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USE OF RENEWABLE ENERGY SOURCES FOR LOW-POWER ENTERPRISES IN UZBEKISTAN

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Abstract.

The article shows the main problems of the development of traditional and renewable energy in the ecological context is considered in the article. The experience of developed industrial states in solving environmental problems and the work carried out in this direction in our country is shown.

Keywords: energy, renewable energy sources, wind energy, hydropower, solar energy, application.

Increasing energy efficiency and the need to conserve resources are pressing problems in almost all countries of the world. To solve these problems, a new energy policy based on the use of hybrid energy systems with renewable energy sources (HRES - Hybrid Renewable Energy System), in which traditional energy sources are combined with renewable ones (such as solar panels, wind generators, and others), has been developed in recent years.

The current hybrid energy systems and their control algorithms do not fully meet the requirements of efficiency for several reasons. Firstly, the cost of electricity generated by different suppliers (electricity sources) is not taken into account; secondly, if the electricity generated by renewable energy sources is not enough for consumers, then external power grids are used without regard to the electricity tariff plan and often at an unprofitable price.

President of the Republic of Uzbekistan Shavkat Mirziyoyev held a meeting on October 3, 2018, dedicated to an in-depth analysis of the state of affairs in the electricity sector, identifying additional measures to develop the industry.

At this meeting, it was noted that the use of modern technologies in the creation of new power generating facilities, and the widespread introduction of renewable energy sources should become the main tasks of JSC "Uzbekenergo".

Our sunny Uzbekistan is just beginning to develop a strategy for the development of renewable energy sources [1]. Although the current costs of renewable energy technologies significantly exceed the costs of conventional energy technologies, today we can identify the obvious objects of their introduction.

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For Uzbekistan, these are installations for obtaining electricity and heat at low-power facilities in the local industry and construction sector, facilities in the agricultural and social sphere, farms, greenhouse farms, etc.

Even today, the use of renewable energy sources in remote and inaccessible areas located in mountainous and semi-desert areas, as well as in remote pastures is quite competitive with traditional energy sources.

The publication prepared by the UNDP office in Uzbekistan gives a fairly complete overview of the current state of energy use in the country and the possibilities of using renewable energy sources not only from the technical but also, very importantly, from the economic and social points of view [2].

Thus, the task of substantiation of expediency of creation on the territory of Uzbekistan electric power generating complexes, converting the energy of wind, solar radiation, and water flow, certainly is actual, and scientific and practical importance of the questions connected with the development of methods of calculation of their parameters causes no doubts [3].

Use of hydropower potential for power generation.

According to JSC "Uzbekhydroenergo", the technically feasible hydropower potential of Uzbekistan is estimated approximately at 27.4 billion kWh of electricity per year.

In 2017, the 37 operating hydropower plants generated 7.93 billion kWh, that is, about 29% of the potential is used. The remaining hydropower resources of the country's waterways amount to 19.47 billion kWh per year, the hydropower company noted in its information.

According to the company, the optimal proportions in the energy structure are considered the ratio of thermal and hydraulic generation respectively 65% and 35%, while in the energy system of Uzbekistan in 2017 was 87% and 13% and depends on the water year.

The main advantages for further development of hydropower and increasing the share of renewable energy sources in the energy system of Uzbekistan are several factors, in particular, HPPs use a natural, free, and environmentally friendly renewable energy source.

Using wind energy to generate electricity

The authorities consider the development of solar and wind energy as part of the transition to renewable energy. Today, these industries are poorly represented in Uzbekistan.

By 2025, solar power's share of the country's generating capacity should rise to 2.3% and wind power to 1.6%, if the plan works. Uzbekistan's only solar power plant operates in Namangan province. The first Uzbek wind power plant in the Tashkent region is still under construction.

Analysis of literature sources allows to determine the following main directions of research in the field of wind power engineering:

- calculation of wind power depending on its speed, altitude, and terrain profile;

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- Determination of wind speed depending on the geographical location of the wind turbine;
- design and features of wind turbines;
- economical efficiency.

The formula for calculating the power of a wind turbine (W), which includes the wind wheel, gearbox, and generator, is [4]:

$$P = 0.5p.5V^3 C_p n_г n_р \quad , \qquad (1)$$

where ρ - air density, kg/m3;

S - area swept by the wind wheel, m2;

C_p - power utilization factor (determined by the design of the wind wheel);

$n_г n_р$ - efficiency of the generator and gearbox.

To determine the energy characteristic of the stationary wind flow (specific power, W/m2) the following expression is used:

$$P_{уд} = 0.5pV^3 \, . \qquad (2)$$

Specific power of wind flow (2) in contrast to the power of wind turbine (1) does not depend on the method of wind energy conversion. Its value is determined only by the wind speed and air density, that is, the geographic location and the height of the installation of the wind turbine.

In expressions (1) and (2), the wind speed, even at a given point in the area, is a random value. Its calculation is carried out by creating a probabilistic description of a random process of wind speed change at a given time interval by dividing it into time intervals, within which the wind speed is considered constant [5].

Measurements of wind velocity on a given territory are constantly carried out at weather stations. However, a purely mechanical transfer of values measured at a weather station to a given point in the area where this weather station is located cannot be considered legitimate, because the result of measurements depends on the relief and landscape characteristics of the area and the height of measurements. The relation between the wind speed reduced to the specific terrain and measured at the weather station is determined by the relation [6]:

$$V_{пр} = \frac{K_0}{K_Ф} V \, ,$$

где K_0 – coefficient of openness according to the Milevsky classification;

$K_Ф$ – coefficient that takes into account the actual openness of the terrain.

The dependence of velocity on altitude is determined by a well-known relationship:

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$$V_1 = V_0\left(\frac{h_1}{h_0}\right)^k . \quad (3)$$

In expression (3) wind speed at the height of the weather vane, V_1 at the height of the rotor axis, k – coefficient, the approximate value of which is 0.14 – 0.2. Different sources suggest different methods for determining the coefficient k, depending on the characteristics of the terrain [5], and wind speed [6].

The use of solar power plants.

The amount of solar energy coming to Earth is simply enormous and far exceeds the energy of all the world's reserves of carbon fuel. Simple calculations show that just 0.0125% of its volume could provide all of the world's energy needs today.

Solar energy is used mainly in two ways - in the form of thermal energy by using various thermal systems, and through photochemical reactions (photovoltaics) [7]. The latter method directly converts solar radiation and electrical energy using solar cells. Photovoltaic solar cells are light-sensitive plates of semiconductor material: selenium, silicon, gallium arsenide, silicon diselenide, etc. Solar cells can be of different capacities - from portable units of a few watts to multi-watt power plants covering millions of square meters of area.

The process of converting solar radiation into electrical energy is carried out in solar power plants (SPP) [8]. SES is one of the most promising and fastest growing areas of renewable energy sources.

Depending on the material, design, and manufacturing method, there are three generations of photovoltaic converters (PV):

- First-generation PECs are based on crystalline silicon wafers. According to the method of manufacturing, there are polycrystalline and monocrystalline silicon wafers. At present PECs of the first generation are the most widespread due to the low cost;
- Second-generation PECs, based on thin films, allow for making flexible, and in the future cheaper, PECs of a large area, but with a lower conversion efficiency compared to the first generation PECs;
- Third-generation PECs based on confining and nonconfining materials are currently at the research stage.

In the general case, PECs included in SES can have a fixed or tracking photodetector without a concentrator or with a concentrator of solar radiation.

Various variants of concentrators and tracking systems are known, which differ in technical and economic indicators and efficiency. However, it is impossible to unambiguously determine any variant of SPS construction as the best, without conducting appropriate research. Power P (kW), produced by SPS can be calculated by the formula [9]:

$$\mathrm{P} = \mathrm{R}_{\Sigma} S_{\eta}, \quad (4)$$

Where R- current total power of solar radiation (direct, reflected, and scattered) in the focusing plane, kW/m2;

S- an area of all FEPs, m2;

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η- FEP efficiency.

In formulas (4), the parameter η determines the ability of PECs to convert the energy of solar radiation into electric radiation. Its value depends on many factors, including the material, design, and method of production of the PEC, temperatures, and light transmission of the protective coating. The value of R is determined by the territorial location of the SES, climatic conditions at a given time, topography, date and time of day, availability of tracking system, concentrator, and their design parameters. In some works, the component R, associated with the presence and design of tracking systems and concentrators, is taken into account as a separate coefficient, or as a component of the efficiency of the solar battery.

The technique of calculation of economic efficiency of transformation of solar radiation into electric power is similar to the technique used for calculation of economic efficiency of WPP. The determining role is played by the total capital investment (K) and the total annual operating costs (C), which depend on the type of solar panels, their design, availability, and design of control systems.

Thus, the use of such power sources as WPP, SES, or MHPP in the minimum configuration, including only an energy converter (wind turbine with FEP generator or hydro turbine with generator) and a device for converting electric current parameters to standard values (inverter, stabilizer), can not provide high-quality and guaranteed constant power supply to the consumer.

The solution to this problem is to use energy complexes or hybrid energy systems (HES) that use wind, solar, and water flow of small rivers as primary energy for the power supply of autonomous consumers (low-power enterprises).

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