Solar Power in the Republic Bashkortostan

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Abstract-This article is devoted to the study of the effectiveness of the use of solar panels in a temperate climate steppe subzone. Studied two types of panels: micromorph type and crystalline. The authors have shown the value of electrical energy can be produced and what they depend for the area. It has been estimated the effects of weather and wasps. Also in arcticle considered ways to clean the snow from the solar panels, which is important for Russia. Work can be used for technical and economic aspects of the use of solar panels for a given climate zone.

Keywords—Solar panels, photovoltaic, micromorph, crystalline.

1. Introduction

The limitations of traditional energy resources against the backdrop of the increasing demand for electricity determines the prospects for the use of renewable energy resources wind energy, tidal, etc. The use of renewable energy source allows to minimize hazards associated with production and use of mineral resources, also allows to reduce the impact of power plants on the environment, human health and climate. Countries such as the United States, Canada, England, Germany and Japan are constantly improving the use of renewable energy source share in total energy generating in order to reduce the economy's dependence on imported oil and gas [1-3].

The development of the use renewable energy source is one of the development priorities energetics of Russian Federation. To do this, there are shared solar power (hereinafter SPP), biogas and wind power plants. Thus, according to long-term plan of the developing Republic of Bashkortostan (north-forest subzone temperate climate) by 2018 it is planned to build two solar power plants with a total capacity of 15 MW. And for the successful operation and effective use of this type of energy source in Republic of Bashkortostan required to resolve the issues related to the production schedule of panels (for matching modes) with weather conditions and snow cover [4, 5].

Why do we need to assess the efficiency of solar power plants for north-steppe subzone temperate climate, depending on the different weather conditions (temperature, precipitation).

2. Characteristics Considered Climate Zone

Considered climate zone (Republic of Bashkortostan) is located between 51 ° and 56 ° north latitude and 22 ° and 30 ° east longitude (from Pulkovo), the average annual temperature of 2,7 °, average rainfall 589 mm per year. This area is characterized by long cold winters and moderately warm summers. [6]

In the area under rainfall observed in the form of snow, rain, hail, frost and dew. Depending on the phase state of the precipitation can be solid, liquid or mixed. Within the city of Ufa solid precipitation as snow falls from October to April. The liquid phase deposits include all types of rainy. To the mixed phase is wet snow and rain, rain and hail, and others. Precipitation mixed type observed in spring and autumn. According to long term average data per year in Ufa 75 days with solid precipitation 71 days - with liquid, 17 days - with mixed, steady snow cover formed in the middle of November and lasts until the end of March, and sometimes the first ten days of April. The average year is about 164 days with snow cover, it is more than five months. The first snow is observed in late October. Obviously, the snow will cause reduced efficiency of SPP, so to evaluate the efficacy of SPP in the given climatic zone is necessary to consider the effect of rainfall patterns, snow and seasons.

3. The object of Research

The object of research is the solar panel installed at the Department of Electromechanics "Ufa State Aviation Technical University", Fig. 1, and representing two photovoltaic panels manufactured by Hevel (micromorph module area of 1.43 m2, the nominal power of 125 W and a crystal module with area of 1.286 m2, the nominal power crystal module 223 W) installation angle of PV modules 39 degrees.

Fig. 1. Solar panels installed in Ufa State Aviation Technical University

4. The Solution of Problem

In studies of the effect of snow cover on the effectiveness of SPP in the above climatic conditions, statistical data for different days with snow cover, and without it, and the static data is selected so that the duration of the light of the day was about the same. Also in the analysis compares two days of cloudy weather with snow cover and without it (20 November 2014 and 12 November 2014 respectively) and two clear days with snow cover, and without it (January 20, 2014 and November 2, 2014, respectively, and). Day length was 8h 5m 01.20.2014, 11.02.2014 was 8h 23m, 12.11 2014 day length was 8h 37m; 20/11/2014 day length 8h 10m. The level of intensity of solar radiation compared to the other day about the same.

Fig. 2 shows the hourly electricity generation SPP for 02.11.14 (a clear sunny day, the snow cover is absent).

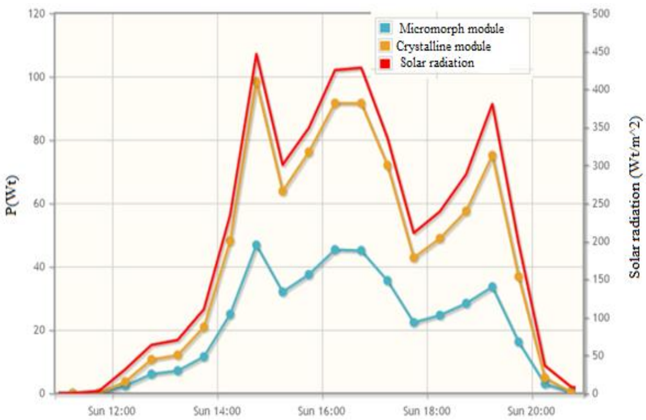

Fig. 2. The average hourly production of electric energy (2 November 2014)

Maximum intensity of solar radiation 11/02/14 was 420 W / m2. The maximum power output for crystalline module was 100 W, and for micromorph 47 watts. Per day, generated electricity was: crystalline module - 450 Wh, for micromorph module - 200 Wh.

Fig. 3 shows the data for 20/01/14 clear day, without precipitation, SPP panel covered with snow. Fig. 3 shows that the maximum intensity of solar radiation was 375 W / m2. The maximum power output for crystalline modules amounted to 47 W, and for micromorph 43 watts. Per day, generated electricity: crystalline module - 180 Wh for micromorph module - 170 Wh.

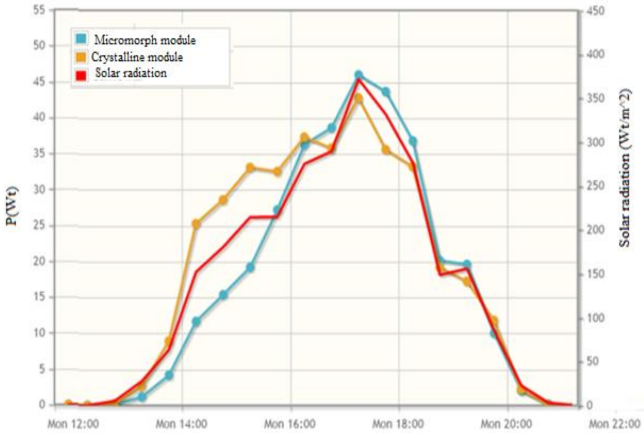

Fig. 3. The average hourly production of electric energy (20 January 2014)

Thus, the formation of snow cover on a clear day reduces the maximum power generated by the SPP for maximum power output for crystalline module is almost a factor of 2, and for micromorph module by 7-9%. The output of energy per day for crystalline module is reduced by 2.5 times, for micromorph modules by 10%.

Figures 4 and showed average hourly production of electric energy for November 20, 2014 and November 12, 2014.

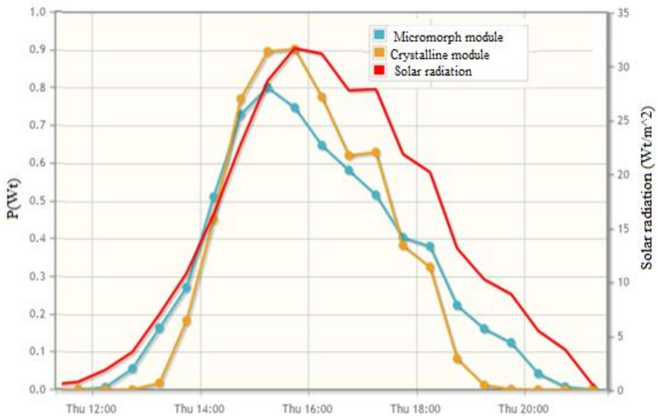

Fig. 4. The average hourly production of electric energy (20 November 2014)

20.01. 2014 - cloudy day, rain, the panel is covered with snow, with a maximum intensity of solar radiation was 32 W / m2. The maximum power output for crystalline module was 0.9 W, and for micromorph 0.8 watts. Per day, generated electricity was: crystalline module - 2 Wh for micromorph module - 2 Wh. Efficiency modules: crystalline module - 1.45% for micromorph module - 1.53%.

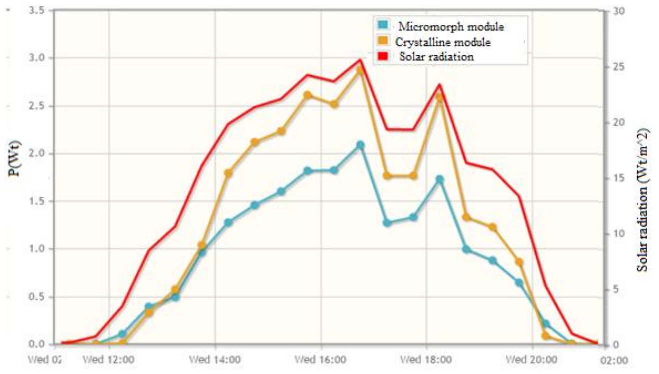

Fig. 5. The average hourly production of electric energy (12 November 2014)

November 12, 2014 - cloudy day, rain, snow cover panel without. Maximum intensity of solar radiation was 25 W / m2. The maximum power output for crystalline module was 2.8 watts , and for micromorph 2.1 watts. Per day, generated electricity was: crystalline module - 13 Wh for micromorph module - 10 Wh. Efficiency modules: crystalline module - 7% for micromorph module - 4.5%.

It seems reasonable obtained statistical data presented in the form of tables for crystalline module (Table 1) and for micromorph (Table 2).

Table 1. Energy data of crystalline module SPP

	Cloudy day		Clear Day	
	Without snow cover (12 November, Fig. 5)	With snow cover (20 November, Fig. 4)	Without snow cover (2 November, Fig.2)	With snow cover (20 January, Fig.3)
Maximum intensity of solar radiation(W/m2)	25	32	420	375
Maximum power output(W)	2,8	0,9	100	43
The electric power generated per day(Wh)	13	2	450	180

Table 2. Energy data of micromorph module SPP.

	Cloudy day		Clear Day	
	Without snow cover (12 November, Fig. 5)	With snow cover (20 November, Fig. 4)	Without snow cover (2 November, Fig.2)	With snow cover (20 January, Fig.3)
Maximum intensity of solar radiation(W/m2)	25	32	420	375
Maximum power output(W)	2,1	0,8	47	46
The electric power generated per day(Wh)	10	2	200	170

From tables 1 and 2 shows that the electric energy generated by the SPP is influenced by such environmental factors as the weather and precipitation, the weather conditions affect more significantly. Thus, the power output in cloudy weather reduced by more than 20 times. Snow reduces the power for crystal module 2 times, for a micromorph 10%.

Humanity can not affect the climate regimes to improve the efficiency of SPP, but may improve the efficiency of SPP by using cleaning solar modules from snow. For example, the Canadian company Isolara Energy Services has developed a system of self-cleaning solar panels at home from the snow. [7] This self-cleaning system for solar cells, which uses the force of the wind and the Venturi effect, which allows you to blow the snow. The main disadvantages of this system is that it depends on the strength of the wind and it does not solve the problem of ice.

It seems appropriate to assess the effectiveness of the system in question to the climatic zone. Fig. 6 shows the dependence of wind speed obtained from the monthly installed on SPP animometra.

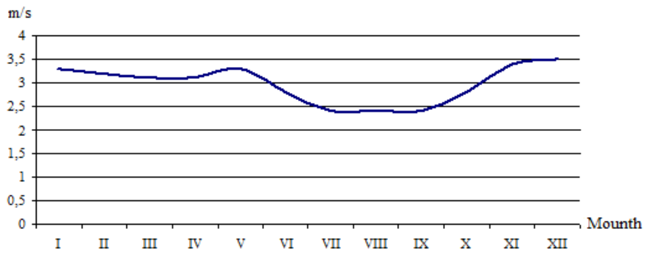

Fig. 6. The annual course of the mean wind speed in m/s.

Fig. 6 shows that the speed in the considered climate zone dominated by week winds. The average wind speed in the area is 3.1 m / s. In the summer months it is reduced and in August reached 2.4 m / sec. During the cold period of time the wind speed increases and fluctuate within 3.2 - 3.5 m/s.

Thus, we can conclude that the efficiency of clearing snow proposed by Isolara Energy Services for the given climatic region is low.

Japanese scientists [8] to improve the efficiency of SPP when snow cover is proposed installation of panels at an angle of 40 °. That reduces the production of electricity in the summer, but in winter increases. In such a tilted snow slides down from the surface of the panels. To drifts do not obstruct the solar panels mounted at a height of 1.8 m. This bilateral panels are made, instead of the opaque substrate layer is transparent. This allows the use of light reflected from the snow, which increases energy production by 6-10%. Such technical solution can also be used for the given climatic zone.

5. Conclusion

Thus, the presented study, based on statistical data to assess the impact of weather conditions and snow cover on the efficiency of solar power in a north-steppe subzone temperate climate. As a result of studies found that solar power generated electricity is affected by such natural factors such as weather and rainfall, and weather conditions affect more significantly. Thus, generated power is reduced in cloudy weather than 20 times compared with a clear day. In this snow reduces the power for crystal module 2 times, for a micromorph 10%.

It is important to note that for more efficient use of solar power is necessary to develop methods and devices to fight with snow cover.

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