

Modern state of the energy sector of Uzbekistan and issues of their development

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Abstract. The data on the current state of the energy sector in Uzbekistan are presented. The need to diversify the structure of the republic's energy balance is shown to ensure the energy security of the state in the medium and long term. The development of the energy sector is extremely important for ensuring sustainable economic growth and solving social problems of the state; as well as the development and modernization of the electrical system, the oil and gas sector, the construction of a nuclear power plant and a gradual transition to renewable energy sources are strategic directions for the development of the fuel and energy complex of Uzbekistan. It is argued that the construction of a nuclear power plant in Uzbekistan is not only advisable, but also necessary. The issues of the prospects for the development of renewable and nuclear energy sources in Uzbekistan, issues of investment and system costs with different shares of their participation in electricity generation are considered. It has been developed and shown that in the future, based on the symbiosis of renewable nuclear energy, by the middle of the 21st century, conditions for carbon-neutral energy can be formed in the economy of Uzbekistan.

1 Introduction

The world in the 21st century is going through a period of transition from an industrial society, with its characteristic high energy costs, to a knowledge society with highly developed technologies, deep economic, social and spiritual restructuring of society's life, ensuring its balanced and sustainable development. At the same time, energy consumption in the world will grow steadily due to population growth and improvement of social conditions. The consumption of energy resources in the world, in comparison with 2000, by 2030 will increase 1.5 times, by 2050 more than 2 times, and the consumption of electricity in the same periods - 2 times and more than 3 times, respectively [1-5].

The global energy transformation currently taking place in the world in the 21st century will have an impact on technological, social, economic and other directions in the development of countries. The emerging new reality will be fundamentally different from the usual energy geopolitics, which has dominated for over a hundred years [3-5].

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Fossil fuels are the backbone of the global energy system, economic growth and modern lifestyles, over the past two centuries, exploitation has increased global energy use fifty times, shaping the environment in the modern world [5]. The geographic concentration of fossil fuels has had a significant impact on the welfare and security of nations. At present, one can observe the emerging energy of the future, which can be represented in the form of a square, the sides of which are the sun, wind, hydropower and nuclear energy. This energy transformation could lead to changes in scale and impact as radical as the industrial and agricultural revolutions. The Republic of Uzbekistan is also subject to such changes.

Over the years of independence, Uzbekistan has achieved impressive success, both in the field of energy and in other sectors of the economy. The power industry of Uzbekistan, including the power industry, is one of the developed not only in the CIS, but also in the world. This is explained by the

unique reserves of energy resources, scientific, technical and personnel potential, the development of the corresponding infrastructure [6-8].

The fuel and energy complex of the Republic of Uzbekistan is the largest in Central Asia association of enterprises for the extraction, processing, transportation of oil, natural gas, coal, as well as the production and distribution of electrical and thermal energy.

By the measures taken by the country's leadership, back in 1995, Uzbekistan achieved energy independence. At present, taking into account the self-sufficiency of the republic, measures are being taken for the medium and long-term satisfaction of its needs with the necessary high-quality energy resources on the basis of the sustainable development of the industry.

The Energy Strategy of Uzbekistan sets the task of ensuring energy independence and security, increasing energy efficiency, and reducing the impact of energy on the environment. To solve these problems, it is necessary to develop and introduce new technologies based on scientific achievements that provide safer, cleaner energy [8].

Increasing energy conservation, reducing the cost of generating electricity, and creating a specific electricity market remain topical tasks. Energy saving and energy efficiency is a key priority of the national energy policy of Uzbekistan. The use of modern methods of energy conservation, the introduction of steam and gas and gas turbine technologies, renewable and nuclear energy sources will increase the energy efficiency of production, transmission and consumption of electricity and heat, saving primary energy sources - natural gas, oil and coal, preserving them for use by future generations [8].

2 Research methods

The main goal of the energy policy and the highest priority for the development of the electric power industry in Uzbekistan for the period up to 2030 and beyond, determined by the state, is sustainable energy supply to economic growth and improving the quality of life of the population based on the most efficient use of the existing production, scientific and technical potential of the industry. The electric power industry is the basic branch of the economy of Uzbekistan, strategically important for the state. Therefore, the issues of energy development are always in the center of attention of the republic's leadership, and they are being addressed consistently.

In recent years, in the Decrees and Resolutions of the President and the Government, the following tasks have been set and are being solved: the introduction of modern energy efficient and energy saving technologies into the energy sector of Uzbekistan [9], further development of renewable energy (RES) [10], created the Ministry of Energy and JSC "Uzbekgidroenergo" [11, 12], Atomic Energy Agency "Uzatom" and approved the "Concept for the provision of the Republic of Uzbekistan with electrical energy for 2020-

2030", "Concept for the development of nuclear energy in Uzbekistan" [13], Strategy for further development and reform of the electric power industry of the Republic of Uzbekistan [14]. Tasks have been set for the development of the efficiency of the coal industry and for the optimal use of water resources [15], attention is paid to the ecology of the energy sector and the use of solid household waste [15-18]. Special attention is paid to the development of earth science and the improvement of the system of organizing geological exploration to increase the production of oil and natural gas [19-21], etc. About 50% of the generating capacities of the countries of Central Asia are concentrated in Uzbekistan, which is more than 13 million kW of installed capacity, with the possibility of generating electricity of about 70 billion kW h per year (Fig. 1).

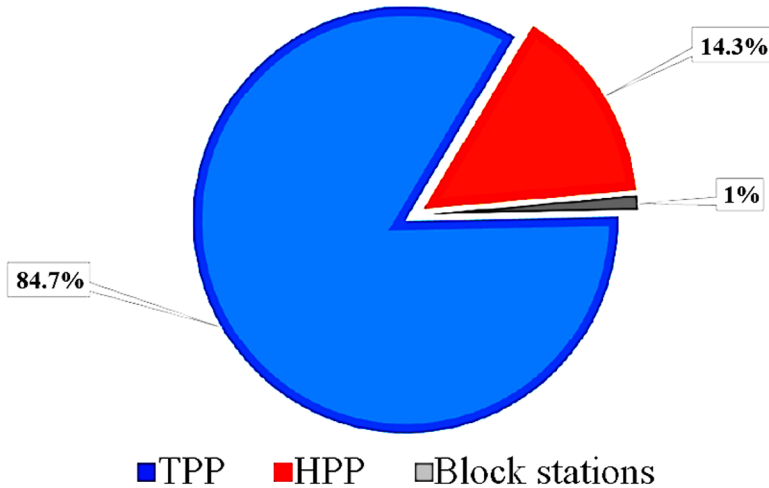


Fig. 1. Structure of electricity generation

The Uzbek energy system is the main link in the unbreakable chain of production and transmission of electrical energy in the region. The geographical location, the presence of developed electrical networks allow us to successfully organize and be an active participant in the electricity and power market.

The power engineers of Uzbekistan have set ambitious tasks - by 2030, to bring the generation of electricity to more than 120.8 billion kWh, which is twice as much as the generation of electricity in 2019 - 66.7 billion kWh and to reduce the conditional consumption fuel to generate a unit of electricity. In the period from 2012 to 2019, there was an increase in electricity production at the level of an average of 2.6 percent per year (Fig. 2). However, the demand for electric energy was not fully satisfied, the deficit was about 9.4 percent of the demand [20].

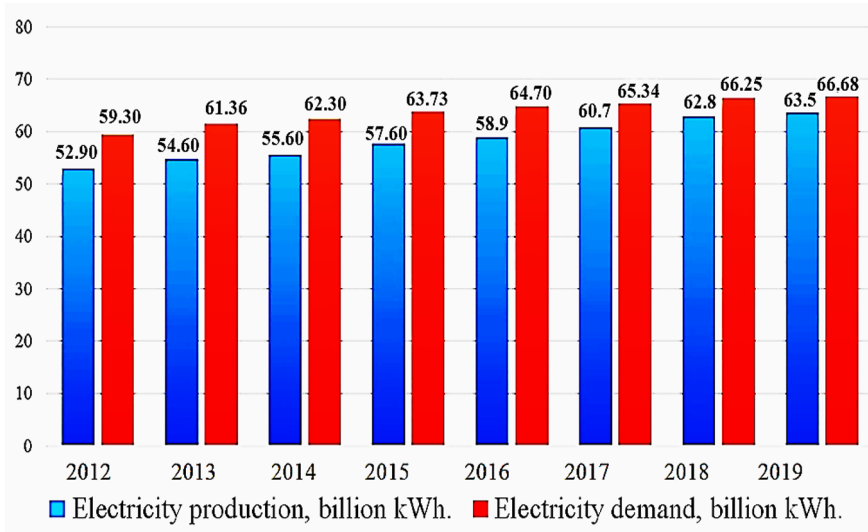


Fig. 2. Actual dynamic of production and demand for electric energy in the period 2012-2019

By 2030, the republican consumption is projected to be 120.8 billion kWh (an increase of 1.9 times by 2018), which is shown in figure 3. At the same time, the population's demand for electricity will amount to 21.9 billion kWh (growth by 1.8 times by 2018), sectors of the economy - 85.0 billion kWh (growth by 2.2 times by 2018) [20].

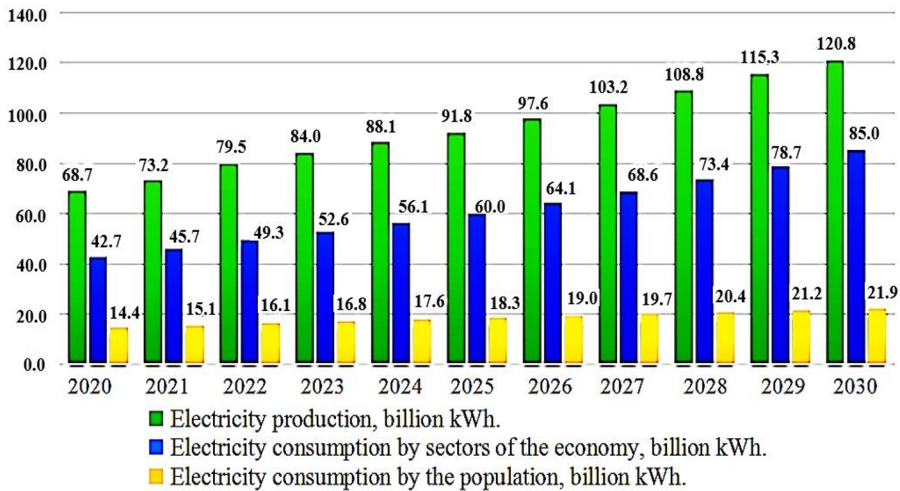


Fig. 3. Forecast dynamics of production and consumption of electric energy until 2030, billion kWh.

3 Results and discussion

The energy sector of Uzbekistan is one of the most developed not only in the CIS, but also on a global scale. Therefore, it is obvious that the issues of its development are related to the processes taking place in the world energy sector. As the world and domestic

experience shows, the problem of increasing the energy efficiency of production and consumption of electricity in the long term is solved in stages, through modernization, reconstruction, renewal of power grid equipment and the widespread use of energy saving methods. The ways of solving these issues are specified in the above documents.

The implementation of this ambitious task will be carried out in the following directions [8]:

1. Intensification of energy efficiency and energy saving (reserve up to 40% of energy savings). This will require an accelerated modernization of fixed assets, diversification of energy sources, implementation of an effective energy saving policy, an assessment of the real costs of energy supply in the country, etc.

2. The widespread introduction of steam and gas technologies instead of steam technologies at thermal power plants will increase the efficiency of units from (32-35)% to (54-60)% and, accordingly, will make it possible by 2030 to use the same amount of natural gas for energy purposes as and now.

3. Development of energy resources of wind and sun. In most countries of the world, extensive work is underway to diversify the energy structure, including by expanding the use of non-carbon renewable energy sources and atomic energy [2-5]. According to the estimates of domestic and foreign experts, the real technical potential of solar and wind energy in Uzbekistan is at least 10 million kW of power in each direction.

4. Increasing the share of coal and shale in electricity generation, using modern technologies for burning low-grade solid fuels. Uzbekistan's brown coal reserves are about 2 billion tons, and about 50 billion tons of shale. At the same time, it is important to comply with the highest environmental standards.

5. Introduction of hydropower and hydroelectric power stations, a flexible tariff system, as well as closer cooperation with the energy systems of neighboring countries - to make the system more flexible, alignment of consumption schedules during peak (maximum) hours.

6. Exploring the possibility of building nuclear power plants by 2030 and beyond.

The solution to this problem in the medium and long term is the content of the reform, development and implementation of the energy development strategy of Uzbekistan, taking into account the preservation of its export opportunities.

At present, when generating electricity, natural gas dominates in the energy balance of Uzbekistan - its use reaches 90%, i.e. there is a disproportion in the use of primary energy resources. In order to diversify, the government of Uzbekistan is expanding the composition and base of energy resources.

The electric power industry of Uzbekistan is the basic branch of the economy of the Republic and having a significant production, scientific and technical potential, has a significant impact on its development [8].

Over the past 30 years, the production of electricity in the republic has grown more than 3 times, with the possibility of generating electricity up to 55-70 billion kWh.

The installed capacity of power plants in Uzbekistan exceeds 13.0 million kW, including thermal power plants (TPP) - 10.6 million kW, hydroelectric power plants (HPP) - 1.4 million kW (Figure 1). The share of departmental power plants in the structure of generating capacities is less than 3%. Currently, in Uzbekistan, 83% of the country's electricity is generated by gas, 13% by HPP, and 4% by coal.

In Uzbekistan, 16.5 billion cubic meters of natural gas, 85 thousand tons of fuel oil and 2.3 million tons of coal are annually spent on the needs of the electric power industry [7].

The most acute problem is the aging of fixed assets in the thermal power industry, which is the basis of the Uzbek energy system. At the thermal power plants of the company with a capacity of 10.6 million kW, 63 turbine generators with a unit capacity of 25 to 800

MW are installed, of which 39 turbines with a capacity of 5.9 million kW (or 55%) have been in operation for more than 30 years.

As the world and domestic experience shows, the problem of increasing the energy efficiency of production and consumption of electricity in the long term is solved in stages, through modernization, reconstruction, renewal of power and power grid equipment.

The need to increase the level of energy efficiency in the electric power industry requires the introduction of the next level of AIMSCME - automated information and measurement systems for commercial metering of electricity generation and consumption. The intensification of energy saving, in addition to regulatory and legal support, should be supported by an appropriate technical and information base.

Reforms have begun in the power industry of Uzbekistan, which is the basic sector of the state economy. By the decision of the President of the Republic of Uzbekistan, the Ministry of Energy of Uzbekistan was created. In this regard, the implementation of the tasks set by the government of Uzbekistan. The large-scale implementation of renewable energy reserves and the construction of a nuclear power plant (NPP) in Uzbekistan will allow stable supplies of electricity, ensure energy security and diversify energy resources in the long term.

The gradual transition to the use of renewable and nuclear energy sources will take decades. During this period, it is necessary to take measures for the rational use of existing steam and gas technologies and cogeneration, increasing their efficiency in combination with energy saving in various sectors of the economy.

The implementation of large-scale programs for the development of electric, thermal and nuclear energy, renewable energy sources, including small hydroelectric power plants, will ensure the energy independence and security of the state in the long term. In Uzbekistan, large-scale work has begun on the use of renewable energy sources - sun, wind and other types, the real potential of which is estimated at approximately 8000 MW (photovoltaic power plant (PPP) - 5000 MW, wind power plant (WPP) - 3000 MW). Fig. 4 shows the structure of generation based on RES by 2030 [20].

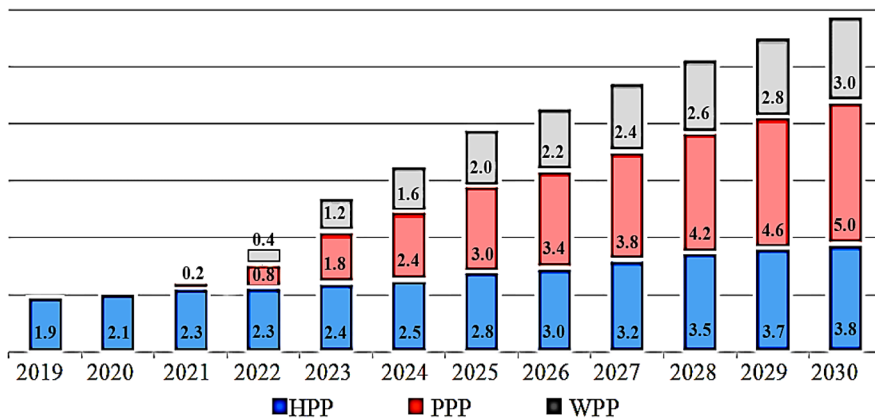


Fig. 4. The structure of generation based on RES by 2030, MW

In Uzbekistan, for the first time in the Central Asian region, by 2030 it is planned to complete the construction of a nuclear power plant with a total capacity of 2.400 MW, with two VVER-1200 units of generation "3+", with a capacity of 1.200 MW each. This fact will provide Uzbekistan with inexpensive electricity and give an impetus to the

development of science and education, in such areas as fundamental science, traditional and nuclear energy, chemical industry, mechanical engineering, construction and others.

A long-term investment program has been developed for the expansion, modernization and diversification of generating capacities in Uzbekistan for the period up to 2030, with the increase of generating capacities from the current 15 GW to 30 GW (Fig. 5), with a decrease in the cost of electricity production by 6% [20, 22]. It is planned to invest about \$ 20 billion to increase production capacity, modernize the transmission and distribution of electricity [23].

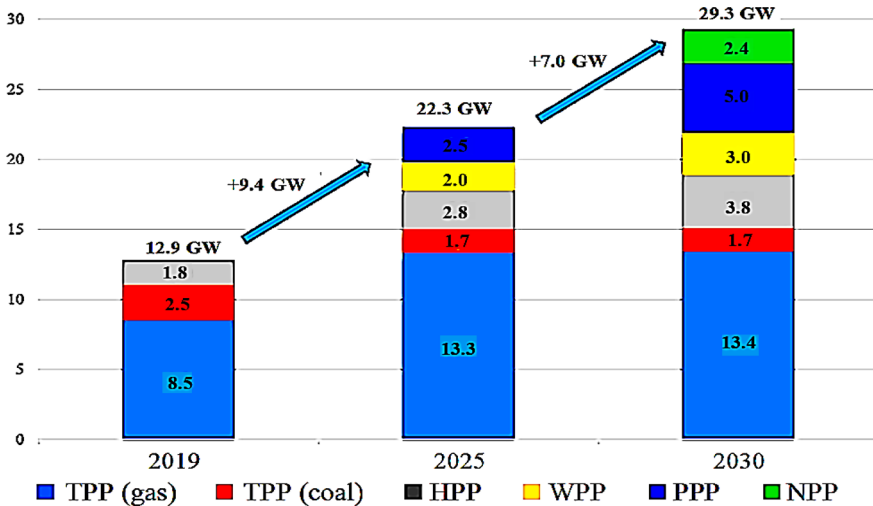


Fig. 5. Change in installed capacity in 2019-2030, MW

In 2021, the first large solar photovoltaic plant with a capacity of 100 MW was commissioned in Uzbekistan. The total cost of this project is \$ 110 million. It produces 260 million kWh of clean electricity per year. This will provide electricity to 31,000 homes. As a result, 80 million cubic meters of natural gas will be saved.

An international tender has been announced for the construction of a 100 MW wind farm in Uzbekistan. In the next five years, wind, solar and hydroelectric power plants with a capacity of more than 5,000 megawatts will be launched in the country to implement the "Green Economy". As a result, about 3 billion cubic meters of natural gas will be saved annually.

As a result of the implementation of the planned measures, by 2030, according to the forecast, the volume of electricity generation will reach 120.8 billion kWh (Fig. 6), including: TPPs - 70.7 billion kWh (58.5 percent); HPPs - 13.1 billion kWh (10.8 percent); PPP - 9.9 billion kWh (8.2 percent); WPP - 8.6 billion kWh (7.1 percent); NPP - 18.0 billion kWh (14.9 percent); block stations - 0.6 billion kWh (0.5 percent) [20].

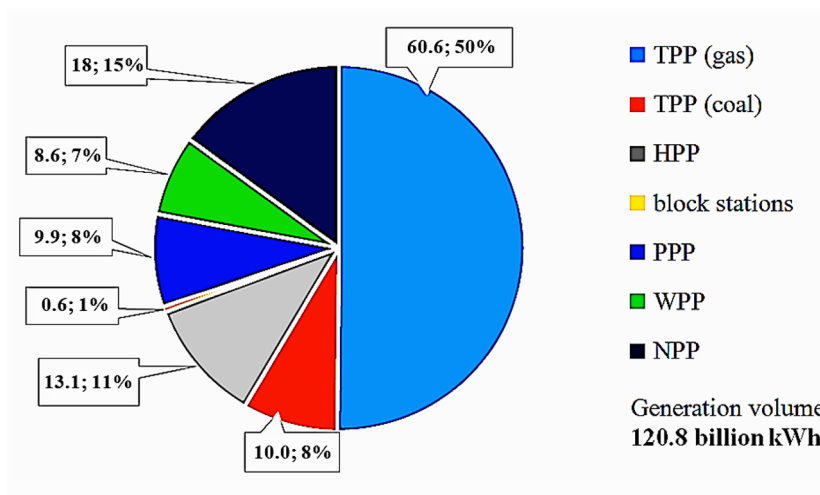


Fig. 6. Diagram of changes in the generated electric energy in Uzbekistan in 2030, billion kWh

According to experts' forecasts, the annual growth of electricity consumption in the republic is about (6-7) %, which means that by 2030 it is necessary to at least double the generation of electricity - to bring its generation to 120 billion kWh, including through alternative energy sources, the production of which will be brought to 25% of the total electricity production. This is possible if there are more than 5 GW of regulating capacities to cover peak loads, ensuring a stable, balanced operation of the energy system of Uzbekistan.

Thus, as a result of the implementation of comprehensive and large-scale measures based on Decrees, Resolutions and decisions of the Government of Uzbekistan, the energy sector of the state will receive a powerful impetus for development, and the structure of electricity generation will become diversified, which will ensure the republic's energy security and sustainable development.

4 Conclusions

In conclusion, it can be noted that the future of the energy industry in the world and Uzbekistan is the joint application (symbiosis) of such promising energy sources as solar, wind, nuclear and hydrogen, with the prospect of a transition to thermonuclear energy.

The main goals of the further development of the fuel and energy complex of Uzbekistan are developed and shown, the basis of which in the medium and long term is the symbiosis of renewable and nuclear energy in the economy of Uzbekistan.

It is argued that the construction of a nuclear power plant in Uzbekistan is not only advisable, but also necessary. In the future, renewable energy sources and nuclear power plants will become the backbone of Uzbekistan's energy sector.

Thus, in the medium and long term, the implementation of program tasks arising from the Laws of the Republic of Uzbekistan and Decrees, Resolutions of the President of the Republic of Uzbekistan, will ensure the development of energy and energy security and the sustainability of the state's development. For this, Uzbekistan has a rich resource base, powerful production potential and qualified scientific and technical personnel.

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