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COMPARATIVE ANALYSIS OF RENEWABLE ENERGY SOURCE AND ENERGY SUPPLY SYSTEMCALCULATION

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The article consider calculation of the energy supply system on a renewable source of energy, namely on the solar panel for laboratory room № 606 in L.N.Gumilyov Eurasian National University.

Keywords: power supply, system of power supply, solar panel, electric power, renewable energy sources.

Introduction

At present, the problems in traditional energy are becoming more acute, the most important of which are depletion of fossil fuel reserves and adverse effects on the environment [2]. Naturally, emergence of problems forced us to look for ways to eliminate them. As a result, several directions were proposed for their overcoming, such as development of energy-saving technologies, search for and use of new types of fuels, use of renewable sources of energy (RSE), etc [1].

Analysis of these directions shows that the first two is not able to eliminate the problems completely. Development of RSE, in turn, met with quite significant obstacles. Thus, many renewable sources are characterized by irregular and uncontrolled energy inflow and high cost of power plants based on them. The first deterrent leads to a decrease in the reliability of power supply, and the second does to a significant increase in the cost of electricity [4].

In recent years, there has been a dynamic growth in solar energy development. Kazakhstan has significant solar energy resources. Potential solar power generation in Kazakhstan is estimated at 2.5 billion kWh per year. About 70% of the territory belongs to areas dominated by sunny days per year. The annual duration of sunlight is 2200 - 3000 hours per year, and the estimated power of 1300 - 1800 kW per 1 m² per year [5].

Main part

Solar panels or photocells are a very real technically and economically viable alternative to fossil fuels in a number of applications. The solar cell (photo panel) can directly convert solar radiation into electricity without the use of any moving mechanisms. Due to this, the life of solar generators is quite long. Photovoltaic systems have proven themselves from the very beginning of industrial application of photocells. For example, photocells serve as the main source of power for satellites in near-earth orbit since the 1960s. In remote areas, photocells serve as autonomous power installations since the 1970s.

In the 1980s, manufacturers of serial consumer products began to integrate photocells into many devices: from watches and calculators to musical instruments.

Solar batteries are reliable, durable (service life up to 50 years) and easy to install, since they do not contain moving parts. Solar panels can be used, where the usual power supply do not work and a lot of sunny days. With the help of a solar panel system it is possible to:

- illuminate and supply electricity to residential houses and cottages, schools, hospitals, offices, farms, greenhouse complexes, etc.;
- illuminate parks, gardens, yards, highways and streets;
- provide power to telecommunication, medical equipment;
- supply energy to oil and gas pipelines;
- provide energy to water supply and desalination;

− charge mobile phones and laptops.

Monocrystalline solar panels

A purified, very pure silicon is used to produce monocrystalline solar panels. This kind of solar panel looks like silicone honeycombs or cells that are connected in one structure. After a purified single crystal solidifies, it is divided into thin plates, up to 300 mcm thick (figure 1.1). Such ready-made plates are connected by a thin grid of electrodes. In comparison with amorphous batteries, these are more expensive, because the technology of their production is many times more complicated [3].

Figure1.1 - Monocrystalline solar panel

Polycrystalline solar panels

Figure 1.2 - Polycrystalline solar panel

A silicon substance is slowly cooled to obtain polycrystals. This approach to production technology is much cheaper than in the previous type of panels, so this type is cheaper. At the same time, less energy is required for manufacturing, and this once again has a beneficial effect on the price. But something must be sacrificed? Therefore, these batteries' efficiency is lower, up to 18%. This drop in the coefficient is associated with the formations inside the polycrystal, which reduce the efficiency (figure 1.2).

Amorphous solar panels

In the case of amorphous panels' production, silane or silica is used, which is applied thinly on the substrate material. The efficiency in such batteries is 6% (figure 1.3).

These panels have very low efficiency, but despite shortcomings, they have a number of advantages:

− optical absorption index is 20 times higher than that of polycrystals and single crystals;
− thickness of elements is less than 1 mcm;
− have a higher productivity in cloudy weather in comparison with polycrystals and

monocrystals;

− increased flexibility.

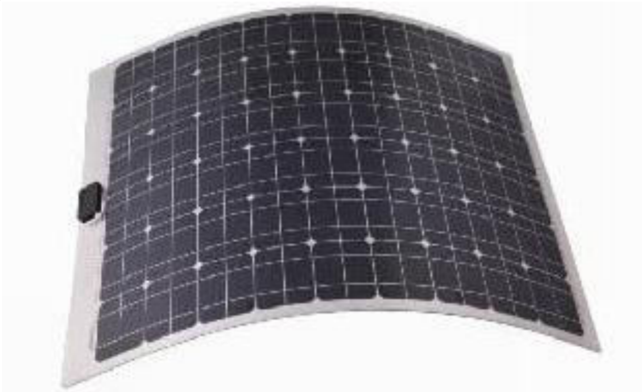

Figure 1.3 – Amorphous solar panel

Table 1.1

Comparison of the characteristics of solar panels

Criteria	Single-crystal	Polycrystal	Amorphous
Crystal structure	Crystal grains are parallel, oriented in one direction	Crystal grains are parallel, oriented in different directions	Crystal structure is not used
Temperature of production	1400°C	800-1000°C	500-700°C
Color	Black	Dark-blue	Dark-blue
Stability	High	High, but less than that of single-crystal	Average
Price	High	High, but less than that of single-crystal	Average
Pay-off period	2 years	2-4 years	5 years
Efficiency	17-22 %	12-18%	8-10%
Production technology	More perfect, more complex, more precise	Simpler, hence the low cost	Simpler, hence the low cost
Servicelife	25 years	20 years	15 years

Considering the comparison table of solar panels, it can be seen that single-crystal solar panels have a number of advantages and are beneficial in application, based on such criteria as stability, price, pay-off period, efficiency and service life.

Therefore, a single-crystal solar panel will be chosen in the development of research work (table 1.1).

As can be seen from the comparative characteristics, there are no big differences between the solar panels of different countries. Therefore, solar panel CS6P-300M from Canadian Solar with high efficiency was chosen for research work. Also, the Canadian Solar company was one of the top 5 manufacturers of solar panels by the results of 2017 (table 1.2).

Calculation of energy supply system for laboratory room

Plan of the laboratory room

Considering laboratory room consist of:

−7 computers;

−6 stands with the microcontrollers;

−2 fluorescent lamps;

−1 electric board

There is a data about DC load in laboratory room (table 1.3).

Table 1.2

Comparison of types of solar panels

SP model and country of production	Power/ voltage, W / V	Effic-cy, %	Dimension,mm	Price, tenge	Working temperature	Effective life
China, GCL, gw260-310w	175/24	17,65	1480x670x35	91260	from -40 °Cto +85 °C	30 years
China, Trina Solar, HONEY M PLUS -DD05A.08	300/24	18,3	1650x992x35	89954	from -40 °Cto +85 °C	Not less than 25 years
China, Global Energy Companyi-intech-300	300/24	17,4	1956x992x50	94150	from -40 °Cto +85 °C	More than 30 years
Canada, Canadian Solar, CS6P-300M	300/24	18,2	1956x992x50	97600	from -40 °Cto +85 °C	30 years

Table 1.3

List of DC load in laboratory room

DC load description	W, (per hour)	Quantity	Total (per day), W
Computer	65	7	5460
Microcontroller	90	6	6480
Fluorescent lamps 20 W	20	2	480
Total			**12420**

$$\text{Total} = 5460 + 6480 + 480\text{W} = 12420\text{ W} = 12\text{ kW (per day)}.$$

Calculation of solar panel design for laboratory room power supply

Power Calculation

This part calculates the AC load consumed by the laboratory room (table 1.4).

Table 1.4

Calculation of full AC load

ACload	Power, kW	Quantity	kW*h/day
For the whole area of the laboratory room	12	1	12

Consequently, based on the table, it follows that 12 kW is required per day for the operation of the entire laboratory room. For this purpose, the numbers of solar panels will be calculated.

Electricity consumption calculation

List of all AC loads, its power and operating hours per day. Multiplies power by operating time to determine the required energy in W*h per day. All these data are then summarized to calculate the total AC load in Watt hours per day (table 1.4).

DC input voltage, V

$$U = 24\text{V}.$$

Divide power per day by 24 V. Get full AC load in A * h per day.

$$\frac{12420}{24} = 517{,}5\text{ A} \times \text{h}.$$

Calculation of the rechargeable battery

Demand for electricity in A * h, equal to

$$D = 517{,}5 \text{ A} \times \text{h}.$$

Multiply this result by the number of days and by 0.7-70% of electricity generated by the solar battery in the system SP+WG (Solar Panel and Wind Generator). These are the amounts of electricity that the locks need in battery [4].

$$517{,}5 \times 0{,}7 = 362{,}25 \text{ J}.$$

It is necessary to enter depth of discharge for battery. Since the discharge depth is 20%, a factor of 0.2 is used.

$$k = 0{,}2.$$

Let's select a factor that takes into account the decrease of battery capacity at temperature decrease.

$$k = 1{,}2.$$

Multiply the electricity demand by the battery capacity reduction factor. This is necessary to ensure that the system operates in cold weather. The total battery capacity is

$$517{,}5 \times 1{,}2 = 621 \text{ A} \times \text{h}.$$

Selected nominal battery capacity is

$$C = 500 \text{ A} \times \text{h}.$$

Divide the full battery capacity by the nominal battery capacity and round to the nearest larger integer. This will be the number of batteries connected in parallel.

$$\frac{621}{500} = 1.$$

It is known that 1 square meters of solar panel produces 1 kW of energy, but since the efficiency of each such panel is 20% (i.e. a total of 200W will be generated).

The total consumption of the entire laboratory room is 12 kW, therefore, 3 solar panels are needed to generate 1 kW of energy. Total is obtained

$$12 \times 3 = 36 \text{ solar panels}.$$

Finally, such a number of solar panels should be installed for the power supply of the entire laboratory room.

Conclusion

1. Comparative analysis of types and characteristics of renewable energy source: solar panel was carried out.

2. The number of solar panels required for the power supply system of laboratory room №606 is calculated.

3. Electric power consumption was calculated using laboratory room DC and AC loads.

4. The calculation result of the storage battery for finding the number of solar panels necessary for the laboratory room was obtained.

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