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Experience in operating a solar power plant in the Saratov region

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Abstract. *The article is devoted to the description of the operating solar power plant, the analysis of the results of its operation in the conditions of the Saratov region and scientific and technical information on the prospects for the use of solar energy sources in Russia.*

Keywords: *alternative energy, solar power plant, electricity supply, electricity consumption, electrical load schedules, solar insolation.*

Energy consumption in the modern world is constantly growing. For its production, as a rule, non-renewable primary sources are used, stored by the planet for millions of years in the form of coal, oil shale, oil, natural gas and peat [1]. However, by the second half of the 20th century, the problems of traditional hydrocarbon energy became visible. Its main reasons are due to the depletion of fossil resources and significant environmental damage [2] associated with the burning of these resources. Many companies in the world: Tesla, Solar, Impulse, Sharp and others are seriously concerned with the environmental problem and are trying to take the path of alternative energy as soon as possible. In Russia, the development and promotion of solar technologies is carried out by the Havel company. At the moment, four solar power plants built by this company are in operation on the territory of Saratov region.

In order to determine the energy and economic efficiency of the operation of a solar power plant on the territory of Saratov region (51.750065 N, 42.758712 E), an operating solar power plant was built. Taking into account the amendments made to the law [5], for more efficient use of a private solar power plant, it is economically profitable to design it without a battery with the possibility of supplying surplus generated electricity to the centralized network in order to reduce energy losses during charging/discharging of batteries and save money on the purchase of equipment. its maintenance, repair and replacement. The station was designed and built to supply power to a private house in a rural area.

The choice of the power and the number of solar modules is carried out taking into account the place of construction and operation of the SPP, the annual illumination of the area (the number of sunny days in Saratov region 86, the number of sunny hours 2054), the average daily power, as well as the restrictions specified in the law [5]. For the selected terrain, the orientation of the panels is south, the azimuth is 0, the angle of inclination of the panels is 300.

Taking into account the load consumed on a daily basis, it was decided to build a micro SPP with an output peak power of 1.1 kW. At the heart of the SES of such power are 4 modern solar monocrystalline panels (SP) of the TW Solar TW310MWP-60-H brand with a power of 310 W each. One panel contains 60 solar cells. This brand of panels was selected due to the PERC (Passivated Emitter Real Cell) technology, which is used in their construction. The main difference between panels with this technology from conventional silicon ones is the presence of a dielectric layer (passivation), which is located over the entire surface of the panel between the silicon base and the back contact. An additional layer is a reflector of solar radiation, which leads to an increase in the efficiency of the panels by up to 20%.

The installation of solar panels was carried out on the roof of the courtyard building. The installation site was chosen based on the direction of the solar panels to the south, the absence of factors affecting the shading of the panels and the convenience of installing and connecting the panels. A wooden beam was chosen as the basis for the construction of the supporting frame of the panels. For each joint venture, its own rigid fixed frame was assembled,

providing a panel inclination angle of 30°. The panels are rigidly fixed to the frames, with the possibility of natural ventilation (figure 1).

Figure 1 – Installed solar panels

The panels are connected in series with each other to generate enough power to start and operate the inverter. The panels are connected using standard MC4 connectors. These connectors ensure the tightness of the panel connection, as well as its reliability, speed and ease of implementation.

To convert direct current into alternating current, a Sofar 1100TL-G3 inverter manufactured by Sofar Solar was selected (figure 2). The inverter has a peak power of 1.1 kW.

Figure 2 – Installed Sofar inverter

TL series inverters are unique, as they can independently reduce power at the command of the delimiter (a device that monitors the transfer of electricity to the grid). Delimiter sensors are installed in front of the meter. The delimiter gives the command to the inverter to reduce the generated power, if an excess of the permitted value of the electricity supplied to the grid is detected. This inverter contains one built-in MPP tracker. The inverter is connected directly to the electrical network of the house through two ABB 16 Amp AC breakers downstream of the electricity meter. The inverter is rigidly mounted on the wall. A prerequisite for its operation is the absence of direct sunlight and the influence of rain and snow. The inverter must be installed vertically with a possible positive tilt angle of not more than 150. Since the inverter is not equipped with an active cooling system (only available, for its normal operation, a free space of at least 50 cm from the front and bottom sides and at least 80 cm from the upper side is required) Data transmission from the inverter about the generated energy, its quality, errors in operation, as well as about the energy input parameters from the batteries are transmitted via Wi-Fi to the Internet to the solarmanpv.com website, where graphs are automatically generated and a daily report on the operation of the entire The average operating time of the station is 14-15 hours per day The average daily power generation is 5.5 kWh per month of operation, the maximum value is 6.8 kWh. The results of electricity generation are shown in figure 3.

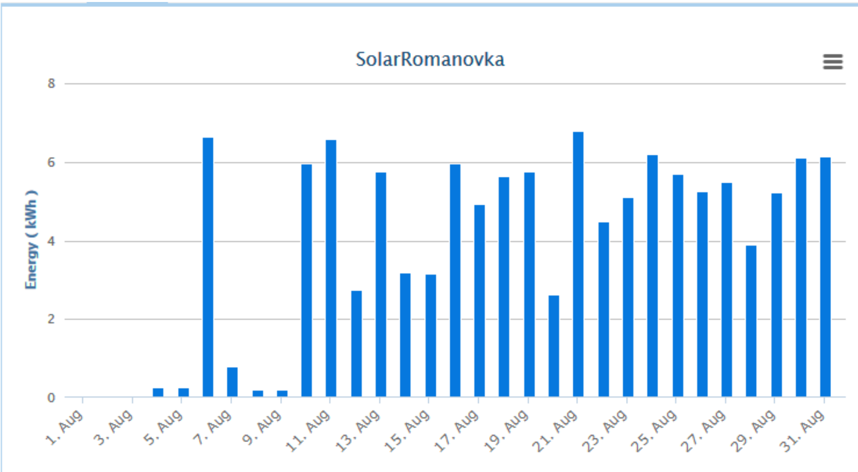

Figure 3 – Electricity generated by the station in August 2020 by days.

The results of plant operation during one day are shown in Figure 4.

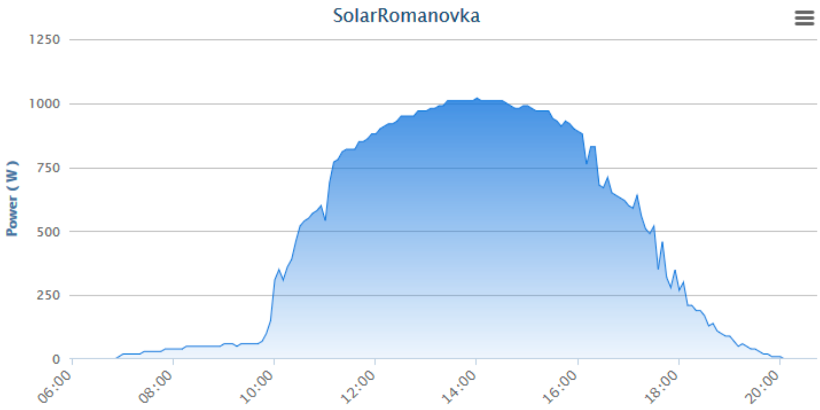

Figure 4 – Station operation within one day (August 21, 2020)

As you can see from the graph, with uniform illumination throughout the day, the station reaches its peak power in the time interval from 13.00 to 15.00.

The analysis of the load graphs for the year of operation shows that the built SPP on summer sunny days is able to provide up to 100% of the load of a private house and even exceed the electricity required for the house, in autumn and spring days up to 80%. On winter days, when snow falls, the solar panels installed on the roof are turned off.

In accordance with the methodology for calculating the power of the solar power plant [3] and the distribution of solar insolation [4], the payback period of the constructed solar power plant, without accumulating electricity, will be 12-15 years. This allows us to conclude that it is possible to use such systems for power supply of residential and industrial facilities and improve the environment not only in Moscow Oblast, but also in other regions of the country with a high level of solar insolation.

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