



ANALYSIS OF THE PROBLEMS OF THE DEVELOPMENT OF PHOTOVOLTAIC SOLAR POWER PLANTS IN UZBEKISTAN

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Nimatov Kamoliddin Bakhriddinovich

assistant

E-mail: kamoliddinnimatov86@gmail.com, tel: +998908720542

Karshi engineering economics institute, Karshi, Uzbekistan.

The article discusses the scale of electricity production by photovoltaic solar power plants in the world and in Uzbekistan at the present time, as well as the problems of the development of these power plants. About the problems caused by the demographic growth of the world's population, as well as about the current state of renewable energy sources, including photovoltaic solar power plants, about the contribution of renewable energy sources to the global energy system, about world prices for 1 kWh of electricity received from solar power plants in Uzbekistan and about factors negatively affecting the efficiency of solar panels. When photovoltaic devices are installed by private individuals, there are a number of advantages, and bureaucratic barriers are minimized. But due to the size of the first investment in autonomous solar systems, the opportunities for people to implement this technology are decreasing. In addition, the lack of specialists is the reason that these technologies are not being implemented sufficiently or properly, and this, in turn, leads to the fact that solar photovoltaic systems are not being fully used or used improperly. The article presents suggestions and conclusions about the technical and legal solution of these problems.

Keywords

Energy, alternative energy sources, solar power plants, solar panels, monocrystalline panels, polycrystalline crystal, efficiency, influencing factors.

According to a UN report, by 2050, the total world population will reach 9.8 billion. Demographic growth also brings new challenges to humanity. Among them are food shortages, drinking water problems, population density, need for Social Protection. There is also such a problem that its solution is able to eliminate most of the remaining difficulties. This is an energy problem. Today, both its presence and its absence are equally problematic: while the lack of energy causes a complication of socio-economic issues, the abundance of energy production capacity has a negative impact on nature. Because now more than 80 percent of primary energy



corresponds to the contribution of conventional hydrocarbon sources and nuclear energy. And the energy transportation is carried out in a liquid state – in the form of oil and gas. In addition to the fact that the limitation of fossil energy sources affects the economy of states, regions also cause geopolitical problems. Therefore, in the last years of the 20th century, scientific and practical efforts began to introduce renewable energy instead of traditional energy sources.

Currently, there is a lot of talk about the prospect of renewable energy sources. For example, the amount of energy that radiation from the sun receives on the planet is on average 1.3-1.4 kW/m². When we do not take into account the amount of radiation that travels from the atmosphere back into space, there is an average of 1KW/m² of energy on the surface of the Earth. This energy is 9,000 times more than the energy needs of the planet at the same time. For this reason, the newly added energy capacity is being implemented at the expense of renewable sources, not conventional energy[1].

According to a report by IRENA international, 268.4 GW of additional capacity was added in global energy production in 2023. Of this, 192gw of power is due to renewable energy sources. This means 76.4 percent of the total added energy worldwide. And 90 percent of this is solar and wind energy. In particular, solar power increased to 97gw in 2023. Looking at the evolution of the share of renewable energy by species, which has been added in the last 10 years, solar energy is considered the fastest growing renewable energy in the added energy capacity. As the main reason for this, it can be shown that solar power devices can be profitable even on a small scale, and technological innovations are constantly being applied to the industry.

In all energy reports, it is possible to see information that solar energy is growing. So why today we are not addressing everyday energy needs through solar energy? Why are solar photovoltaic devices still not widely used, even if there is an energy problem in remote villages?

This article will look at the main problems that prevent the widespread use of solar energy in our country. Only photovoltaic (PV, semiconductor devices that convert solar radiation directly into electricity) devices and panels are mentioned in the article. No mention is made of solar concentrators and other devices of radiation that convert it into useful energy.

The “cost-benefits” in solar energy - how expensive is the energy that solar power plants generate, in fact? Today, the average price for 1kW hours of electricity in the world is US \$ 0.14, that is, 14 cents, while in Uzbekistan this figure is 0.0245 dollars (295 rubles 0 kopecks) – 2.45 cents. Now let's dwell on the cost of generating electricity in solar stations. The cost of electricity from solar radiation in 2023 was an average of \$ 0.045 (4.5 cents) worldwide. In the last 10 years, prices



have fallen significantly, and this trend remains. Solar stations that went into operation in 2024 maintain their profitability even at a cost of \$ 0.032 per 1kW ·hour. The “maturation” of solar energy technologies for widespread use on an industrial scale made it possible to produce solar panels on a large scale. As investments in the creation of technologies began to work in this area, moreover, as a result of the continued introduction of innovations, the price of panels has decreased by almost 90 percent in the last 10 years, and the total generation capacity has increased by 400 percent. This drop in prices in a short period is a technological breakthrough. But can we return the price “dive” again in the same way? None of the experts is in a hurry to answer this question “yes”. Because in this way in prices there is a significant role of subsidies and large projects in a sharp decline. But technologically there are points where prices can be hit [2].

So far, there are the following problems that directly affect the price:

- the design, marketing, and licensing of solar energy costs more than its alternatives at equal capacities. These costs, (soft costs) usually make up a percentage of the station (15÷20) to be installed in your home;
- the low efficiency of solar energy compared to traditional alternatives of mercury and the relatively expensive materials of raw materials used in it affect the cost of energy produced;
- the need for individual integration in the design of solar panels creates additional costs in the design and installation process. The stations to be installed in the apartments are designed based on their architecture. Fitting panels to a roof or other part of the house usually requires an additional technical solution, and this affects the cost. This cost would have been reduced if solar panels were taken into account in homemade projects.

Nevertheless, the cost of photovoltaic energy produced in solar stations has been able to be competitive. In particular, this trend is felt in large stations. Solar plants have the best performance in Germany in terms of the cost of energy from newly built stations. This situation is observed in all countries. Therefore, the right choice should be made in the construction of new power plants in Uzbekistan. Because Uzbekistan has the most negative indicator in the region in terms of energy infrastructure. In 75% of electricity production, the operating period is more than 30 years. Only 7 percent did not exceed 5yil when the infrastructure came into operation. That is, the structure of electricity production in Uzbekistan is both spiritually and technologically outdated and needs modernization. In the formation of a new infrastructure, it is advisable to refer to the “sunny” infrastructure of the

world. But before that, let's see how much money citizens will cost self-sufficiency by autonomously operating mini-stations.

In our country today there are about 10 companies that install solar panels on buildings based on an individual project. When buying the same solar panels, citizens can determine the size of the premises in the house or apartment (number of rooms, kitchen, balcony, corridor, etc.) given that they can be selected based on their capabilities. In turn, the selected power of the device affects its cost. According to experts, the cheapest solar panels have a power of 150 W, which allows you to use them to illuminate 5-6 rooms of the house and use one TV. If it is necessary to provide electricity to two televisions, one refrigerator for lighting rooms in the house, then solar panels with a capacity of at least 2kW will be needed. If the family also uses air conditioning - 3kW power panels will be necessary.

In the production of innovative products such as solar panels, domestic manufacturers use import components, that is, they depend on the price of foreign suppliers. Today, the 2kW block Price (18÷30) is estimated at Rs, considering the installation costs, the installation of a 3kW unit (20÷45) will cost Rs. The difference in prices depends on the brand of domestic products.

Are the expected results justified? It is often observed that there will be no expected results from obtaining autonomous energy by installing a solar power plant in the host. For example, you install a 2kW station-it, you can not get more energy from 1kW. There are several reasons for this [3].



Figure 1.1. PV photovoltaic solar panel types.



That is, it takes a long time in naturally aggressive (hot, cold) conditions for this. The panels will eventually decrease their output power under the influence of external conditions, that is, undergo natural degradation. While the output power degradation is (2÷3)% in the first 2 years, by the following years, the rate of degradation decreases dramatically and is a percentage of (0.5÷0.7)% per year. Panels that deviate from these indicators and have a high rate of degradation are considered of poor quality. For this reason, when purchasing solar panels, it is necessary to ask the manufacturer and seller for a guarantee of at least 5 years[6].

Factors that negatively affect the efficiency of solar panels.

The effect of climate on efficiency - the efficiency of solar panels is also influenced by the climatic conditions of the location of the panels. The manufacturer tests the solar elements and panels in a special laboratory before launching them for sale. Indicators must meet the established standards of the characteristic of solar panels. The same indicators are written on the device passport. And we buy products based on this characteristic. The problem is that the values of the characteristic indicated in the passport corresponding to the climatic conditions of the Mediterranean Sea are presented. That is, in order for the characteristic shown in the passport to be fully manifested in practice, winter should be mild (10÷16)°C, and summer dry and moderately warm (22÷30)°C). Air humidity should be 50÷65% in summer and 65÷80% in winter. Solar panels are tested in conditions close to this climate, the characteristic of which is written. To be even more precise, the 1000 W / m² radiation, the air mass coefficient for the solar spectrum 1.5 panels with a temperature of 25°C, is the standard test condition (STC). Therefore, the characteristic information shown by the manufacturer differs from its actual value on Earth, which is different from the laboratory conditions. In general, the performance efficiency of solar panels depends on 5 main factors: the annual distribution of solar radiation intensity, the change in the efficiency of the panels in accordance with this intensity, the annual temperature distribution, the temperature coefficient of the panels and the rate of degradation by time. The most fundamental factor that directly affects efficiency is the temperature of the environment. As the air temperature increases, the efficiency of solar panels decreases. At first glance, it may seem that the more radiation content falls on the surface of the panel, the more electricity will be generated, but in fact, it is not. An increase in temperature leads to an increase in internal resistance in the solar element. Temperature creates an increase in the flow of electrons. This leads to an increase in current strength and a voltage drop. But since the voltage drop is greater than the current increase, the total power decreases. It assesses how different the temperature coefficient of the panels is from the standard characteristic shown under certain temperatures. The temperature coefficient varies



depending on the type of solar panels. The best-selling monocrystalline silicon-based panels in our country at temperatures above 25°C – at each degree, the efficiency decreases by 0.5%. For example, consider the best-selling monocrystalline silicon panel in the Uzbek market, which has an efficiency of 17%. In his passport, the temperature coefficient is indicated from the total efficiency - 0.45%. That is, a panel with an efficiency of 17% loses its effectiveness at a temperature of 25°C – 0.077% per degree. The efficiency is 16.6% when the temperature is 30°C, and 16.2% at 35°C. If the temperature exceeds 40°C, the efficiency drops from 10%. In the summer season in our country, a similar situation is observed. During the heat of the day, the efficiency of solar panels will drop to double, and the amount of electricity-energy being generated will also decrease by the same amount[7].

There are two solutions to this problem. The first is that when installing solar panels, air circulation should be taken into account, and the panels should not be stacked as much as possible. At the installation location, it is necessary to choose the maximum suitable place for wind roads. It is necessary to pay attention to the frame materials of the panels. It is necessary to purchase panels made of materials that, as far as possible, conduct heat well and do not allow local heating. The second is to choose panels made up of climate-friendly solar elements. As noted above, the temperature coefficient varies depending on the type of panels:

- Polycrystalline silicon QE-0.40-0.43% / °C
- Monocrystalline silicon QE-0.38 - 0.40% / °C
- Monocrystalline IBC-0.30 to 0.32% / °C
- Monocrystalline SHJ-0.26 to 0.27% / °C

The most suitable for our climatic conditions are solar panels – panels made up of shj solar elements. Their temperature coefficient is (1.5÷2) less than that of conventional silicon elements[5.8].

Another problem is the factors that affect the dust coating of the panel surface. The pollution caused by the landing of dust particles on the surface of the panels is one of the most basic factors that negatively affect efficiency. Unfortunately, since our geographical location is mainly a relief consisting of Plains, dust particles are abundant in the climate of our country. The pollution characteristic of the surface of the panels depends on two factors: the nature of the dust and the environment. The property of dust is understood as the size, shape, weight, surface of particles, chemical and biological properties of dust particles. All this affects the accumulation of dust particles on a certain surface. When it comes to pollution, the environment must also be taken into account. Around the location where the panels are installed, work on agriculture or the location of car tracks determines the degree of pollution. If there is light wind at this location, the pollution rate will also be higher. The strong wind reduces the amount of pollution in return for



cleaning the surfaces from dust. For this reason, when installing photoelectric solar panels, the properties of dust in the environment and that environment are taken into account. Recommendations on this matter can be obtained from specialists and literature. It is also necessary to carry out preventive cleaning work on the surface of the panels. As another solution, it is recommended to protect the surface of the panels with transparent layers that are hydrophobic and dust-proof[4,6].

Legal aspect of the issue - The decree of the president of the Republic of Uzbekistan dated February 16, 2023 "on measures to accelerate the introduction of renewable energy sources and energy-saving technologies in 2023" PQ-57 and the decree of the Cabinet of Ministers of the Republic of Uzbekistan dated June 14, 2023 "on establishing the procedure for the sale of excess of electricity produced by individuals and business entities using renewable energy Based on these decisions, from April 1, 2023, individuals and legal entities who have installed renewable energy devices with a total capacity of up to 100kW pay a profit tax on these devices, a land tax on plots occupied by devices, and a profit tax calculated from the profits received by legal entities for electricity sold to the general network for a period of 3 years, if installed with an electrical energy storage system with a capacity of no less than 25% in relation to the capacity of the installed solar panels - it is exempt from taxes for a period of 10 years[1];

As of March 1, 2023, it is not required to obtain an additional technical condition when connecting renewable energy devices to electrical networks that are not higher than the capacity specified in the technical conditions provided for connecting to a single electric power system.

As of April 1, 2023, in the regions of the Republic, a subsidy of 1,000 rubles per kilowatt-hour (positive discrepancy) of electricity produced on solar panels installed in facilities owned by individuals under the "solar cell" program to encourage the installation of small-capacity (up to 50kW total capacity) solar panels on population households will be allocated from the state budget. (Via the "tax" mobile app); subsidy payments are not included in the total income of individuals[1];

Conclusion. The air of the territory of the Republic of Uzbekistan is considered relatively dry and dusty. In conclusion, scientists are currently doing a lot of research to improve the efficiency of solar panels. In turn, there are more than 10 ways to remove accumulated dust particles on the surface of the panels. With these methods, it is possible to increase its effectiveness by cleaning the surface of the panels.

When individuals install solar photovoltaic panels, there are a number of benefits, and bureaucratic barriers are reduced to a minimum. But because of the



size of the first investment amount of autonomous solar systems, opportunities for individuals to introduce this technology are declining.

The scarcity of specialists is causing these technologies to not be introduced sufficiently or correctly, and this, in turn, is leading to the failure or misuse of the full potential of solar photovoltaic systems.

The introduction of alternative energy, in particular solar photovoltaic systems, leads to the formation of a culture of energy efficiency and the popularization of economical appliances-technologies in domestic life.

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