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COOPERATION OF EU AND AZERBAIJAN IN GREEN ENERGY

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ABSTRACT

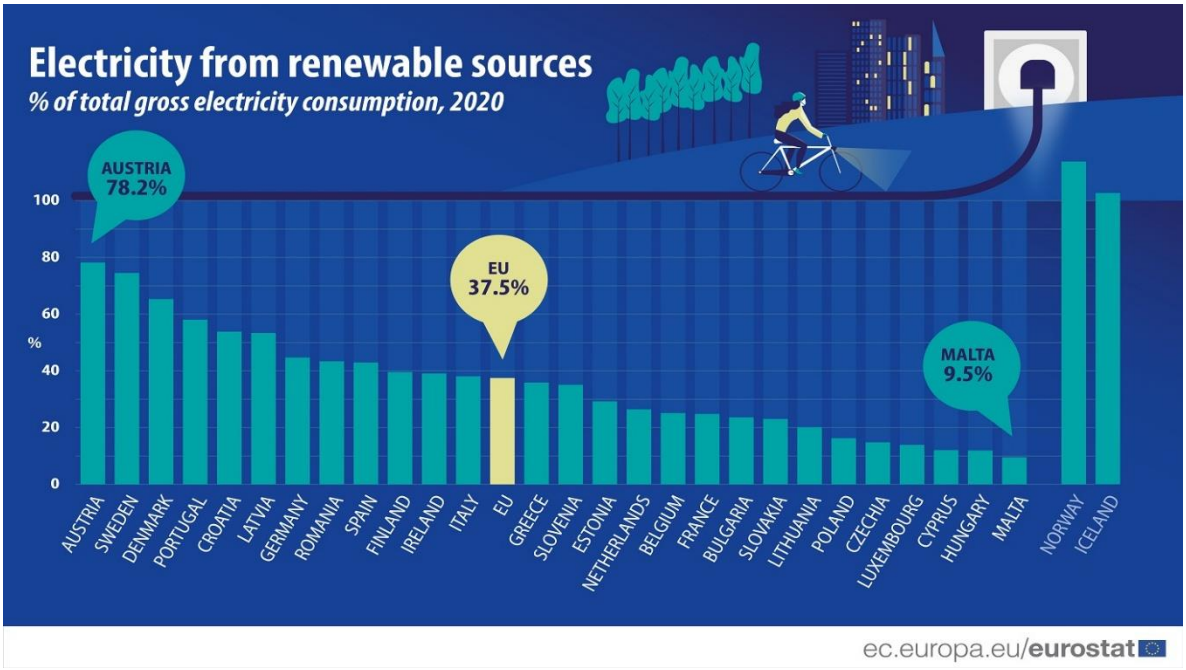
The purpose of the article is to prepare proposals and measures, taking into account the more convenient and efficient use of alternative and renewable energy sources in preventing the pollution of the natural environment due to serious climate changes that have recently occurred on our planet. Alternative regenerative energy sources, their development history, types, working principles, structures are widely interpreted in the research work, as well as the factors affecting alternative and renewable energy sources are explained, state programs implemented in the development of this field, their tasks and application, European International cooperation with the Union is explained in detail. Use of alternative, regenerative energy sources, research conducted in this direction, implementation of approved projects, including the efficient use of natural resources. The use of alternative and renewable energy sources is becoming a very promising field in terms of use in our modern times. By expanding the development and use of this area, it is possible to achieve protection of the environmental balance, restoration of equilibrium, and also non-disruption of ecosystem dynamics. Disturbance of this balance is accelerating more and more.

Keywords: energy sources, European Union, Azerbaijan, resource, consumption, economy

INTRODUCTION

In recent years, the share of renewable energy sources in the total electricity production in the countries of the European Union (EU) has increased to 39 percent. Renewable energy is the green light for our independence. The indicator in renewable energy production increased as a result of 28 percent increase in solar energy and 7 percent increase in wind energy.

Figure 1. Renewable energy on the rise: 39% of EU's electricity



Source: *Eurostat (2022).*

Azerbaijan is a country with great development potential of renewable energy. The country has excellent wind and solar resources and significant prospects for biomass, geothermal and hydropower plants. In order to realize this potential, the government has already set itself the task of adding 420 MW of potential to the renewable energy source by 2020. With this goal in mind, the country began implementing projects using engineering, procurement and construction contracts. However, the level of implementation in practice has been limited compared to the extent of resources available in the country and long-term goals. A higher share of renewable energy sources in the energy balance can bring many other benefits besides economic diversification. Renewable energy sources can act as a catalyst for new employment opportunities in a country traditionally dominated by oil and gas by creating opportunities for technological innovation and opening up new sectors to provide economic value and associated GDP growth. In addition, the rapid use of renewable energy sources, along with the continuous increase in energy efficiency, can lead to a decrease in oil and gas consumption in the country (Masud M., Ananno A., Arefin A., 2019).

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goal in mind, the country began implementing projects using engineering, procurement and construction contracts. However, the level of implementation in practice has been limited compared to the extent of resources available in the country and long-term goals. A higher share of renewable energy sources in the energy balance can bring many other benefits besides economic diversification. Renewable energy sources can act as a catalyst for new employment opportunities in a country traditionally dominated by oil and gas by creating opportunities for technological innovation and opening up new sectors to provide economic value and associated GDP growth. In addition, the rapid use of renewable energy sources, along with the continuous increase in energy efficiency, can lead to a decrease in oil and gas consumption in the country (IRENA, 2015).

Figure 2. Power generation and types of resources used in Azerbaijan (million kWh)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
TPP and PPs working with fuel	15003	17317	19537	20066	21401	20905	20699	20445	21243	22290
Hydro Power Plants	3446	2676	1821	1489	1300	1638	1959	1746	1768	1565
Autonomous producers (working with fuel)	260	301	1630	1664	1848	1955	2062	1900	1934	1873
Wind Power Plants	1	0	0	1	2	5	23	22	83	105
Solar (photovoltaic) Power Plants	0	0	0	1	3	5	35	37	39	44
Electricity generated from waste incineration	0	0	0	134	174	182	175	170	162	196

Source: *Mustafayev, Kulawczuk and Orobello (2022).*

Given the projected increase in energy demand in Azerbaijan, renewable energy sources provide a technical solution for faster access to energy generation capacity due to shorter project implementation costs compared to traditional sources. Renewable energy sources also offer a significant low-carbon solution to achieving Azerbaijan's climate targets. Under the Paris Agreement, the country has committed to reduce GHG (greenhouse gas) emissions by 35% by 2030, measured starting from the base year of 1990, as set out in its Nationally Determined Contribution (NDC) document, and to achieve this target, alternative and renewable energy the use of sources is of particular importance (Moller and Krater, 2022).

1. MATERIALS AND METHODS

In accordance with the President's Decree No. 1209 dated May 29, 2019 "On Accelerating Reforms in the Energy Sector of the Republic of Azerbaijan", the draft law "On the use of alternative (renewable) energy sources in the production of electricity" has been started.

Azerbaijan's energy sector developed rapidly in 2022 and marked history with important events. During the year, energy security became one of the most important issues on the

global agenda. The energy cooperation of our country with the European Union (EU) has become more important. The signing of the "Memorandum of Understanding on Strategic Partnership in the field of energy between the Republic of Azerbaijan and the European Union represented by the European Commission" in Baku on July 18 marked the beginning of a new, broader cooperation in this field. Cooperation in the field of energy has always had a prominent place in the agenda, and as a result, important achievements have been achieved. And now it has become more important than before. The signing of the said document was born out of the need of the day (Inogate, 2016).

President Ilham Aliyev and the President of the European Commission Mrs. Ursula von der Leyen emphasized this while making a statement to the press about the signing. The head of state said in his statement: "Our active cooperation in the field of energy has a history of more than fifteen years. Today's memorandum is not the first document signed between us. We signed the memorandum of understanding in 2006 and the joint declaration on the "Southern Gas Corridor" in 2011. in short, we have a good history and achievements. The energy projects initiated by Azerbaijan and supported by the European Union, including our partners, are completely changing the energy map of Europe. We started with oil production. We built the oil pipeline connecting the Caspian Sea with the Black Sea and the Mediterranean Sea." Looking at the annals of previous years, let us recall that after the Baku-Tbilisi-Ceyhan main export oil pipeline named after Heydar Aliyev, the Baku-Tbilisi-Erzurum line transporting "Shah Deniz" gas was commissioned. The blue fuel extracted from the Azerbaijani sector of the Caspian Sea was delivered to Georgia in 2006 and to Turkey in 2007, and thus our country became known as a gas exporter in the world. After that, the 3,500-kilometer "Southern Gas Corridor" megaproject, which diversified the export of Azerbaijani gas, was realized.

Four segments of the project were launched one after the other. Within the framework of the second phase of the "Shahdeniz" project, production has started. SCPK (South Caucasian Pipeline), which passes through the territory of Azerbaijan and Georgia and brings gas to the Turkish border, was expanded. TANAP (Trans-Anatolian Gas Pipeline) has been laid across the territory of Turkey for a distance of 1,850 kilometers. The last part of the corridor, TAP (Trans-Adriatic Gas Pipeline), transported our natural gas through the territory of Greece, Albania and the Adriatic Sea to the European continent. TAP has been delivering Azerbaijani gas to Italy for two years now.

The Greece-Bulgaria Interconnector (IGB), which was put into use in the summer of 2022, became the harbinger of the projects that will be implemented in the direction of the expansion of the "Southern Gas Corridor" in the following years. All this shows that energy security is now clearly one of the top issues on the global agenda. For that reason, our global projects, which are implemented jointly by Azerbaijan with its partners and supported by the European Union, are of particular importance. So that, they have changed the energy map of Europe. It is no coincidence that the President of the European Commission Mrs. Ursula von der Leyen emphasized three points of the signed Memorandum of Understanding. First, he stated that they will double the volume of gas supplied from Azerbaijan to the European Union, through this document they have committed to the expansion of the "Southern Gas Corridor", saying that it is a very important supply route for the European Union. The second important point is related to renewable energy. The President of the European Commission emphasized that Azerbaijan has a huge potential in

the field of renewable energy and especially noted offshore wind energy and "green hydrogen": "Through the signed Memorandum of Understanding, we are laying a solid foundation for our cooperation in that field (IRENA, 2019).

Besides being a fuel supplier, Azerbaijan will gradually become an important and reliable partner supplying renewable energy for the European Union. Finally, our gas cooperation must be reconciled with our climate responsibility. For example, this includes methane gas emissions. Our memorandum envisages a commitment to reduce emissions of methane gas throughout the entire gas supply chain". and other issues, a broad energy dialogue was started. As it can be seen, the great potential of our country in the field of renewable energy production is highly valued by the European Union (Zhang, Y., Tang, N., Niu, Y., Du, X. (2016).The process of investing in wind and solar energy has already been started. A preliminary assessment of renewable energy potential was also conducted. Our territories freed from occupation were declared a "green energy" zone shortly after the Victory. So, the potential of solar and wind energy here is 9200 megawatts. The potential of wind energy in the Caspian Sea is equal to 157 megawatts (MEA, 2023)

2. RESULTS AND DISCUSSION

Currently, in Azerbaijan, renewable energy sources occupy a significant place in the total final energy consumption, this figure reached its peak in 2010 and became 3.1%, and in 2022 it decreased to 1.7%. One of the explanations for this difference is the seasonal and annual changes in hydroelectric power production, which was 3,446 million kWh in 2010 and 1,746 million kWh in 2022. The share of renewable energy sources in non-energy use remains steadily low, and this figure was 0.4% of total final energy consumption in 2022 (Mustafayev, Kulawczuk, and Orobello, 2022).

Table 1: Installed electricity generation capacity, MW, 2022

State electricity producers /autonomous electricity producers /independent electricity producers	Power plants					
	General	Heat	Water	Sun	The wind	Boycott
"Azerenergy" JSC	6 935	5 881	1 055	-	-	-
Nakhchivan State Energy Agency	237	147	68	22	-	-
Self-producers of electricity (BP, SOCAR, Azersun Holding)	722	722	-	-	-	-
"Clean City" OJSC	37	-	-	-	-	37
"Azerishiq" JSC	52	-	-	-	52	-
"Azalternativenerji" LLC	16	-	-	13	3	1
Private wind and hydropower plants	17	-	9	-	8	-
Total, MV	8 017	6 750	1 132	35	62	38
Share, %	100	84.2	14.1	0.4	0.8	0.5

Source: *Authors' own creation, (SSCA)*

In July 2015, the Ministry of Energy of the Republic of Azerbaijan approved ten priority directions aimed at the implementation of market operations in the electricity and gas sectors in order to attract private investments (Table 3).

Table 2: Potential of renewable energy sources

Renewable energy sources	Technical Potential, MVT
The wind	3000
Sun	23 040
Bio/Waste	380
Small SES	520

Source: *Authors' own creation*

Table 3. Ten priority directions for the energy sector

Preparation of the country's energy sector development strategy for the next 25-30 years.
Development of a 15-20-year state program on efficient use of energy resources, improvement of energy efficiency of end consumers and use of alternative energy sources.
Development of a 5-year state program for the development of the energy sector (the 1st five-year Strategic Development Plan).
Preparation of the draft law on the regulation of the domestic electricity market.
Preparation of the draft law on the regulation of the domestic natural gas market.
Preparation of the draft law "On the Network Code" in the field of electric energy.
Drafting a draft law on an independent energy regulator to regulate domestic energy (electricity and gas) markets.
Draft law on "Network Code" for natural gas.
Restructuring of energy system structures (Azerenergy, Azerishik) on the basis of new market entities provided for in the legislation.
Creation of a flexible tariff system based on the cost of goods and services that reflect and supply the interests of end consumers and other market participants (X-Factor).

Source: *Authors' own creation*

Market reforms aim to use competitive market forces to achieve energy carrier prices that reflect actual costs and thereby increase economic efficiency for the entire country. Development of six of these ten strategic goals was supported by international development partners.

Table 4: Technical assistance projects in the renewable energy sector

OBJECTIVE OF THE PROJECT	DONOR	BENEFICIARY
Supporting the development of Azerbaijan's long-term energy strategy (initial stage).	**European Commission, EU4ENERGY, Energy Charter Secretariat**	Ministry of Energy
Supporting the drafting of the electricity market law in line with the EU's Third Energy Package.	**USAID**	Ministry of Energy
Development of the regulatory and legal framework for the expansion of the Renewable Energy Sources sector.	**European Commission**	Ministry of Energy
Development of the regulatory and legal framework for the expansion of the renewable energy sector.	**SHAME**	Ministry of Energy
Supporting the holding of auctions for renewable energy sources in Azerbaijan.	**SHAME**	Ministry of Energy
A regional TA (Transportation Alternatives) project to improve energy statistics and policy in Eastern Europe, the Caucasus and Central Asia.	**European Commission, BEA**	State Statistics Committee, Ministry of Energy
TA project "Azerbaijan: preparation of the financial recovery plan of the energy sector".	**AIB**	Ministry of Energy, Ministry of Finance
Supporting the creation of an independent energy regulator to regulate domestic energy (electricity and gas) markets and drafting a draft law on "independent energy regulator".	**SHAME**	Ministry of Energy, Energy Regulation Agency
Preparation of the Network Code.	**AIB**	Ministry of Energy

Source: *Authors' own creation*

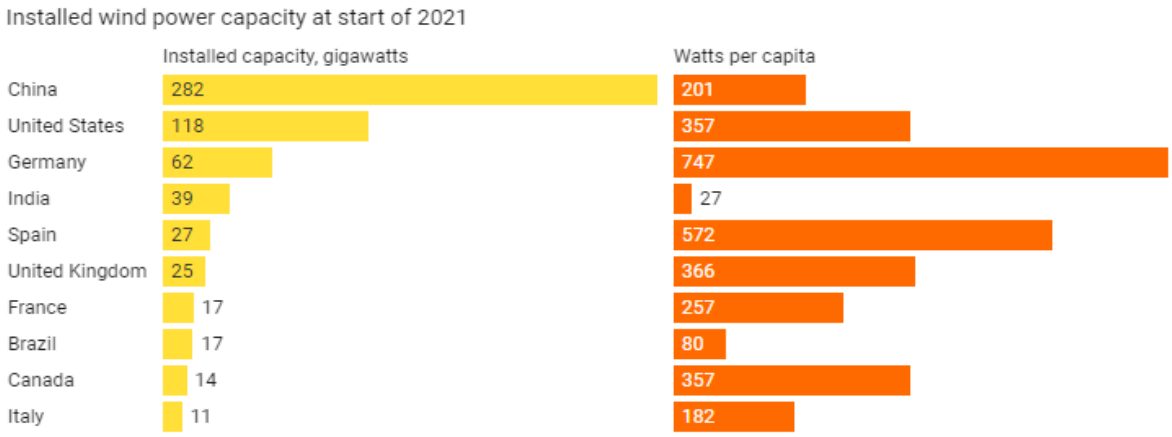
2.1. Hydroelectric power stations

Hydropower has traditionally maintained a strong position in the energy balance of the country. Among renewable energy sources, hydropower had the highest potential of 1,131 MW in 2017 compared to thermal energy potential of 6,750 MW. Resources are located along the Kura River and its tributaries, the Araz River, the Caspian Sea, and irrigation canals. The small hydropower sector (including Sheki, Mugan, Zeykhur, Gusar, Nügadi, Chinarli, Balakan, Guba and Zurnabad power plants) is also developing well with the participation of independent electricity producers in Azerbaijan, as well as independent energy producers who produce electricity for consumption at their own facilities. has done The 1.5 MW Balakan HPP, added in 2017, also aims to increase production in this small hydropower sector. Seasonal conditions influence hydropower production, ranging from a peak of 1,959.3 GWh in 2016 to a low of 1,299.7 GWh in 2014. Although hydropower is subject to seasonal changes, due to its significant share in the country's electricity system, it has great potential to support the integration of solar and wind energy potential in the future.

2.2. Wind energy

Azerbaijan has excellent wind resources, especially in the coastal regions along the Caspian Sea. According to the analysis conducted by ABOEMDA (2016), the wind potential is estimated at 3000 MW. This potential is reflected in the government's goal of acquiring 350 MW of new power by 2020. At the end of 2017, 62.4 MW of power was created, of which 51.7 MW was owned by "Azerishiq" OJSC, 2.7 MW by "Azalternativeenergy" LLC, and 8 MW by the private sector. fell to his share. Development of a number of projects continues, including the "Absheron Wind" project in Azerbaijan and the newly commissioned "Yeni Yashma" Wind Power Plant.

Figure 3: The world's leading countries in the use of wind energy



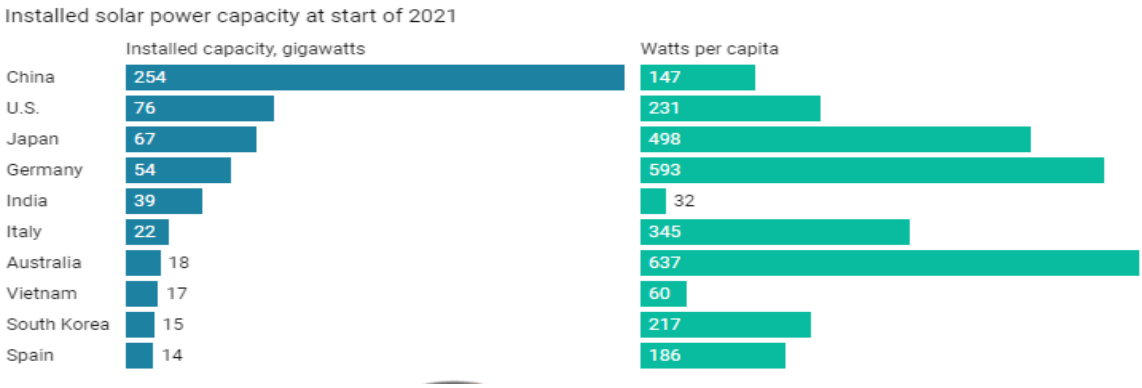
Source: *Canary Media, 2023*

2.3. Solar energy

Azerbaijan's solar energy potential is estimated at 23,040 MW. The annual amount of sunny hours varies from 2400 to 3200. Global horizontal radiation varies from 1,387 kW/m2 to 1,534 kW/m2 over most of the area. Direct normal radiation varies from 1,095 kW/m2 to 1,534 kW/m2, with most of the area less than 1,387 kW/m2. There are four solar photovoltaic plants with a potential of more than 1 MW. Nakhchivan Solar Power Plant has a capacity of 24 MW

Ǝin addition, construction of 5 solar power plants with a capacity of 2.8 MW each and one solar power plant of 4 MW is planned. By the end of 2017, 34.6 MW of solar panels had been installed across the country, including at social enterprises and on the roofs of various public buildings. An example of such projects is the sports center in Masalli with a 70 kW photovoltaic device. This system belongs to "Azalternativenerji" Public Legal Entity and all relevant administrative and financial procedures are developed in ABOEMDA (2016).

Figure 4: The top 10 countries with the most solar power

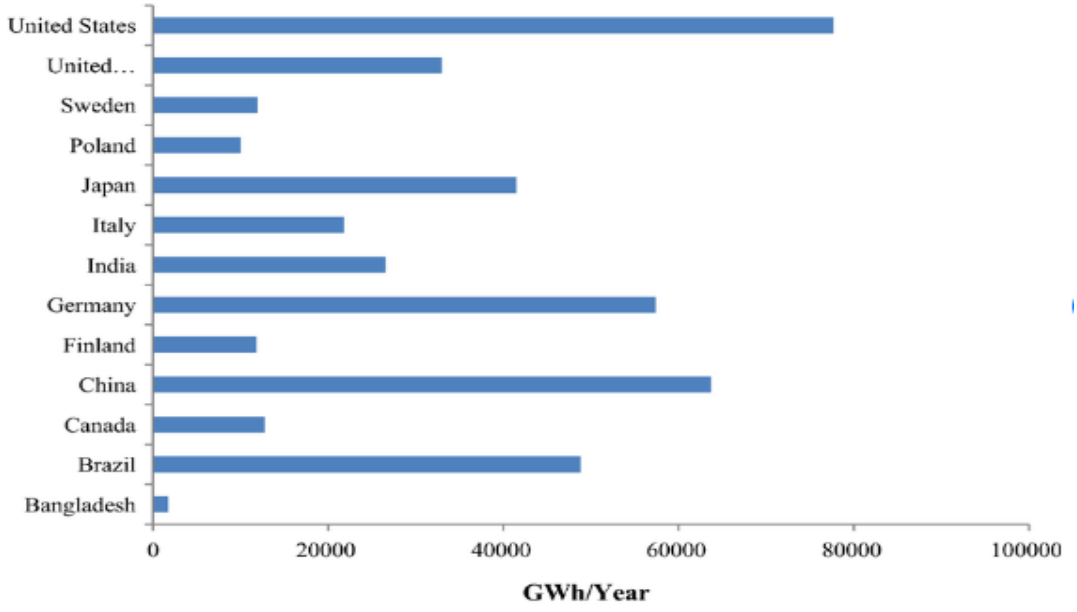


Source: *Canary Media, 2023*

2.4. Bioenergy

Azerbaijan has an estimated potential of 380MW for converting biomass and waste to energy. Currently, bioenergy is mainly used in the form of traditional biomass, mainly for heating and cooking in remote areas. In addition, there is significant potential for energy production from biodegradable household waste, and the Baku Solid Waste Plant (Block 4) demonstrates the government's efforts to realize this potential.

Figure 5: List of countries by electricity generation from biomass energy sources

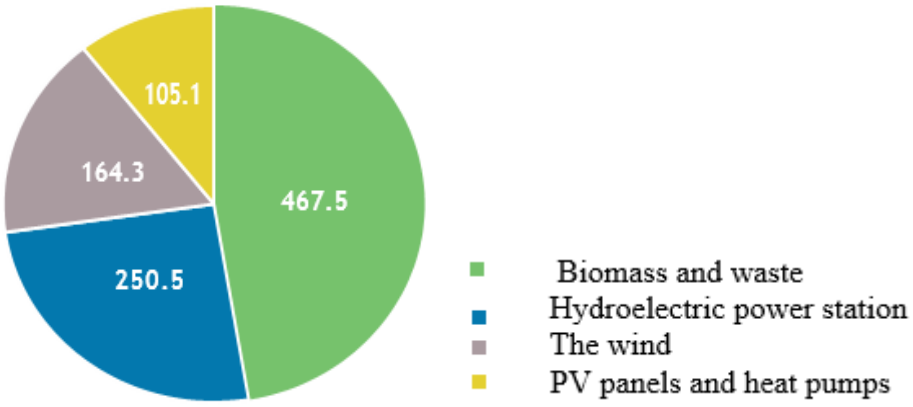


Source: *(Masud, Annano and Arefin, 2019)*

3. ECONOMICS OF RENEWABLE ENERGY SOURCES

The state budget is the main financial source for the development of renewable energy sources in Azerbaijan. According to ABOEMDA, between 2010 and 2022, US$579.1 million ($987.4 million) will be allocated to individual energy sources, including solar photovoltaics and heat pumps, wind, small hydropower, biomass and waste. AZN) was invested, of which 480.9 million US dollars (820 million AZN) or 83% were state investments. Lending in energy efficiency and renewable energy sources is not favorable in the current investment climate due to high interest rates. In 2019, the Central Bank of Azerbaijan increased the interest rate from 4% at the beginning of the year to 14% by the end of the year.

Figure 6: Investments in renewable energy sources, mln. in AZN, 2010-2022



Source: *Authors' own creation*

Considering the importance of the country for the regional and global energy markets, a number of international organizations operate in Azerbaijan. Asian Development Bank (ADB), International Energy Charter, European Bank for Reconstruction and Development (EBRD), European Union (EU) and US Agency for International Development (USAID) act as partners actively implementing infrastructure projects in the country (IRENA, 2017). However, so far development partners have contributed to the renewable energy sector mainly in the form of technical assistance with limited direct investment in renewable energy projects (Moller and Krauter, 2022).

CONCLUSION

Support mechanisms should be identified to help the process of transition to the functioning of the renewable energy sources market. Guaranteed tariffs are essential to support initial development in the national market for renewable energy sources. However, as the market for renewable energy sources develops, the possibility of using auctions to purchase renewable energy sources at lower prices through market pricing can be considered. However, a number of conditions must exist for this approach to apply, including a stable policy and regulatory framework and a high degree of competition in the market.

Azerbaijan is a country with great development potential of renewable energy sources. The country has excellent wind and solar resources and significant potential for biomass, geothermal and hydroelectric power generation. In order to realize this potential, the

government has set itself the task of obtaining 420 MW of renewable energy capacity by 2020. In accordance with this goal, projects on design, purchase and construction of contracts through the use of renewable energy sources have been implemented in the country. However, the implementation of the projects in practice has been limited compared to the extent of available resources and the country's long-term goals.

Increasing development in the field of alternative energy in the future:

1. Increasing the role of alternative and renewable energy sources in the country's energy security and general electricity production;
2. Increasing energy production and consumption by using alternative energy sources, including efficient use of other energy resources and ensuring reduction of environmental damage caused by man-made effects during the energy production process;
3. Use of alternative energy sources, directing oil and gas raw materials to the petrochemical industry;
4. The most cost-effective way of using solar energy is the operation of space power plants powered by solar batteries;
5. Wide application of the use of innovative technologies in the field of application of alternative energy sources and adoption of international practices;
6. Creation of material and technical base based on high technologies in the use of alternative energy sources in the Republic;
7. Purchase and use of biogas energy in areas with developed animal husbandry;
8. the use of AEM to ensure energy security in the use of traditional energy resources such as oil and gas;
9. Wide use of alternative energy sources in the conditions of Azerbaijan leads to a significant decrease in dependence on traditional fuels; (energy diversification)
10. The prospects for the use of wind and geothermal resources in the Republic of Azerbaijan depend on the investment of financial resources and other State-level measures.

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