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PROSPECTS FOR THE USE OF SOLAR ENERGY IN RAILWAY TRANSPORT IN UZBEKISTAN

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Abstract: Energy is of great importance for economic Uzbekistan. The development of renewable energy will ensure environmental safety and energy independence. Systems based on renewable energy sources are being developed in developed countries. For the solution, the energy problems of railway transport are solved by the use of solar energy. Solar energy can compete with the energy produced at power plants by the traditional method.

Keywords: energy-saving technologies, renewable energy sources, ecology, energy-saving technologies, solar energy, solar cells, transport, energy supply.

Introduction

Uzbekistan's energy system is in short supply: in 2020, with a generation of 66.4 billion kWh, consumption in the country amounted to 69.1 billion kWh, the deficit was closed by importing electricity from border countries. At the current pace of economic development and population growth, consumption could reach 117 billion kWh in 10 years. Uzbekistan has adopted a strategy for the development of solar energy sources. The share of alternative (carbon-free and non-nuclear) energy in the total volume of electricity production in the republic by 2030 should increase from the current 10% generated exclusively by hydroelectric power plants to 25% - thanks to new projects of solar power plants. The electric power system of the republic is conditionally divided into 5 territorial power nodes:

Northwest (Republic of Karakalpakstan and Khorezm region);
Southwest (Kashkadarya, Samarkand, Bukhara and Navoi regions);
Yuzhny (Surkhandarya region);
Vostochny (Andijan, Namangan and Ferghana regions);
Central (Jizzakh, Syrdarya, Tashkent regions and Tashkent city).

The maximum load during peak hours of electricity consumption in the winter of 2019 was 10.4 thousand tons. MW, the difference between the minimum and maximum load was 2.3 thousand MW. At the same time, in the summer of 2019, the peak figure reached 9.4 thousand. MW with a difference between the minimum load of 2.6 thousand MW. The current lack of regulatory capacity leads to daily additional restarts of TPP power units, respectively, to fuel overspending and additional wear of technological equipment, the main problems are: low efficiency (25-35 percent) of thermal power units introduced more than 25 years ago and high specific fuel consumption. Uzbekistan is taking measures to form a legislative framework for the development of solar energy. The Law of the Republic of Uzbekistan "On the use of renewable energy sources" and "On public-private partnership" was adopted, and the "Regulations on

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connection to the unified electric power system of business entities producing electric energy, including from renewable energy sources" were approved.

The natural conditions of Uzbekistan have great resources for the use of solar energy. The use of solar energy is one of the promising areas of reliable and environmentally friendly energy supply of electric transport. Solar energy sources on the railway can be used to pull trains, power auxiliary equipment of locomotives, lighting of wagons, air conditioning systems, alarm and locking devices. This is especially true on non-electrified sections of railways located in remote places where power supply is difficult. For passenger trains, the mass norms are 5.2 times less than for freight trains, and the passenger turnover in ton-kilometers is 100 times less, therefore, solar energy can be effectively used for traction for passenger, suburban, high-speed trains. Natural resources of the regions. Uzbekistan allows you to get the maximum concentration of solar radiation. The share of solar energy from total production may increase to 25%. total energy consumption. The duration of sunshine in the regions is 2200 - 3000 hours per year, solar radiation is 1300 kW/m^2 per year [1, 2]. In the southern regions, the duration of solar radiation is from 2200 to 3200 hours per year, the annual arrival of solar energy on the horizontal surface is from 1288 to 1870 kWh per 1 m^2. The growth of solar energy in total energy consumption and generation of electric energy of Republic Uzbekistan is shown in Figure 1. Nowadays, an important criterion is the cost of solar energy produced, it is comparable to the price for electricity generated by traditional methods. The innovative development of the efficiency of modern solar panels makes it possible to reduce the cost of solar energy and solve the issue of their use on the railway transport. Monocrystalline solar cells are used in railway transport for economic reasons [3]. When using such elements, part of the energy is lost in power conversion and storage devices (batteries, inverters, distributors, etc.), therefore, the actual values of the power received from solar cells are significantly less than potentially possible.

Materials and methods

The global solar photovoltaic (PV) market has been growing by an average of 40% per year since 2005. This is much more than for any other industry [1]. The total capacity of solar PV by 2030 will exceed 650 GW [2, 3]. For the seventh year in a row, more funds are invested in the global solar PV market than in other renewable energy industries. In 2017, investments accounted for 57% of the total volume and amounted to USD 113.7 billion. There is an annual decrease in total global investment in solar energy, for example, by 34% compared to 2015, the newly installed capacity of solar photovoltaic energy increased by 38% and exceeded 80 GW in 2016.

More than 90% of the world's current production of modern solar photovoltaic panels use wafer-based crystalline silicon technology. The design capacities for silicon production for 2019 range from 450,000 to 508,000 tons. Of these, approximately 30,000 tons are used by the electronics industry [4, 5]. At the moment, the average cost of such a material as silicon in the production of SE is about 4.7 g/W [3]. Despite the rapid development of solar PV, the cost of electricity production at solar power plants remains one of the highest among alternative generation methods. However, in the last few years, there has been a decrease in the cost of electricity produced by solar photovoltaic energy converters.

For innovative photovoltaic solar energy conversion systems, the main element is monocrystalline and polycrystalline silicon, ribbon, sheet, layered, amorphous, as well as cadmium telluride and gallium arsenide and AlGaAs-GaAs converters. The productivity of which reaches 22% (silicon cells give only 12-17%), but these elements are currently labor-intensive in manufacturing and have a high cost, which will increase the cost of solar panels. [4.5]. Therefore, the share of silicon in the production of solar energy is 75% in global production. The choice of

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silicon as the starting material for the manufacture of solar cells allows you to achieve minimal reflection losses. Silicon solar cells are less sensitive to temperature fluctuations, which is important in the conditions of railway transport. The dimensions of the trains allow the use of the roofs of the train, charging can be done during parking.

In the conditions of the global crisis, the price of polycrystalline silicon is decreasing, but the need for material for photovoltaic cells remains constant. Reducing the cost of silicon as a necessary condition for obtaining photovoltaic energy comparable to energy obtained from other sources is possible in two ways:

- obtaining monocrystalline silicon of semiconductor purity;
-obtaining cheap silicon, but less effective.

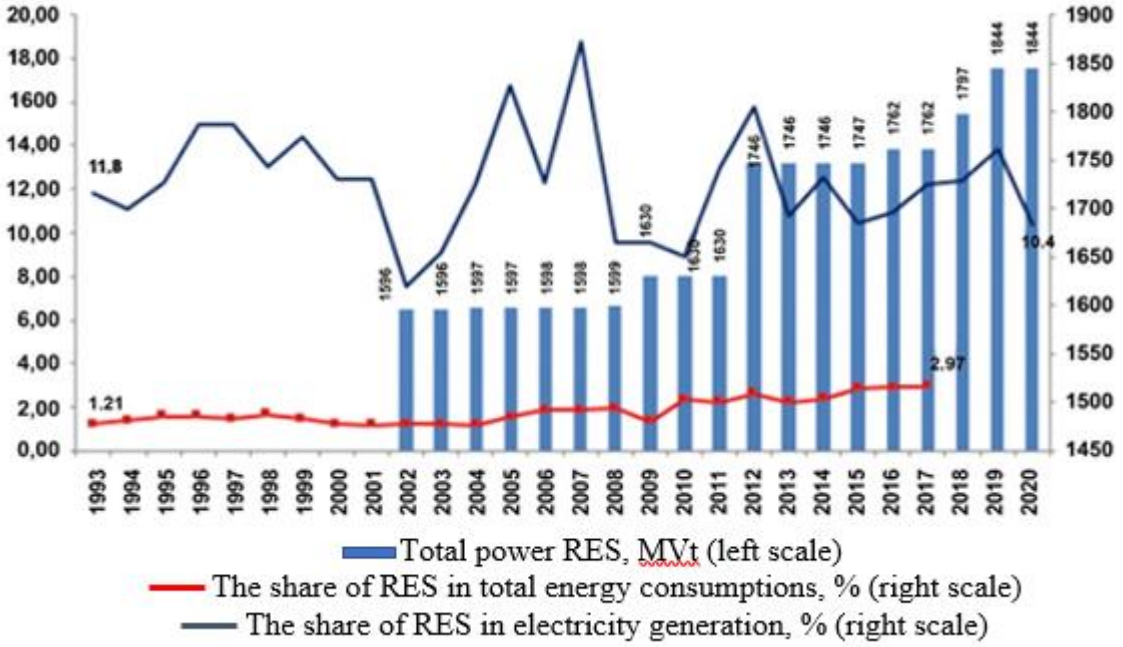

Figure 1 - The total capacity of solar energy in the total generation of electric energy in Uzbekistan

The complexity of processing thermal radiation is the main disadvantage of solar energy converters used today. The problem of processing thermal radiation hinders the development of solar energy. Removal of thermal radiation from photovoltaic converters uses thermal filters. These devices increase the size of the converters, lead to additional losses. The condition for the operation of semiconductor converters is a certain wavelength. This requires wavelength separation devices. Structurally, solar panels of vehicles do not differ from their stationary variants. Solutions to improve energy efficiency are widely used on the railway. For example, 8% of the total energy consumption can be returned to the AC contact network due to recovery during braking or accumulated. The power supply of air conditioning systems, auxiliary units and lighting is carried out mainly in the usual way, and in the future should be supplemented by solar energy sources (photovoltaic modules.). The additional potential for saving electrical energy is the use of a vector optimal method for controlling the traction engine of locomotives. Stationary generation of solar energy remains the most important way of its production for the foreseeable future. This is successfully complemented by modern management methods with (Smart Grid), with increasing

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criteria for energy networks, as well as due to the growing share of solar energy in railway transport. The possibilities of increasing energy efficiency are to facilitate the structures of rolling stock through the use of innovative composite materials in the production of more economical locomotives and motor-car rolling stock,

The production of lightweight rolling stock and the use of composite materials with first-class properties (based on glass and carbon fiber GFK and CFK) is another resource for saving energy, reducing the weight of structures and reducing the cost of production by 20-30 %. Energy generation should be combined with the possibilities of electricity storage. This is provided in the energy complex of electric power generation. Planning and production and consumption of energy and generation from alternative sources and will provide the necessary profitability. The instability of energy generation from renewable energy sources creates at the same time an incentive to search for reliable and economical energy storage. During periods of solar activity, a combination of sources with energy storage devices can be used, which provides sufficient energy supply during periods of weak solar activity. A promising direction is the use of supercapacitors (Supercaps) for the accumulation of electrical energy. To date, such solutions can be used to accumulate energy received from solar installations. This system is able to accumulate electrical energy in large volumes. Supercapacitors with a capacity of up to 5000 farads are known, the voltage values of h of such capacitors are small. Their efficiency is 90-95%, the application potential is very high. A hybrid electric energy storage system can be used in the rail circuit of a contactless network: two-layer supercapacitors Two-layer capacitors are supplemented with lithium-ion batteries. If it is necessary, the battery is charged at railway stations. Batteries are necessary not only for starting the locomotive, but also for powering auxiliary equipment. When the diesel engine is switched off, the power of the load connected to the battery can be increased. The use of a solar battery allows you to quickly recharge the battery. Increased reliability helps to reduce operating costs and reduce Maintenance time of the electric rolling stock.

Results and conclusions

The generated energy can be used to operate the engine, auxiliary equipment, fan motors, brake compressor motors, lighting circuits. In the process of generation, energy can simultaneously accumulate in batteries for further use [6, 7]. Energy savings can also be achieved by applying the optimal method of vector control of the locomotive traction engine, this will significantly increase the energy saving of the control system. Advantages of solar installations:

- clean electricity production,
- versatility of application;
- simple design and light weight;
- noiselessness during operation;
- modular principle of power set;
- high reliability.

Solar energy is becoming an important energy resource for the railway industry. Work on the introduction of solar panels on railway transport is carried out in two directions:

1. Power supply of trains by installing batteries directly on the rolling stock

2. Power supply from solar panels of infrastructure and alarm devices (operation of condensing systems, ventilation, heating equipment) The efficiency and reliability of railway power supply, the use of new energy sources, resource-saving technologies and the decentralization of railway power supply will result in greater energy savings and significantly increase traffic safety. The use of energy storage not only at traction substations, but also on maneuverable locomotives allows balancing the load on diesel engines and performing their

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overhaul life several times, when used on electric locomotives - reducing the number of pairs of passing trains on some sections of the track.

Conclusion

The use of alternative energy sources and resource-saving technologies in railway transport has a huge potential for saving energy. The transition to local energy supply will ensure the energy independence of railway transport and increase traffic safety. The above review demonstrated the prospects and possibilities of using solar energy and energy-saving technologies in the railway transport of Uzbekistan. Photoenergy is not only a promising direction of the energy industry. The cost of solar energy is rapidly approaching the price for electricity generated by traditional methods. The analysis of the growth of solar energy in the share of Uzbekistan's energy supply is given.

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