СЕКЦІЯ 2
ПРИРОДНИЧО-ГЕОГРАФІЧНІ ТА ГЕОЕКОЛОГІЧНІ ДОСЛІДЖЕННЯ

UDC 9:91:911.2
DOI 10.32999/ksu2413-7391/2022-17-4

Azizov S.G.,
Ph.D. in Geography, Associate Professor
Lankaran State University. Lankaran, Azerbaijan
senan.ezizov.1958@mail.ru
ORCID: 0000-0002-9514-823X

Mammadova G.Sh.,
Ph.D. in Geography
Lankaran State University. Lankaran, Azerbaijan
mammedova_gulnare@mail.ru
ORCID: 0000-0003-1040-0668

THE IMPORTANCE OF USING ALTERNATIVE ENERGY SOURCES IN THE PROTECTION OF THE ATMOSPHERE IN AZERBAIJAN

The article talks about the possibilities of using the main energy fields that serve to protect the atmospheric air in Azerbaijan. The basis of the formation of the living world is the air layer. However, in modern times, lack of oxygen and thinning of the ozone layer have become one of the most important problems. Atmospheric air pollution has become one of the most important issues that need to be solved among the countries of the world due to the influence of several factors. Although the factors affecting air pollution lead to the development of industrial and economic areas, on the other hand, they lead to the violation of the biological regularity of nature. As a result of this pollution, the demands of living things from nature are increasing, and natural resources are decreasing. The reduction of atmospheric air, which is considered the main source of the biosphere, has a direct negative effect on the increase of various diseases among living things and their development dynamics. Air pollution is observed in our republic, like all the countries of the world, and various measures are taken to prevent pollution, protect the air, and develop the biological world from an ecological point of view. Prospective use of renewable energy sources in the territory of the Republic, their environmental cleanliness, and low operating costs are related to the expected shortage of fuel in traditional energy. In terms of keeping the atmospheric air clean, the ways and importance of expanding renewable and ecologically clean energy production and more efficient use of energy resources by using Azerbaijan's natural resource potential have been analyzed. For this purpose, alternative energy sources have been created to prevent environmental pollution in many areas using inexhaustible resources in the country.

Key words: alternative energy sources, thermal electric stations, thermal power plants, geothermal energy sources, power transmission lines, wind power plants, solar thermal power plants.

Азізов С.Г., Мамедова Г.Ш. Важливість використання альтернативних джерел енергії в захисті атмосфери в Азербайджані

У статті йдеться про можливості використання основних енергетичних полів, які служать для захисту атмосферного повітря в Азербайджані. Основою формування живого світу є повітряний шар. Проте в наш час нестача кисню і витончення озонового шару стали однією з найважливіших проблем. Забруднення атмосферного повітря стало однією з найважливіших проблем, які потребують вирішення серед країн світу через вплив кількох факторів. Фактори, що впливають на забруднення повітря, хоч і призводять до розвитку промислово-господарських зон, з іншого боку, призводять до порушення біологічної закономірності природи. В результаті цього забруднення зростає потреба живих істот у природі, а природні ресурси зменшуються. Скорочення атмосфер-

ного повітря, яке вважається основним джерелом біосфери, безпосередньо негативно впливає на збільшення різноманітних захворювань серед живих істот та динаміку їх розвитку. У нашій республіці, як і в усіх країнах світу, спостерігається забруднення повітря, і вживаються різноманітні заходи щодо запобігання забрудненню, охорони повітря, розвитку біологічного світу з екологічної точки зору. Перспективність використання відновлюваних джерел енергії на території республіки, їх екологічна чистота, низькі експлуатаційні витрати пов'язані з очікуваним дефіцитом палива в традиційній енергетиці. З точки зору збереження чистоти атмосферного повітря проаналізовано шляхи та важливість розширення виробництва відновлюваної та екологічно чистої енергії та більш ефективного використання енергетичних ресурсів за рахунок використання природно-ресурсного потенціалу Азербайджану. Для цього створені альтернативні джерела енергії, які запобігають забрудненню навколишнього середовища в багатьох районах, використовуючи невичерпні ресурси країни.

Ключові слова: альтернативні джерела енергії, теплові електростанції, теплоелектростанції, геотермальні джерела енергії, лінії електропередачі, вітроелектростанції, сонячні теплові електростанції.

Formulation of the problem. Atmospheric air protection means the prevention of the release into the air of substances in the form of liquids and solid particles of various gases that affect living organisms, as well as the environment as a whole. Pollutants enter the atmosphere under the influence of natural and anthropogenic factors, and the study of this process, its prevention, development of necessary protection measures is of great scientific and practical importance. For this purpose, the monitoring system of environmental pollution, as well as atmospheric pollution, has been systematically observed for more than 30 years to protect the air from pollution in major industrial centers of the country, including Baku. Analysis of the obtained observations shows that the share of air pollution is high because the fuel and energy complex is a major producer of oil and natural gas, as well as energy (Məmmədov, Xəlilov 2005). The facilities of this complex account for 50% of the toxic emissions released into the environment in Azerbaijan. Other sources of air pollution in the major industrial cities of the country are thermal power plants (TPPs) and small heating plants. The energy of industrial cities is a complex multifaceted hierarchical system designed to ensure the normal operation of industrial enterprises and departments located in the territory of cities, in addition to organizing the life of the population.

Rising prices for organic and inorganic fuels are forcing people to look for other forms of energy. At present, the use of solar and wind energy, groundwater thermal energy, the energy of flowing rivers, tides, and oceans, changes in depth and temperature in the seas, fuel cells, etc. are becoming more urgent. Special converters that allow obtaining electricity directly from solar energy, special wind power plants have been created to generate electricity using wind energy, and a lot of work has been done to use inexhaustible hydropower resources.

Analysis of recent research and publication. This field has been investigated by a number of research scientists, such as Abdullayev K.M, Latifov Y.I, Abdullayeva G.K. and so on. an example can be given. Apart from the research has been conducted in different periods, as a result of further improvements over the years, there is a need to re-examine this field.

Statement of the task. It consists of an analysis of the distribution directions and potential energy resources of alternative energy sources, which are considered ecologically clean energy production that has been approved in the world, in the territory of the Republic of Azerbaijan, as well as the ways and importance of using these energy sources in order to protect the atmosphere and meet the country's energy demand.

Statement of the main research material. One of the main steps taken to protect the atmosphere in our country is the creation of non-traditional (alternative) energy sources. Azerbaijan has ample opportunities to use environmentally friendly wind, solar, and geothermal energy sources. The potential reserves of these energy sources are estimated at 60 billion tons of conventional fuel. It has been determined that the fuel equivalent of solar energy in the area alone is 16 billion tons of conventional fuel. Studies show that it is possible to increase the amount of electricity produced in Azerbaijan by 5-7% and thermal energy by 10% through the use of alternative energy sources.

Between 2005 and 2012, global wind power generation increased by 57% and solar power generation by 3,4 times. According to the International Energy Agency, in 2018 the share of renewable energy sources in world electricity production will increase to 25%. For comparison, in 2012 this figure was 20%. 80% of the world's modern energy production is based on oil, gas, and coal. In 2008, the share of wind energy production in the energy balance of the European Union was 3,7% (İsmayılov, 2015).

The Action Plan for the effective use of the reserve potential of the regions in the State Program for 2014-2018 envisages specific work to be done for each region of the Greater Caucasus. As early as October 21, 2004, based on the Order of the President of the Republic of Azerbaijan, the "State Program on the Use of Alternative and Renewable Energy Sources in the Republic of Azerbaijan" was approved (Əsgərov, 1966). As indicated in the State Program, the limited hydrocarbon resources as a traditional energy source and the prevention of environmental pollution make it necessary to increase the amount of energy produced in the world through alternative and renewable energy sources. Positive experience has already been gained in this direction, and in some countries, the use of solar, wind, thermal waves, and mineral waters, as well as other clean and renewable energy sources is expanding year by year. From this point of view, Azerbaijan also has a lot of alternative and renewable energy potential due to its favorable natural conditions.

Wind energy. We present information on the use of wind energy (WE) based on the results of research by N.S. Huseynov and E.P. Yusifov (2002). Distinguished by its environmental friendliness and inexhaustibility, WE are considered the most cost-effective and efficient of all alternative energy sources.

The first simple wind turbines date back to ancient Egypt and China. People have been using wind energy since ancient times to grind grain in windmills. The first ancient windmills were installed in Iran in the 7th century AD. Since the Middle Ages, windmills have been widely used in Azerbaijan in the plains, especially in Absheron. Since the 13th century, WE have been widely used in the movement of ships and pumping water from wells. The annual wind energy on Earth is estimated at 10^{12} KW/h, and the power it generates is estimated at 10^{9} KW/h. However, due to the unstable wind, it is possible to use only 5% of its energy.

Thousands of Wind Energy Installations (WEIs) with a total capacity of 18 MW operate in more than 20 European countries and Turkey. On the east coast of France, 16 Weis, each 1,3 MW, provide electricity to 25,600 people at an annual rate of 64 million kWh, preventing the release of 32,000 tons of CO_2 into the atmosphere that year. Australia, which is rich in WE, currently has a total capacity of 100 MW of wind turbines, reaching 7,000 MW in 2018. The total output of 214 wind turbines in the King Mountain area of Texas is 277 MW.

Due to its geographical location and natural conditions, Azerbaijan has an annual wind energy reserve of 800 MW. This reserve means 4 billion KW/h of electricity per year, or 3,700 tons of carbon dioxide emissions per year, saving 1 million tons of conventional fuel. It should be noted that the Absheron Peninsula, its coastal zone, and surrounding islands are considered suitable for the use of wind energy. As the average annual wind speed in these areas is 5,5-7,0 m/sec., it is considered to be fully suitable and highly profitable for WEI system's.

Sharur, Julfa, and Ganja-Dashkesan districts are also suitable for WEI systems. Since the average annual wind speed in these areas is 3-5 m/sec., it can be used for the construction of medium-strength WEI systems. Oil wells in the Absheron archipelago are more efficient and profitable in terms of electricity supply, both technically and economically. The annual electricity of 80 turbines, each with a capacity of 2 MW, installed in the North Sea of Denmark, is 600 GW.

Shortly, a feasibility study has been prepared for the installation of a wind power plant with a total capacity of 30 MW (12 wind power plants with a capacity of 2,5 MW each) in Gobustan. By the State Program, the center being built in the area is equipped with wind, solar, and biogas stations. The connection of the hybrid type HS installed within the project to the network of "Azerenergy" OJSC has been completed.

Solar energy. The upper surface of the Earth's atmosphere receives 5,6×1024 C solar energy per year. Although 40% of this energy (Earth's albedo) is returned, the radiation absorbed by the earth's surface is used to heat the seas and oceans, liv-

ing things, and the circulation of the atmosphere and hydrosphere. The average annual amount of solar energy entering 1 m² of the Earth's surface in 1 hour is estimated at 80-130 W/m² at the poles, 130-210 W/m² in the temperate zone, and 210-250 W/m² in the tropics (deserts). Due to the uneven distribution of solar radiation on the earth's surface, depending on the daily cycle, seasonal variability, and weather conditions, its concentration is relatively weak. However, the amount of solar energy entering the earth's surface exceeds the energy of oil, gas, coal, and uranium reserves, allowing it to compete with other energy sources.

As our country is the largest recipient of solar radiation in the Caucasus, it is called "Sunny Azerbaijan". The annual number of sunny hours in the area varies from 1800 to 2900 hours. The highest rates of sunny hours are in the plains, especially in Nakhchivan (2900 hours/year), Kur-Araz lowland, Jeyranchol, Absheron peninsula (2200-2400 hours/year), in the middle and high mountains of the Greater and Lesser Caucasus (2100-2400 hours/year) and so on is being observed. Solar radiation is also unevenly distributed in the country. Thus, the annual amount of total solar radiation in the Kur-Araz and Lankaran lowlands is 125-134 kcal/cm², and in the Nakhchivan Autonomous Republic 145-160 kcal/cm², and towards the foothills, due to cloudiness, it decreases to 120-130 kcal/cm², and in the highlands, it increases again to 140-150 kcal/cm².

Although solar energy is rich in the country, it is still poorly used. As can be seen, the territory of the republic has enough non-traditional energy resources, which are considered ecologically clean. In the future, if these inexhaustible, renewable resources are used efficiently, they will save a lot of depleted raw materials and create conditions for maintaining the ecological balance of the environment.

Implementation of the order on socio-economic development of the regions in 2004-2008 and 2009-2013 years, State programs on the development of the fuel and energy complex in 2005-2015, and additional measures to meet the electricity demand and improve the supply in the country has yielded positive results. The Independent energy system of Azerbaijan is being further strengthened by new generation forces. In recent years, Azerbaijan plans to put into operation additional facilities with a capacity of 700 MW, and shortly to increase the capacity to 1700-2400 MW, which is 50% more than the existing potential of Azerbaijan. If the total production capacity of power plants included in the energy system of Azerbaijan is estimated at 4,500-5,000 MW, it is planned to increase this capacity by another 2,000-4,000 MW in the future.

At present, along with the construction of several Power plants in the country, systematic changes have been made in the power transmission networks and a sustainable energy system has been created. The power system of the republic includes 110, 220, 330, and 500 KW power transmission lines (PTL) and more than 170 substations. The total length of 138 PTL with a voltage of 110 KW and above is 6,300 km, and the total length of lines with a voltage of 35, 10, 6, and 0.4 KW (including distribution lines) is more than 120,000 km. Construction of the 2nd Imishli-Parsabad (330 KW), Imishli-Shirvan (330 KW), Shirvan-Salyan-Masalli-Astara (220 KW), and other transmission lines has begun. For the first time in the CIS, an SES-class substation will be built underground on Babek Avenue in Baku.

To increase the energy exchange between the energy system of Azerbaijan and the energy system of the Russian Federation, the construction of the "Khachmaz" substation with a capacity of 400 MW and a voltage of 330/110 KW was carried out.

Geothermal waters. Azerbaijan Science Center (ASC)-what can be attributed to solar and wind energy, as well as thermal water. Geothermal waters are one of the non-traditional, environmentally friendly energy sources. The world's first GEO TPP was built in 1872 in Italy. Currently, such stations are located in more than 25 countries-Iceland, Russia, the United States, New Zealand, and others are operating. In general, a well producing 50 tons of steam or 1,000 tons of hot water is estimated to have a capacity of 2 MW to 7 MW.

In the Republic of Azerbaijan, the Greater and Lesser Caucasus, the Absheron Peninsula, Talysh, the vast areas of the Kur basin and the Caspian-Guba zone are rich in geothermal water resources. The projected reserves of these thermal waters are 245,6 thousand m³ per day.

In the Lesser Caucasus, geothermal water sources are distributed in the Tartar and Arpachay basins (Istisu (Hot water) and Baghirsag (Intestine) are particularly different). The water temperature at these thermal water sources at a depth of

70-100 m is 62°C-80°C, the daily water flow is 25 thousand liters/a day and 800-900 thousand liters/a day. As the water in the hot springs is chemically carbonated, chloride-sulfate, and hydrocarbon-sodium, it is possible to use them for balneological purposes.

Although geothermal water sources of Nakhchivan AR are poorly studied, mineral waters of the Sirab, Nahajir, and Julfa districts have been found to have therapeutic value. Water with a temperature of 41°-52°C and a daily flow rate of 1080-2850 m³/a day was found in a well drilled at a depth of 137-665 meters in the Daridagh region.

The thermal waters in Lankaran, Masalli, and Astara regions located in the southern region correspond to the tectonic fault zone passing through the territory of the republic. In Masalli (Arkivan), Lankaran (Meshesu, Ibadisu, Havzava, Haftoni), and Astara, the temperature of water from wells with a depth of 465-1000 m is between 35° and 50°C, and the flow rate is 2260 m³/a day. The total flow rate of water sources in the Talysh zone is 23625 m³/day, and the amount of heat provided by the water is 5.56×105 Gcal.

The Greater Caucasus region is very rich in geothermal waters. From this point of view, Gakh (Ilisu, Kurmuk), Gabala (Bum), Oguz (Khalkhal), Shamakhi (Chagan), Absheron (Hovsan, Bibiheybat, Guzdek, etc.) as well as Guba, Khachmaz, Yalama, and other thermal water sources are very different. The water temperature in these sources is 30-40°C, 50-95°C, 100-135°C, and the water flow rate is 400-500 m³/a day (20,470 m³/a day in the Guba-Khachmaz zone). The amount of heat given by the water varies from 3,5×105 to 4,4×105 Gcal (Məmmədov, 2015).

The rich thermal waters available in the Kur basin region can be used for heating social and household facilities, as well as for balneological purposes. The temperature of these thermal waters is 45-100°C, the flow rate is 1000-2000 m³/a day, and the amount of heat they give fluctuates between 1,4×109-7,5×105 Gcal.

Conclusions from the conducted research. In the Republic of Azerbaijan, there are ample opportunities to use environmentally friendly wind, solar and geothermal energy sources. Studies show that it is possible to increase the electricity produced in Azerbaijan by 5-7%, and heat energy by 10% due to the use of alternative energy sources.

Thus, improving the demand for energy by maximally and efficiently using the alternative energy sources available in the Republic, protecting the atmospheric air, which is important for the health of the population, will lead to the development of the living world, and also lead to the prevention of the problem of global warming and the destruction of the ozone layer.

REFERENCES:

1. Məmmədov R.M. (2015). İqtisadi, sosial və siyasi coğrafiya. AMEA. Bakı [Mammadov R.M. (2015). Economic, social and political geography. ANAS. Baku (In Azerbaijani)] https://mega.nz/file/MWx0UDgT#6x4zlL9lZgiAqwEVHPuuBi8u5gBeEPv-HggCfdJ56sg

2. Məmmədov Q.Ş., Xəlilov M.Y. (2005). Ekologiya və ətraf mühitin mühafizəsi. Bakı. [Mammadov G.Sh., Khalilov M.Y. (2005). Ecology, and environmental protection. Baku (In Azerbaijani)] https://achiqkitab.aztc.gov.az/upl/books/pdf/Ekologiya_ve_etraf_muhitin_muhafizesi_559bac927d847.pdf

3. Cəlilov M.F. (2009). Alternativ regenerativ enerji sistemləri. Bakı [Jalilov M.F. (2009). Alternative regenerative energy systems. Baku (In Azerbaijani)] http://anl.az/el/c/cm_ares.pdf

4. Azərbaycan Respublikasında Alternativ və bərpa olunan enerji mənbələrindən istifadə olunması üzrə Dövlət Proqramı. (2004). 21 oktyabr tarixli 462 N°-li sərəncam. [State Program on the Use of Alternative and Renewable Energy Sources in the Republic of Azerbaijan. (2004) Order No. 462 dated October 21(In Azerbaijani)] https://e-qanun.az/framework/5796

5. Əsgərov Ə.H. (1966). Azərbaycanın mineral suları. Bakı [Askerov A.H. (1966). Mineral waters of Azerbaijan. Baku (In Azerbaijani)]

http://static.bsu.az/w8/Xeberler%20Jurnali/Tebiet%20%202012%202/117-123.pdf

6. İsmayılov Ç. (2015). İqtisadi və sosial coğrafiyanın əsasları. Bakı [Ismayilov Ch. (2015). Fundamentals of economic and social geography. Baku (In Azerbaijani)] https://www.researchgate.net/publication/360720295_Siyasi_v_iqtisadi_cografiya_tdrsi_proqrami

Стаття надійшла до редакції 17.11.2022.
The article was received 17 November 2022