century" was signed in 1994, proven oil reserves in Azerbaijan amounted to 511 million tons. Azerbaijan produced 32.6 million tons of oil and 46.7 billion cubic meters of gas 2022. The State Oil Company of Azerbaijan claims that oil reserves in the Azeri-Chirag-Gunashli block amount to 2 billion tons, of which only 1.2 billion are being extracted. In Azerbaijan, you can provide for yourself. At thermal power plants in Azerbaijan, 90% of energy is generated by burning natural gas. Hydroelectric power plants and alternative energy sources produce 6%. Azerenergy JSC and AzerIshig are possible electricity producers in Azerbaijan. On December 6, 2016, strategic dangerous maps were approved in the national economy, which caused a slowdown in the development of the Azerbaijani economy and, first of all, the economy.

Possible energy sources on the territory of Azerbaijan are all the inexhaustible sources of energy produced there. Azerbaijan's most important renewable energy sources are hydropower, wind, and solar.

Indirect impact

Green policies have a significant impact on the process of social development in many countries, especially in Western Europe, as well as on the gradual transition from non-renewable to renewable energy sources.

Only recently has humanity realized the negative impact of using traditional resources for energy supply on the environment. Even though many UN (United Nations) meetings and conferences have occurred over the past few years, most countries still fail to reach a consensus.

In 2022, the European Union received more energy from renewable energy sources than from burning natural gas for the first time in history. This information is provided in a report published by the Ember think tank, which studies EU climate policy.

According to its data, published on January 31, 2023, last year, solar and wind sources accounted for about 22 percent of electricity production in the EU–more than ever before. At the same time, gas flaring produced about 20 percent–one percentage point lower than in 2021.

The EU produced 203 terawatt-hours (TWh) of solar energy in 2022, up 39 TWh, or 24 percent, from the previous year. This has reduced gas procurement costs by approximately 10 billion euros, according to a report published by Ember. Wind energy gave the EU 420 TWh, 33 TWh more than in 2021. In 2023, global renewable energy capacity increased by half compared to the previous year, reaching 510 gigawatts (GW). According to a new report from the International Energy Agency (IEA), this growth was the highest in the last two decades. According to expert forecasts, by 2028, the share of renewable energy sources in the global electricity supply will exceed 42%. In 2023, 96% of new solar and onshore wind capacity were found to be more cost-effective for generating electricity than new coal and gas power plants. It is important to note that the price of solar panels has decreased by almost 50% year-on-year, and production volumes have tripled compared to 2021. In December 2023, at the UN Climate Change Summit (COP28), more than 120 countries agreed to triple the world's renewable energy production capacity by 2030 to reduce the use of fossil fuels.

In 2022, the share of renewable energy sources in the global energy balance increased by 1.5 points,

reaching 30%, 10 points above the 2010 level. The share of renewable energy sources is exceptionally high in countries with extensive hydro resources, such as Brazil, Colombia, Canada, New Zealand, Sweden, and Norway, where they account for more than 2/3 of the total electricity produced. In other countries, ambitious renewable energy policies and falling costs of generating electricity from solar and wind technologies have stimulated increased renewable energy production and significantly increased their share of the energy mix.

Induced impact

On November 10, 2020, the military operation of the Republic of Azerbaijan to liberate Karabakh from the Armenian occupiers ended. More than 30 years of exile from their homeland, they have affected the region's social, economic, and political state. Cities turned into ruins. Lonely Planet magazine called the city of Agdam "the Hiroshima of the Caucasus."

However, liberated lands are currently of great value in all areas, including developing renewable energy. Many projects were signed by decree of the President of the Republic of Azerbaijan. The most sensational among them are the Smart City and Smart Village projects. The Smart City project will include Agdam itself and about eight villages. The territory of Agdam will be approximately 1800 hectares, and 2500 hectares will be suburban plantings, i.e., gardens. The population will be 100,000, allowing Aghdam to become the largest city in Karabakh and the sixth largest in Azerbaijan. Approximately 70% of the population is expected to be housed in apartment buildings and the rest in private houses. In the first stages, 1,750 residential buildings and 24,000 apartments in multi-apartment buildings will be built. A forest park will also appear in Agdam. Almost a quarter of the city will have forested areas (green zone).

Hydropower potential. Karabakh has rich renewable energy resources. In Azerbaijan, Karabakh is one of the main areas where local water resources are formed. 25% of Azerbaijan's local water resources, about 2 billion 560 million cubic meters of water, are formed annually in this region. Large rivers of the province, such as Terter, Bazarchay (Bargushadchay), Khakari, and other small rivers, have excellent water and energy potential. Some have been used since the Soviet period, but most may be used in the future.

Three sizeable hydroelectric power stations operated in the occupied territories of Azerbaijan, one of which was the Tartar hydroelectric power station, built in 1976 in the Tartar region along with the Sarsang reservoir on the Tartarchay River. The station includes two hydraulic units, each with a capacity of 25 MW. Sarsang is a reservoir with one of the highest dams in the country in terms of dam height (125 meters). The Sarsang reservoir provided about 125 thousand hectares of 6 districts (Tartar, Agdam, Barda, Goranboy, Yevlakh, and Agjabedi) with irrigation water.

Long-term impact

In order to develop the renewable energy industry in our country and improve the legislative and institutional environment in this area, the necessary laws and regulations have been adopted. The work carried out in this area over the past years has been successfully continued, and the Law of the Republic of Azerbaijan No. 339 of May 31, 2021, "On the use of renewable energy sources in electricity production," was adopted, which makes a unique contribution to the development of renewable energy. In order to ensure the execution and application of the law, appropriate measures are taken to prepare by-laws.

The fifth paragraph of "Azerbaijan 2030: National priorities for socio-economic development" ("Clean Environment" and "Green Growth Country"), adopted by Presidential Decree dated February

2, 2021, pays attention to the issues of changing climate conditions and countering them, as well as the use renewable energy sources in all sectors of the economy based on the introduction of the principles of creating a green energy space in our country.

Thus, in connection with the identified priority areas of the country's socio-economic development, in the present and future periods, more attention is being paid to using renewable energy sources and expanding the scope of implementation of "green" technologies. As part of the ongoing work in this area, specialized internal research continues throughout the republic to identify and prioritize areas with opportunities for using renewable energy sources. Particular attention is also paid to national priorities in implementing the responsibilities arising from the UN resolution "Transforming our world: the 2030 Agenda for Sustainable Development".

The total electricity production capacity in Azerbaijan is 7542.2 MW, and the capacity of power plants using renewable energy sources, including large hydroelectric power plants, is 1304.5 MW, 17.3% of the total capacity.

Interest in successfully developing the state's economy requires more active use of investment potential. World experience shows that for the successful development of the economies of Western European countries, foreign direct investment at different times became one of the essential elements of economic relations, contributing to economic growth, increasing scientific, technical, and structural potential, and structural restructuring of the economy. Foreign investment plays a vital role in reforming the economies of Eastern Europe, China, and Southeast Asia.

In the field of renewable energy, Azerbaijan can benefit from increased incentives for investment in this sector of the economy and from an increased role of organizational and economic means in increasing the competitiveness of green energy and using traditional energy resources.

The main goal is implementing renewable energy projects in the liberated territories with foreign investment: the concept of "green energy" is planned to build a 100-megawatt wind power plant in Kelbajar and Lachin with foreign investment. The main objective of the flow of new capital investment is to increase the share of renewable energy in total energy production in Azerbaijan from 17% to 24% in 2025 and 30% in 2030. For this purpose, it is planned to create a production capacity of 1,500 MW. The primary task for implementing a program to improve alternative and renewable energy supply resources is to create favorable conditions for investors.

In order to successfully study the characteristics of using renewable energy sources and traditional resources such as oil and gas, you first need to understand what energy resources are and what types of energy resources exist. Energy resources are sources of all energy available for Azerbaijan's domestic and industrial development. Energy is divided into renewable and non-renewable energy, as well as nuclear. By type of origin, energy resources are divided into renewable and non-renewable fuels, energy from natural processes, and nuclear energy. Humanity exploits such types of energy as nuclear, thermal, chemical, and mechanical.

Prospective development and implementation of renewable energy sources in Azerbaijan

Azerbaijan has not yet fully exploited its potential in renewable energy and energy efficiency. However, the government has already prepared several laws for this purpose, which are being approved. Greater ambitions and efforts in renewable energy and energy efficiency will also enable the country to save natural gas and oil for export and meet its greenhouse gas emissions commitments.

With long-term energy independence at the center of Azerbaijan's energy policy, it recognizes the

importance of diversifying its economy, increasing energy efficiency, and supporting emissions reduction programs. Therefore, it supports the development of renewable energy sources with the following objectives: 1) Recognition of the capabilities of alternative and renewable energy sources in electricity generation. 2) Study of alternative and renewable sources to improve energy efficiency. 3) Providing jobs in research innovation to develop new energy production technologies. 4) Diversifying and improving the country's energy potential to ensure energy security.

Azerbaijan has significant untapped potential for renewable energy. The country is relatively sunny and windy and has significant hydropower, biomass, and geothermal energy resources (Table 1).

Industry	March	June	September	December	Average annual rate
Baku	6.9/7.5	6.5/6.2	6.2/4.7	5.6/4.8	6.3/67
Oil stones	6.9/6.9	5.3/3.3	6.4/4	6.7/4	6.2/52
Mardakan	6.6/7.4	5.8/4.7	5.4/5.2	5.6/4.6	5.9/67
Mashtaga	6.7/7.9	5.7/4.2	5.3/4.7	5.6/4.6	5.9/67
Devechi	4.6/4.8	4.6/4.2	4.6/5	4.1/3.4	4.5/51
Neftchala	4.8/3.8	4.4/2.3	4.2/2.9	3.7/1.9	4.2/30

Table 1: Average annual	wind speed	(in m/s) and	l number of	windy days
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Source: (Energy of Azerbaijan, 2023)

In 2012, a plant for producing solar panels and LED lamps was opened in Sumgayit. It should also be noted that wind generators have been assembled in Azerbaijan recently, personnel has been recruited and trained, and innovative technologies have been introduced. However, these measures are currently insufficient and unprofitable for energy supply. The solution to these problems can be to attract investment. Although the estimated wind energy potential in Azerbaijan is lower than that of solar energy, much effort is being invested in developing wind energy. Another factor is the lower cost of wind power, which stimulates interest in the industry. According to Forbes, in 2018, the cost of wind energy fell compared to traditional generation. According to calculations by energy specialist Nijat Imamverdiyev in his work "Wind Energy Potential of Azerbaijan and Prospects for Its Use" (2014), the settlement of Shubani is the windiest in Azerbaijan.

Azerbaijan has rich energy resources and is a world-recognized exporter of energy resources. The Republic of Azerbaijan has always paid close attention to using renewable energy sources. Expanding renewable energy sources in our country is one of the important vectors of the energy security policy pursued by the President of the Republic of Azerbaijan, Ilham Aliyev.

To ensure the effective use of the country's renewable energy potential in 2004, one of the main steps was the adoption of the "State Program on Alternative and Renewable Energy Sources in the Republic of Azerbaijan." In continuation of the work done in this area, by Decree of the President of the Republic of Azerbaijan No. 1159 dated September 22, 2020, the State Agency for Renewable Energy Sources was created under the Ministry of Energy of the Republic of Azerbaijan. The Regulations of the Agency were approved.

Relationship between world prices for gas and oil and supplies of renewable energy in Azerbaijan

Correlation and regression analysis were used to test the hypothesis that world prices for natural gas and oil influence renewable energy development. Using the software EViews-9, the following equation was obtained:

 $greenenrg = 257.2 - 2.33 \times oil - 2.15 \times gaseu + 16.23 \times liqgas - 76.43 \times d20$ (1)

The results of testing the quality of the regression equation (1) are presented in Table 2.

 Table 2: The results of testing the quality of the regression equation (1)

 Variable
 Variable

Variable	Variable	p-value		
С	20.36459	12.62973	0.0002	
oil	0.750446	-3.102018	0.0362	
gaseu	0.681561	-3.154406	0.0344	
liqgas	4.738841	3.425390	0.0266	
d20	16.00314	-4.775980	0.0088	
		Value		
R-squared		0.885133		
Adjusted R-squared	0.770267			
Durbin-Watson statistic	3.006084			
Akaike info criterion	8.277154			
Schwarz criterion	8.386724			
Hannan-Quinn criterion	8.040704			

Source: Elaborated by authors using software EViews-9.

Note: greenenrg – total renewable energy supply in Azerbaijan (thousand TOE), c – constant, oil – the price of crude oil, average (\$/bbl), gaseu – the price of natural gas, Europe (\$/mmbtu), liqgas – the price of liquefied natural gas, Japan (\$/mmbtu), d20 – dummy variable.

Since the Durbin-Watson statistic equals 3, there is an autocorrelation of the residuals. Therefore, the following equation was developed:

 $greenenrg = 264.8 - 2.08 \times oil - 2.4 \times gaseu + 14.5 \times liqgas - 93.55 \times d20 + [AR(1) = -0.94, UNCOND]$ (2)

This equation indicates that the price of liquefied natural gas influences and causes the growth of the renewable energy supply in Azerbaijan.

The efficiency of the renewable energy sector

The Republic of Azerbaijan's traditional energy sources include gas, oil, and electricity. These three industrial sectors create the country's fuel and energy complex.

Renewable energy sources, called "green" energy, are inexhaustible, such as solar energy. The most

crucial principle of why renewable energy is used is that it is obtained from natural processes that occur constantly. Renewable energy is extracted from natural resources, such as sunlight, water flows, and wind, which are renewable and replenished naturally through natural processes.

Analysis of renewable energy efficiency showed that renewable energy intensity decreased in 2019-2022, but specific renewable electricity consumption increased in 2021-2022 (Table 3).

Industry	2018	2019	2020	2021	2022
Gross Domestic Product, mln. manats	80092.0	81896.2	72578.1	93203.2	133972.7
Number of populations, thousands of persons	9898.1	9951.4	9974	10026.1	10063.3
Total renewable energy, TOE	273200	263400	212700	225100	245900
Renewable energy intensity, TOE/mln. manats	3.41	3.22	2.93	2.42	1.84
Specific renewable electricity consumption, TOE/ thousands of persons	27.60	26.47	21.33	22.45	24.44

Table 3: Renewable energy efficiency in Azerbaijan

Source: Authors' calculations.

Azerbaijan has the potential to develop green energy. In the future, our state can export electricity produced using renewable sources.

Conclusions and Recommendations

The ever-increasing role of renewable energy sources in our country plays a crucial role in solving the energy-security problem in and beyond its borders. This sector of the economy is one of the significant areas in ensuring the socio-economic stability of society as a whole, ensuring the development of the country and its regions.

Introducing effective intensification methods by accepted world practice will help the state properly use natural phenomena such as wind, solar rays, and hydropower. First, effectively using the latest technologies will achieve this strategic approach.

The large-scale use of equipment can be improved by attracting foreign entrepreneurs from countries that have already successfully provided electricity through renewable sources. Countries such as Norway, Japan, and Iceland have made incredible progress in this area in recent years. However, it should be noted that the achievement of final results cannot be limited only to foreign investments. This process should also be accompanied by measures for government incentives for programs signed by the President of the Republic of Azerbaijan.

Thus, the liberated territories will become the apogee of the above. Projects such as "Smart City" and "Smart Village" will contribute to the active introduction of these territories into the economy of the Republic of Azerbaijan. Azerbaijan and the British oil company British Petroleum signed an agreement to cooperate in the assessment and implementation of a project to construct solar power plants in the Karabakh region. The 240MW solar plant is part of BP's plan to cut carbon emissions by 35% by 2030 and its strategy to cut net emissions to zero by 2050. Such a policy is applicable,

first of all, for our country, as well as for the world community.

References

Adamowicz, M. (2022). Green deal, green growth, and green economy as a means of supporting attainment of the sustainable development goals. Sustainability 14, 5901.

Ang, T., Salem, M., Kamarol, M., Das, H., Nazari, M., & Prabaharan, N. (2022). A comprehensive study of renewable energy sources: Classifications, challenges and suggestions. Energy Strategy Reviews, 43, 100939.

Bogdanov, D., Ram, M., Aghahosseini, A., Gulagi, A., Oyewo, A. S., Child, M., et al. (2021). Low-cost renewable electricity as the key driver of the global energy transition towards sustainability. Energy 227, 120467.

Candra, O., Chammam, A., Alvarez, J., Muda, I., & Aybar, H. (2023). The Impact of Renewable Energy Sources on the Sustainable Development of the Economy and Greenhouse Gas Emissions. Sustainability, 15(3), 2104.

Energy of Azerbaijan. (2023). Statistical yearbook. The State Statistical Committee of the Republic of Azerbaijan. <u>https://www.stat.gov.az</u>

Gutium, T., Gojaeva, E., & Huseynova, S. (2023). Social exclusion and poverty in the European Union and candidate countries. Cogito Multidisciplinary Research Journal, XV (2), 124–145.

Gutium, T. (2021). Gas pricing mechanisms: overview, comparative analysis and recommendations. 2021 International Conference on Electromechanical and Energy Systems (SIELMEN) (IEEE, 2021), pp. 045–050.

Hyginus, V., Edozie, E., Umaru, K., Wisdom, O., & Chinyere, U. (2023). Overview of Renewable Energy Power Generation and Conversion (2015-2023). Eurasian Journal of Science and Engineering, 4(1), 105–113.

Jie, H., Khan, I., Alharthi, M., Zafar, M. W., & Saeed, A. (2023). Sustainable energy policy, socioeconomic development, and ecological footprint: the economic significance of natural resources, population growth, and industrial development. Utilities Policy, 81, 101490.

Osman, A., Chen, L., Yang, M., Msigwa, G., Farghali, M., Fawzy, S., Rooney, D., & Yap, P. (2022). Cost, environmental impact, and resilience of renewable energy under a changing climate: a review. Environmental Chemistry Letters, 21, 741–764.

Rahman, A., Farrok, O., & Haque, M. (2022). Environmental impact of renewable energy sourcebased electrical power plants: solar, wind, hydroelectric, biomass, geothermal, tidal, ocean, and osmotic. Renewable and Sustainable Energy Reviews, 161, 112279.

Rutskiy, V.N., & Filippov, I.A. (2022). Relationship between poverty levels and green economy factors in the countries of the European Union. Financial Journal, 14(1), 56–70.

Yongjun Lv. (2023). Transitioning to sustainable energy: opportunities, challenges, and the potential of blockchain technology. Frontiers in Energy Research, 11, 1258044.

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