

ALTERNATIVE ENERGY SOURCES AND STATE POLICY IN EXPANDING ITS PRODUCTION IN AZERBAIJAN

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Abstract

The energy problem is one of the most urgent problems in the modern world. It is impossible to imagine the development of human society without energy resources. Energy resources are one of the main resources to maintain our modern civilization. Therefore, its supply must be complete and safe. However, the ever-increasing demand for energy and the extensive exploitation of hydrocarbon resources are rapidly depleting existing reserves. Depletion of traditional energy resources and their negative impact on the environment make it necessary to increase the share of alternative energy sources (AES) in energy consumption. Today, countries all over the world are looking for new ways to solve their energy and environmental problems, and one of these ways is the search and production of AESs. The main sources of energy are still non-renewable natural resources such as oil, gas and coal, which lead to depletion of their resources and negative effects on the environment. Therefore, solar, wind, water energy, geothermal energy, etc. more attention is given to AESs such as Their use can reduce dependence on oil, gas and coal, as well as reduce the level of environmental pollution.

Resumo

O problema energético é um dos mais urgentes do mundo moderno. É impossível imaginar o desenvolvimento da sociedade humana sem recursos energéticos. Os recursos energéticos são um dos principais pilares para a manutenção da nossa civilização moderna. Portanto, seu abastecimento deve ser completo e seguro. No entanto, a demanda cada vez maior por energia e a exploração extensiva dos recursos de hidrocarbonetos estão esgotando rapidamente as reservas existentes. O esgotamento dos recursos energéticos tradicionais e seu impacto negativo sobre o meio ambiente tornam necessário aumentar a participação das fontes de energia alternativas (FEA) no consumo de energia. Hoje, países em todo o mundo buscam novas maneiras de resolver seus problemas energéticos e ambientais, e uma dessas maneiras é a busca e a produção de FEA. As principais fontes de energia ainda são recursos naturais não renováveis, como petróleo, gás e carvão, o que leva ao esgotamento desses recursos e a efeitos negativos sobre o meio ambiente. Portanto, cada vez mais atenção é dada às AES, como a energia solar, eólica, hidráulica e geotérmica, entre



Keywords: Technology. Environment. Alternative Energy Sources (AES). Green Energy. Electricity. Wind. Solar. State Program.

outras. Sua utilização pode reduzir a dependência do petróleo, do gás e do carvão, bem como diminuir o nível de poluição ambiental.

Palavras-chave: Tecnologia. Meio Ambiente. Fontes Alternativas de Energia (FAE). Energia Verde. Eletricidade. Eólica. Solar. Programa Estadual.

1 INTRODUCTION

The modern era can be considered a period of scientific and technical progress, because technology has almost reached its highest level of development in the entire history of mankind and has contributed to all areas of human activity. One such technology is green technologies, which greatly help in solving environmental problems. As a result of the formation and use of green technologies, economic subjects will be interested in taking care of the environment, saving natural resources, reproducing, as well as improving the living conditions and ensuring the safety of the population. One of the areas where green technologies are most widely applied is the field of green energy. The field of green energy combines the development of a number of technologies, including technologies for the use of energy from alternative sources, in order to increase energy efficiency.

In the conditions of the modern development of all existing areas of the economy, the use of AESs gains great value. In the 30s of the last century, the emergence of green energy began to act as such an alternative source. Alternative energy is a type of energy created by converting natural resources such as solar, wind or hydropower. Alternative energy can be defined as a source of energy that has zero or minimal impact on the environment, is cleaner and more sustainable and is produced from solar, hydro, biomass, wind, geothermal and etc. They play an active role in improving the environment and meeting the demand for clean energy for industrial and non-industrial purposes. The use of AESs significantly reduces the need to use natural resources, which allows to minimize environmental pollution and rationalize their use. AESs may soon replace traditional ones, which is possible and even necessary in the future. Therefore, expanding the

production of AESs in Azerbaijan and investigating the issues related to the role of the state in this field are among the main priority tasks.

Research methods: In the article, methods such as planning, forecasting, factor analysis, economic-statistical analysis, comparative analysis and etc. were used to evaluate the advantages of using AESs in Azerbaijan and the role of state policy in expanding their production.

2 ALTERNATIVE ENERGY SOURCES AND THEIR ADVANTAGES

AES is, on the one hand, ordinary natural phenomena, inexhaustible resources produced naturally, and on the other hand, an environmentally renewable resource when converted. Unlike traditional types, it is infinitely renewable, more efficient and environmentally friendly. This energy is also called renewable or "green". "Green" energy is represented by unlimited sources that are less expensive financially and do not have harmful emissions. The reproducibility of these sources, their safety for the natural environment, their availability and cheapness, and their wide range of uses are its main positive indicators. At the present time, it is required to find ways to use AESs efficiently. The problem of the use of AESs is not only an environmental one, but also an economic one. Replacing traditional sources with alternative sources is economically beneficial and can lead to an increase in the competitiveness of local enterprises and the country as a whole in international markets.

The strategic objectives of using AESs are:

- efficient use of existing fossil fuel resources and reduction of the growth rate of consumption in the conditions of the inevitability of the inexhaustibility of energy resources;
- reducing the consumption of non-renewable fuel and energy resources and the environmental burden from the operation of the fuel and energy complex, etc.

According to K. O. Tsyganok and A. V. Cherep, the use of AESs helps to avoid toxic materials, to reduce the consumption of traditional fuels and emissions, and to become more competitive for enterprises in that field (Tsyganok, 2018).

It is known that traditional energy sources are based on fossil fuels and cause environmental pollution and climate change. AESs, on the other hand, are

environmentally friendly and safe. The energy potential of such sources is ten times higher than the current level of energy production and consumption. Consequently, they are considered important potential sources of energy supply and are environmentally friendly and widely used energy sources. Compared to fossil fuel resources, AESs are relatively evenly distributed over most of the planet, their use can improve energy security and reduce dependence on imported energy resources.

S.T.Hansen and E.Moe note that countries without energy security should implement policies related to the expansion of alternative energy production aimed at reducing dependence on imported energy and increasing the level of its own energy supply. Implementation of such a policy can ensure the energy independence of those countries. For this, he should control this process, regulate it and manage it efficiently (Hansen, 2022).

STI has armed humans with the ability to realize massive projects, rebuild existing water systems on land, change forest cover, and use different forms of energy, but using all these advances creates possible consequences for the natural environment. In such a period, the use of AESs has considerable advantages, but is not widespread due to high cost and low power.

Among the advantages of using alternative energy types, the most important is their compatibility with the environment. They allow reducing environmental pollution, which undoubtedly has a beneficial effect on human life and health, as well as on the state of the environment. In addition, AESs contribute to the sustainable use of natural resources. The second advantage is the inexhaustibility of alternative energy, which mainly comes from sustainable natural sources and therefore allows unlimited use. Another important advantage is the creation of new jobs, because "green" energy requires constant monitoring and maintenance. The geographical availability of alternative energy should also be emphasized. Different AESs can be deployed almost anywhere. This allows to provide energy to large cities, small settlements, as well as individual households. They are renewable, which means they do not run out of resources, and also do not pollute the environment, which helps reduce greenhouse gas emissions and combat climate change.

The sustainable development of mankind depends on the widespread use of AESs. However, this also has its downsides. First, the costs of transmission of those energy

sources are higher, and this happens due to the variability of their production. In addition, AESs require the installation of expensive ancillary equipment. Also among the disadvantages is that the continuity of the activity of alternative energy production leads to an increase in costs.

Using AESs allows us to solve problems in the field of using traditional energy sources. First, it reduces dependence on fossil fuels, the world's main source of energy. Second, it helps reduce greenhouse gas emissions, an important goal in combating climate change. Third, it can stimulate economic development. Currently, the share of AESs in global energy consumption is increasing. This growth is influenced by a number of factors, including increasing fossil fuel prices, government support for the development of alternative energy technologies and AESs.

The development of alternative energy in the economic sphere will allow:

1. Increasing the number of jobs.
2. Reducing consumer spending.
3. Eliminating dependence of countries on fossil fuel imports.

V. A. Gasimli, R. Z. Huseyn and a group of other researchers touched on the role played by the production of AESs in creating new jobs. According to them, AESs play a major role in creating new jobs. Thus, solar, wind and other energy sources have the ability to create more jobs per unit of energy production than traditional energy sources. Moreover, since AESs are inexhaustible, they can also create long-term jobs and provide workers with less hazardous working conditions. Thus, at almost every point of the existing production chain, from traditional energy extraction to processing, the workforce works in dangerous conditions that have a negative impact on their health. For this reason, the expansion of AESs can improve the quality of workplaces, the health and productivity of the workforce, and ensure decent work (Gasimli, 2022). Y. Akymenko and I. Kostyuchenko also note that the development of AESs is one of the important steps in solving social issues, creating new jobs, improving the country's trade balance and strengthening its energy independence, and increasing its international competitiveness. The advantage of using such sources is their environmental cleanliness and inexhaustibility, which does not lead to changes in the energy balance on the planet and positively affects the improvement of the ecological situation (Akymenko, 2021).

In recent years, there has been a steady increase in the use of AESs around the world.

The main factors in the development of AESs are:

- The desire for sustainable development - the world community is trying to reduce greenhouse gas emissions and protect the environment;
- State support - many countries provide subsidies and tax incentives for the development of AESs;
- Technical progress – technologies for power generation from AESs are constantly being improved, which leads to a decrease in their cost.

By 2030, the share of AESs in global electricity production is expected to be 40%.

A number of factors will contribute to this:

- Low cost of AESs – As power generation technologies from AEs develop, their cost will decrease. This will make AESs more competitive compared to conventional energy sources;
- Increase in energy demand – energy demand is expected to increase in the future. This is due to the increase in world population and economy. AESs are one of the few energy sources that can meet the growing energy demand without causing environmental pollution;
- Raising the environmental awareness of the population - the world's population is becoming more and more ecologically conscious. This leads to an increase in the demand for environmentally friendly energy sources.

Thus, AESs have good development prospects in the future.

3 THE ROLE OF THE STATE IN THE DEVELOPMENT OF AES IN AZERBAIJAN

AESs play an increasingly important role in the energy system of the modern world. They are environmentally friendly, safe and inexhaustible sources of energy. Also, AES is one of the main tools in the fight against climate change. They do not produce greenhouse gases or other pollutants, which makes them environmentally friendly. In the future, AESs may become the world's main source of energy.

The research shows that Azerbaijan is one of the countries with high potential in terms of AESs. In order to develop this field in our country, according to the Decree of the President of the Republic of Azerbaijan dated October 21, 2004, the State Program in the field of using AESs was approved in our country. The Ministry of Fuel and Energy of the Republic of Azerbaijan was identified as the coordinator of the measures provided for in that program and covering the years 2004-2013. The purpose of the State Program is to expand energy production from alternative sources by using the country's natural potential and ensure more efficient use of hydrocarbon energy resources. It was noted in the State Program that Azerbaijan's favorable geographical location and climatic conditions allow our country to widely use AESs, which are considered ecologically clean, which, in addition to saving a large amount of fuel burned in thermal power plants, which are thrown into the environment and considered harmful will significantly reduce the amount of waste. The involvement of AESs obtained from the country's natural potential in the production of the energy industry will allow achieving progressive changes in the future development directions of that industry of Azerbaijan (2004).

Then, by the Decree of the President of the Republic of Azerbaijan dated December 29, 2011, the State Agency for Alternative and Renewable Energy Sources of the country (established in 2009) was given the task of preparing the State Strategy for 2012-2020 on the use of the potential of AESs. Attention has been paid to the use of AESs in the country, and related issues are reflected in the "Azerbaijan 2020: Vision of the Future" Concept, which was approved in 2012 and covers the years 2013-2020. In this Concept, the promotion of the close participation of the private sector in the projects realized by the state and the provision of flexible regulation of alternative energy tariffs are reflected (2012).

The issue of the use of AESs in Azerbaijan was also reflected in the "Strategic Roadmap for the Development of Communal Services in the Republic of Azerbaijan" approved in 2016. In that document, the use of alternative energy for heating purposes, mainly the potential of solar, wind, geothermal energy and biomass is intended, as well as the promotion of its application in order to ensure the mass use of these sources in new residential and non-residential buildings (2016).

"Azerbaijan 2030: National Priorities for Socio-Economic Development" approved in February 2021 is aimed at efficient use of energy in the country and

prioritization of new sustainable energy sources. It is noted here that the use of environmentally friendly "green" technologies should be expanded to fully meet the needs of society not only today, but also in the future. Based on that potential, the impact on climate change should be reduced by increasing the share of AESs in primary consumption in all sectors of the economy. Using environmentally friendly cars will have a positive impact on air quality and the environment. Achieving "green growth" here, as well as increasing the share of AESs to 30% in electricity production capacities in Azerbaijan by 2030, reflect the energy transformation goals of the country (2021).

One of the five main goals reflected in this document is the creation of a clean environment and "green development" for the country. The main goal in determining this priority is to ensure sustainable development that will fully meet the needs of current and future generations while maintaining ecological balance in the country, including increasing the share of AESs in total energy consumption. Our investigations show that certain works have already been done in this direction in accordance with the tasks set. It is noted that recently important and real steps are being taken in the direction of expanding the use of AESs in Azerbaijan. For this purpose, the legislative base in the relevant field has been improved, perspective plans have been prepared and pilot projects have been implemented.

Taking into account the existence of enough AESs in the Karabakh and Eastern Zangezur regions of Azerbaijan, the decisions made on the transformation of these regions into "green energy" zones can be considered timely decisions. Undoubtedly, in order to turn these areas into "green energy" zones, it is important to increase the role of local companies, including the involvement of foreign investors, in addition to the funds allocated from the state budget. For other foreign investors, the inclusion of BP company's funds in this process can be an incentive. BP, the main strategic ally of Azerbaijan in the field of oil and gas, is especially interested in working in Jabrayil region.

The Ministry of Energy of Azerbaijan has already prepared a forecast about the "green energy" potential of Karabakh and East Zangezur together with leading international companies. Thus, the potential of wind and solar energy in these regions is estimated at more than 7,200 and 2,000 megawatts, respectively.

Already in 2021, 4 hydropower plants were built in Karabakh and East Zangezur, with a total capacity of 20 megawatts. Another important project that can contribute to

the creation of the "Green energy" zone is related to the construction of wind power plants in Lachin and Kalbajar regions. Already foreign companies are very interested in this project. According to preliminary assessments, the construction of a wind power plant with a capacity of up to 100 MW is more promising in these areas. Also, the implementation of the "Giz Galasy" (80 MW), "Khudafarin" (200 MW) hydroelectric junctions and HPP projects are being successfully implemented, and the work in this area is already nearing completion.

In general, Karabakh and Eastern Zangezur regions are highly valued for both hydropower potential and solar and wind energy potential. The alternative energy projects implemented in these regions and their connection to the energy network of the country will help diversify the energy system of Azerbaijan.

Despite the fact that Azerbaijan is rich in energy resources and is recognized as an exporter of these resources worldwide, the use of AESs has always been and continues to be the focus of the country's attention. One of the main directions of the energy security policy implemented under the leadership of President I. Aliyev is strengthening the use of such energy sources in our country.

4 CURRENT STATE OF ENERGY PRODUCTION FROM AES IN AZERBAIJAN

The availability of energy resources and provision of uninterrupted access to them also ensures economic security, which means strengthening the state independence of each country. Thus, energy security is of great importance on a global scale, and the depletion of traditional resources makes it urgent to expand the use of alternative sources. From this point of view, natural resources and the successful policy of the state in this field promise Azerbaijan great prospects in the field of alternative energy. Azerbaijan's alternative energy sector is engaged in the search for new promising ways to obtain energy from non-traditional sources and minimize their negative impact on the environment.

Let's pay attention to the following table to analyze the current situation of energy production from AESs in Azerbaijan.

Table 1*Volume of electricity production from different sources in Azerbaijan, in million kWh*

Years	Total electricity generation	Including				
		On fuel-fired PS and TPS	on HPSs	On solar power plants	On the wind power plant	From other sources
2015	24688,4	20904,6	1637,5	4,6	4,6	2137,1
2016	24952,9	20699,0	1959,3	35,3	22,8	2236,5
2017	24320,9	20445,4	1746,4	37,2	22,1	2069,8
2018	25229,2	21242,9	1768,0	39,3	82,7	2096,3
2019	26072,9	22289,7	1564,8	44,2	105,4	2068,8
2020	25839,1	22471,3	1069,5	47,0	96,1	2155,2
2021	27887,8	24308,8	1277,3	55,2	91,4	2155,1
2022	29039,8	25137,4	1595,7	60,9	83,3	2162,5
2023	29305,9	25237,9	1763,4	80,7	55,4	2168,5

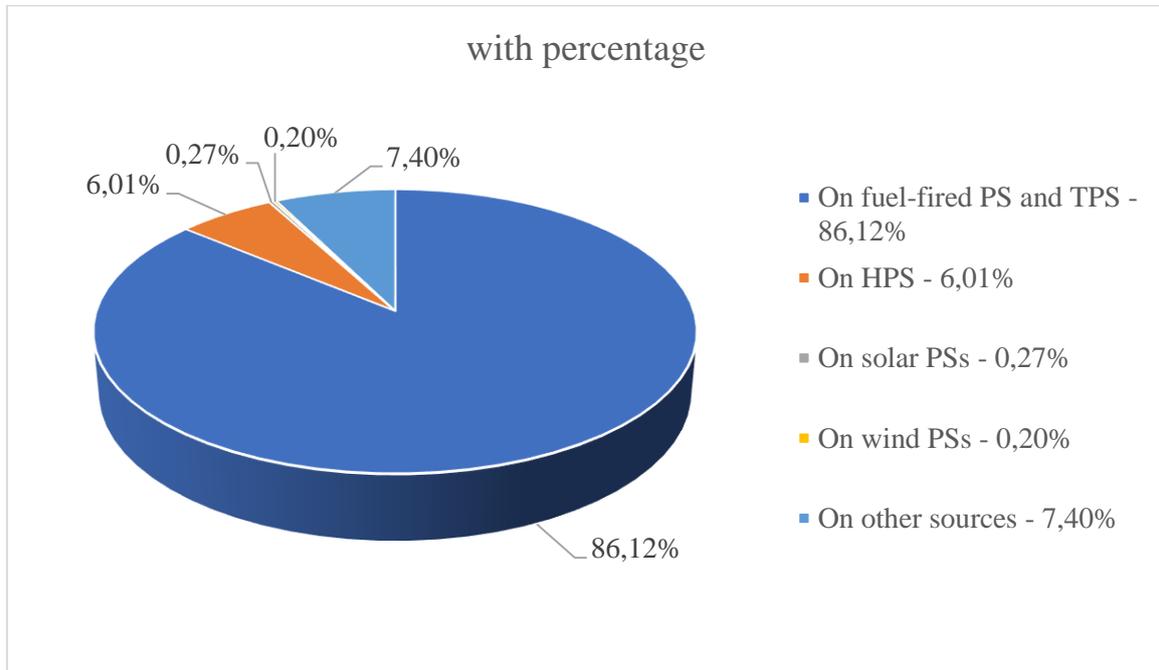
Source: (SSC, 2024).

It can be seen from the table that the main part of electricity production in Azerbaijan is obtained from fuel-fired power plants (PS) and thermal power plants (TPS). But despite this, electricity production from water, mud and solar PS, which are AESs, has been achieved. Energy production from solar and wind ESs from AESs has shown almost constant growth over the studied periods, while growth in HPS has been uneven.

Total electricity production in 2015 was 24,688.4 million kWh, of which 84.67% came from fuel-fired PS and HPSs, 6.63% from HPSs, 0.2% from sun, 0.2% wind PSs, 8.66% due to other sources, in 2023, their special shape was as shown in figure 1.

Figure 1

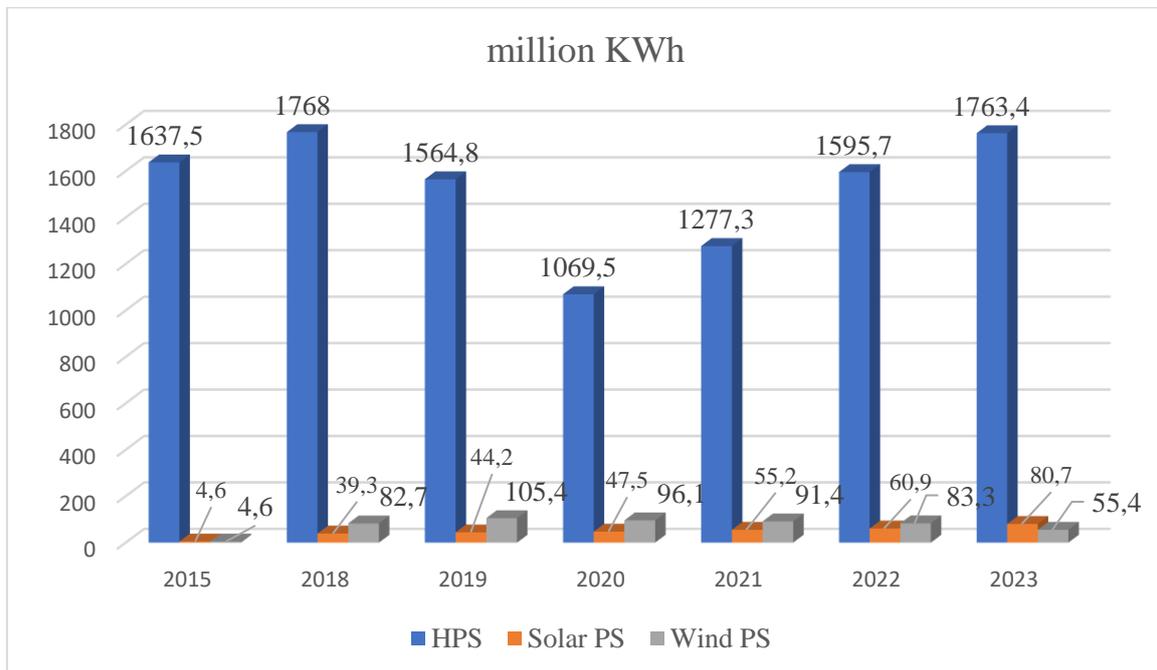
Specific weight of electricity production in Azerbaijan in 2023 by individual sources



Source: Compiled by the authors based on SSCAR data

Since the main AESs in Azerbaijan are obtained from water, solar and wind PSs, let's pay attention to their growth dynamics in recent years.

It can be seen from Figure 2 that there has been no increase in the amount of electricity generation from AESs. If in 2015, 1646.7 million kWh of energy was produced from water, wind and solar PS, the total volume of this indicator increased by 11.5% to 1899.5 million kWh.

Figure 2*Growth rate of energy production from AESs in Azerbaijan*

Source: Compiled by the authors based on SSCAR data

From Figure 2, during the studied periods electricity was produced the most from HES in 2018 (1768.0 million MWh), from solar PS in 2023 (80.7 million MWh), and from wind PS in 2019 (105.4 million MWh).

In her scientific article "The role of alternative and renewable energy sources in energy security", T. Masimova emphasizes that the natural and climatic conditions of the country, including the use of solar energy, open up wide opportunities for increasing the production of electricity and thermal energy in Azerbaijan. Thus, sunny hours in Azerbaijan are in the range of 2,400-3,200 hours a year, which means that the amount of annual solar energy falling on the territory of the country exceeds many countries, which can be considered as one of the efficiency criteria for directing investments to the use of that energy. The development of the use of this type of energy in Azerbaijan can play an important role in partially solving the problem of energy supply in the regions of the country (Masimova, 2021).

Azerbaijan is considered one of the countries with favorable conditions for the use of wind energy facilities. From this point of view, the favorable areas are the coast of the Caspian Sea, the islands in the northwestern part of the country, the Absheron

peninsula, the Sharur-Julfa region of Nakhchivan, and the Ganja-Dashkasan regions located in the west of Azerbaijan.

Currently, the main priority task in Azerbaijan is to increase and develop energy production from AESs.

Indeed, in recent years, the government of the Republic of Azerbaijan has been actively working in this field, and the purchase of energy from AESs has become an important, future-oriented direction of the country's energy strategy. Azerbaijan plans to produce 3 GW of wind and 1.0 GW of solar energy by 2027, 80% of which is intended for export. It is planned to create at least 6 GW of additional capacity by 2037. In Nakhchivan, work is being done to assess the possibilities of building a 500 MW solar PS. The foundation of a new power plant with a capacity of 1280 megawatts has been laid in the city of Mingachevir, it is planned to be put into operation by 2025, which will significantly increase the energy potential.

According to Sh. Mammadova's conclusion, the development of AESs as sources of growth of national wealth and green economy in Azerbaijan, their evaluation and efficient use depends greatly on the innovative technologies applied in this field (Mammadova, 2021).

In the next ten years, we can expect a significant increase in AESs in Azerbaijan. However, it is impossible to realize a high share of the use of these sources without allocating subsidies for the production of AESs, without applying tax incentives, without research and technological innovations, without infrastructure changes. Therefore, steps towards creating conditions for the development and use of AESs should be taken at the state level first.

5 RESULTS

The reserves of traditional energy sources such as oil and gas will decrease year by year, and therefore we should pay attention to expanding the production of AESs. The use of AESs is extremely relevant today, as STI's advances are being applied at a rapid pace and an increasing amount of energy is required for the survival of economies and society as a whole. The variety of AESs and the potential we can get from them is huge. Only improving alternative energy production technologies and applying them

intelligently to the energy sector and economic activities as a whole are top priorities. It can be expected that COP-29, one of the largest events to be held in Azerbaijan in November 2024, will give a great impetus to the increase of electricity production from AESs in our country. The holding of such an event in our country will contribute to the production of green energy in Azerbaijan and will significantly increase its share in the total electricity production. If we take into account that there is already a great potential for the production of AESs in the Karabakh and Eastern Zangezur regions of Azerbaijan, then the share of electricity obtained from those sources in the total electricity production volume of the country will be significantly increased in the coming years.

6 FINAL RECOMMENDATIONS

Thus, taking into account the advantages of using AESs, the production of energy resources from these sources should be expanded, state support for this field should be strengthened, and attention should be paid to the following directions:

1. In many countries, the population supplies their homes only with solar and wind energy, and they also earn money by selling the produced energy to the state. Using AESs is the future of humanity. Billions of dollars are already being invested in this industry, and engineers and scientists are developing new ways of generating and saving energy. Investing in AESs and energy-efficient solutions isn't just about saving money, it is also an opportunity to improve one's well-being and the environmental condition of the planet itself.
2. The Republic of Azerbaijan has enough potential to become a "green energy" zone, and this will greatly contribute to the formation of the "green economy" in our country. Let's take into account that the reconstruction of infrastructure in the territories of Karabakh and Eastern Zangezur is realized on the basis of the principles of "green economy", then Azerbaijan will become one of the exemplary countries in the world developing on the basis of these principles. Therefore, it is necessary to strengthen state support for the development of the alternative energy sector in Azerbaijan.
3. State support for the development of alternative energy consists in creating favorable conditions for manufacturers and consumers of equipment using AESs.

This is, first of all, free access to the electricity market, preferential connection to the electricity grid without discrimination and regulation of energy tariffs and taxes on emissions and environmental pollution.

4. Alternative energy is a means of solving global problems and stimulating the economic activity of the population. For example, the development of alternative energy in the field of transportation is a good way to increase tax collections from citizens. Thus, it makes sense to create an environmentally friendly transport sector that will help solve the problem of environmental pollution.
5. AESs are also important in terms of ensuring the country's energy security. It is known that different countries meet the energy needs of their citizens in different ways: some at the expense of domestic resources, and some at the expense of imports. While some countries have better access to energy due to natural resources or favorable geological terrain, some countries are resource poor and therefore dependent on imports for energy supplies. For this reason, it is possible to reduce dependence on fluctuations in energy prices by ensuring the diversification of AESs. This can lead to the development of local economies and the creation of new energy technologies.

RELEVANCE OF THE TOPIC

The development of AESs has great potential to reduce greenhouse gas emissions, dependence on imported energy sources, and lower electricity prices. AESs cannot completely replace conventional sources in the near future, as they still have several limitations, such as the instability of energy production and storage. Also, political and economic measures to support the use of AESs and move away from conventional energy sources may require significant effort and time. Nevertheless, alternative energy is a key component of the transition to a more sustainable and environmentally responsible energy system, and its development should continue in the future. All this suggests that the topic of the article "AESs in Azerbaijan and the role of state policy in expanding its production" is relevant.

THE PURPOSE OF THE ARTICLE

consists of researching the role of state policy in the expansion of AESs and their production in Azerbaijan. The article appropriately provides information on the main advantages and disadvantages of the use of AESs compared to traditional sources, their role in solving global problems, analyzes the current state of energy production from these sources in Azerbaijan, and touches on a number of normative-legal acts and state programs adopted by the state in this field. . In addition, recommendations have been put forward regarding the expansion of the production of energy resources from AESs in Azerbaijan and the strengthening of state support to this field.

RESEARCH METHODS

Planning, forecasting, factor analysis, economic-statistical analysis, comparative analysis

SCIENTIFIC INNOVATION

The role played by AESs in solving problems in the field of using traditional energy sources, the main factors of their development were studied, and their contribution to the development of the green economy in Azerbaijan was explained. In addition, it was justified to take important and realistic steps in the direction of expanding the use of AESs, for this purpose, it was proposed to improve the legislative framework in the relevant field, prepare perspective plans and implement pilot projects.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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