NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY
[IJIERT] ISSN: 2394-3696 Website: ijiert.org
VOLUME 8, ISSUE 4, Apr.-2021

CALCULATION OF A SOLAR POWER STATION FOR LOW-POWER ENTERPRISES

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ABSTRACT
In the article discusses the advantages of solar energy and its method of use by direct conversion of solar radiation and electrical energy using solar modules. The formula for determining the rated power of solar modules is given. Depending on the material, design and production method, there are three generations of photovoltaic converters. The calculated formula of the power generated by the solar power plant is given. It is shown that for high-quality power supply of low-power enterprises, it is necessary to use hybrid power systems that use the energy of wind, solar and water flow of small rivers as primary energy.

Keywords: Solar energy, conversion, electric energy, advantages, disadvantages, power, calculation formula, quality of electric energy, hybrid power systems, use for low-power enterprises.

INTRODUCTION

Solar energy is a renewable energy source. Now scientists around the world are developing systems that use solar energy.

The amount of solar energy entering the Earth is simply huge and significantly exceeds the energy of all the world's carbon fuel reserves. Simple calculations show that only 0.0125% of its volume could meet all the current needs of the world's energy [1].

Solar energy is used mainly in two ways – in the form of thermal energy, through the use of various thermal systems, and through photochemical reactions (photovoltaics) [2]. The latter method is the direct conversion of solar radiation and electrical energy using solar panels. Solar cell photovoltaic cells are photosensitive plates made of a semiconductor material: selenium, silicon, gallium arsenide, etc. Solar panels can be of various capacities-from portable installations of several watts to multi-watt power plants covering millions of square meters of area.

When using solar panels for low-power enterprises, there is an advantage associated with the fact that they have a very simple design, as well as simple installation, and minimal maintenance requirements and with a long service life. When they are installed, they do not require additional space. We should strive to ensure that they are not in the shadows for a long time.

The process of converting solar radiation into electrical energy is carried out in solar power plants (SPP) [3,4]. SPP is one of the most promising and fastest growing areas of renewable energy use.

In order for the SPP to find practical application, it is necessary to calculate it.

The calculation of the SPP means the determination of the nominal power of the modules, their number, connection scheme; the choice of the type, operating conditions and capacity of the accumulator battery (AB)б; the capacities of the inverter and the charge-discharge controller; the determination of the parameters of the connecting cables.

Determination of the rated power of solar modules.

You must first determine the total (estimated) power of all consumers connected at the same time. This capacity is indicated in the product data sheets.

The amount of energy consumed $W\ (kW \cdot h)$ during time T is determined by [5]:

$$W = P_{calc.}T$$

where где $P_{calc.}$ – calculated rated load power, kVt.

It is believed that electricity supply from solar energy is economically feasible with a daily energy consumption of up to 4 kWh.

The calculated load capacity of the $P_{calc.}$ is determined by the statistical method.

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

- First-generation PhC based on crystalline silicon wafers. According to the manufacturing method, polycrystalline and monocrystalline silicon wafers are distinguished. Currently, the first-generation PhC due to its low cost has become the most widespread;
- Second-generation PhC based on thin films, allow you to produce flexible, and in the future cheaper, large-area PhC, but with a lower conversion factor compared to the first-generation PhC;
- The third-generation PhC based on organic and inorganic materials is currently at the research stage.

In general, the PhCs that are part of the SPP can have a fixed or tracking photodetector without a concentrator or with a solar radiation concentrator.

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 option for building a SPP as the best, without conducting appropriate research. The power P (kW) generated by the SPP can be calculated using the formula [6,7]:

$$P = R_{\sum} S \eta, \qquad (1)$$

where P - the actual total power of solar radiation (direct, reflected and scattered) in the focusing plane, kW/m^2;

S - the area of all PhC, m^2;

η - the efficiency of the PhC.

In formulas (1), the parameter η determines the ability of the PhC to convert the energy of solar radiation into electrical energy. Its value depends on many factors, including the material, design and method of production of the PhC, temperature and light transmission of the protective coating. The value of R is determined by the territorial location of the SES, the climatic conditions at a given time, the terrain, the date and time of day, the presence of a tracking system, a hub, and their design parameters. In some studies, the R component 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 a solar battery.

The method of calculating the economic efficiency of converting solar radiation into electricity is similar to the method used to calculate the economic efficiency of wind power plants (WPP). The overall investment (I) and the total annual operating costs (C), which depend on the type of solar panels, their design, the availability and design of control systems, play a decisive role.

However, for solar panels, the following disadvantages are inherent: there is a sensitivity to contamination of working surfaces; there is a dependence on high temperatures; quite a high cost.

Thus, the use of such sources of electricity as wind power, solar power or mini hydroelectric power plants in a minimum configuration, including only an energy converter (wind turbine with a PhC generator or a hydro turbine with a generator) and a device for converting electric current parameters to standard values (inverter, stabilizer), is not able to provide high-quality and guaranteed constant power supply to the consumer.

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

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