Effectiveness of Photoelectric Systems Against Intensive Gardening and Desertification

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Abstract: The increase in the efficiency of photoelectric panels from year to year is the basis for the large-scale use of this type of renewable energy source. Many subsidies are allocated for the use of renewable energy sources in our country. The use of solar energy, which is one of the renewable energy sources, is one of the most optimal solutions for creating intensive gardens in desert areas. In the article, the efficiency of the photoelectric system (PES) was compared with the portable generator (PG) used to supply water pumps with energy. It was determined that the payback period of PES is equal to 3.5 years compared to PG. It was found that there is an opportunity to use long-term green energy at almost no cost for the remaining 15-20 years. Instead of a system with a total power of 5kW, a PES system of 9.9kW was connected as an energy supply for irrigation works. 4.2 tons of CO_2 emissions from PG are avoided annually. This practical work proved that the most problematic desertification, water supply and green energy sources can be solved in one place.

1 INTRODUCTION

Today, critical situations are occurring all over the world. These are global warming, air pollution all over the world, especially in cities, desertification, water supply and many other factors. Among the projects aimed at mitigating such processes at least a little, the work done using the photoelectric system is commendable. The application of photoelectric systems in the necessary directions is bearing fruit all over the world. Uzbekistan has set a plan to increase the amount of energy obtained from renewable energy sources to 40% by 2030 [1]. It should be noted that this was a move typical of European countries in this direction. One of the most effective solutions to desertification is the creation of intensive gardens. In Uzbekistan, as well as in the whole world, strategic goals are being set against desertification and measures are being taken to prevent it. Since more than 70% of the territory of Uzbekistan corresponds to desert and waterless areas [2], it is clear that it is necessary to carry out specific targeted work in this regard. It is appropriate to use drip irrigation in the organization of intensive gardens in the desert region [3]. The durability and degradation properties of polymer materials used in drip irrigation are also important [4]. In addition, a source of energy is needed to manage water in the desert and to draw and distribute water from wells through pumps.

An AC power source is cost-effective and requires minimal maintenance when there is a power grid nearby. However, in places where there is no grid, they are forced to use diesel or similar fuel generators to power water pumps. The design of this type of power source is compact, convenient, easy to install and portable. One of their major disadvantages is constant refuelling and maintenance work. In addition, fuel prices are high and unavailable in many rural and desert areas. One of the problems is the constant supply of fuel and the constant increase in fuel prices. For this reason, the rational use of solar energy in such areas is widely promoted worldwide. Photoelectric systems (PESs) are a safe, reliable, maintenance-free, noise-free and environmentally friendly power source in desert areas [5]. There are also works comparing the efficiency of diesel and PES mentioned above [6]. Of course, when installing photoelectric systems (PES), the power of all pumps and other consumers is considered. Based on the maximum daily energy consumption and the suitability of the system for the purpose, the optimal PES is set.

Degradation of many materials is high in desert areas due to high temperatures and radiation. Therefore, it is recommended to make high-quality backup systems.

2 METHODS AND MATERIALS

Our experiment was conducted in the Surkhandarya region, located in the southernmost part of Uzbekistan. The main goal of the work is to evaluate the technical and economic efficiency of PES, which is being used as water supply on 10 hectares of land, which is being built in the desert area. It is planned that this area will become an intensive garden in the future, and a suitable part of the desert area was selected and a well was dug for the irrigation system at a depth of 35-37 meters. This water was subjected to technical expertise and it was found that it can be used for watering plants. Information about the general view of the studied area is given in Figure 1.

Figure 1: General view of the area.

Capillary hoses for drip irrigation have been laid for irrigating this 10 hectares of land, and they can be recycled at the end of their service life. 3 water storage tanks were dug ($20m^3$, $20m^3$, $25m^3$). The main two irrigation reservoirs are potentially above the irrigated land. The reason is to irrigate oneself in the evening without spending energy. Due to the high temperature during the day, watering has a bad effect on the plant. Bacterialization and heating of water in the open air are very beneficial for the plant. Water is pumped from a well to the reservoir in the lower part of the reservoir, and two reservoirs located above this reservoir are filled with water during the day using PES energy. PES overview with water tanks Figure 2.

Figure 2: PES system overview with water reservoirs.

The total power of PES is 9.9kW. Ipvisola panels were used in the system. The panels are installed at an angle of 18 degrees facing south. Panel characteristics are shown in Table 1.

A frequency inverter is used in the system. The reason is that water reservoirs are filled using daytime PES energy using three pumps (total power 3.5kW, 1.7kW, 1.1kW, 0.7kW). During the day, the pumps work using maximum PES energy. During irrigation, at night, irrigation works are carried out using the potential energy of water without energy consumption. Before the PES was used, a Portable Generator (PG) was used and this PG was continuously supplied with fuel. PG has an average maximum power of 5 kW and consumes 1 litre of petrol per hour. The main aim of our work is to compare the efficiency of the systems in these two cases and to calculate the economic payback periods. In addition, it is to prove that desertification can be stopped at least a little by creating intensive gardens with water extraction.

Table 1: Geometric size and physical parameters of photoelectric battery.

Model Type	YH550W-36MN
Rated Maximum Power (P_{max})	550W
Power Tolerance	± 3 %
Open circuit voltage, U_{oc}	50.1V
Short circuit current, I_{sc}	13.9 A
Maximum Power Voltage (Vmp)	42.13V
Maximum Power Current (Imp)	13.06A
Dimensions, mm	2279·1134·35
FIK, %	21.51 %
PEB weight, kg	28,4kg
Maximum System Voltage Nominal	1500VDC
Maximum Series Fuse Rating	25A
E=1000W/m2, T_{PEB}=25ºC, AM=1,5 STC conditions	

Table 2: The total cost of PES and PG systems.

PES (Photoelectric System)		PG (Portable Generator)	
550W BEBs	$3960	PG	$800
Frequency inverter	$1000	Installation of connecting wires	$100
Construction and connecting wires	$1000		
Total cost for PEB:$5960		Total cost for PG: $900	

It should be noted that the irrigation and reclamation season begins in April and ends in early November at the highest level of solar radiation flow density. During this period, along with the high level of solar radiation flow density, the air temperature also rises to a high level, especially in the desert regions. Since there are few cloudy days during the irrigation season, the use of photoelectric systems in water extraction is effective, but the main drawback of photoelectric water extraction systems is the decrease in system efficiency due to the loss of PES power at high temperatures [7]. We will consider the energy efficiency of drip irrigation works in the case of PES and PG. In addition, we will dwell in detail on the payback period of these systems and their impact on the environment. Table 2 shows the total cost of PES and PG systems.

For the PES system, the initial cost is almost 6.5 times higher than that of the PG system.

3 RESULTS AND DISCUSSION

Pumps used to irrigate 10 hectares of land in a desert area far from a power station definitely need a source of energy. Initially, the farmer used a 5kW PG as this energy source, but now 9.9kW PES is installed considering the scale of the system. Initial costs for PES are high. However, the 20-year warranty for the panels and almost negligible maintenance costs ensure the long-term operation of this system. PG consumes 1 litre of petrol per hour and spends $6 on petrol during an average working time of 6 hours per day. This average value is for spring, summer and autumn months. In addition, there is a problem of constant transportation of fuel for PG. In this case, the average cost of fuel for the envisaged 8-month period will be $1,440. Costs for maintaining the technical condition of PG and PES are not taken into account at this time. The economic payback period of PES compared to PG was calculated as follows (1)

$$N = \frac{PES_{Total\_\cos t} - PG_{Total\_\cos t}}{P_{\text{Fuel\_cost}}} \tag{1}$$

In this case, the PES system can justify itself in 3.5 years (Figure 3). The farm has also started a greenhouse project on 1 hectare of land for the winter season. Construction of an efficient greenhouse has been started to grow crops even on cold days. The aim is to use green energy for the electricity supply for this greenhouse.

The new garden and these green energy plants, which are being built against today's ever-expanding desertification, are certainly not without benefits for the environment. PES performance depends on radiation, PV panel surface cleanliness and module temperature [7-9]. For this purpose, the PEB station is installed in a convenient position for cleaning, 0.5 m above the ground at 18^0 degrees for convective cooling. The power obtained from the PEB is enough to ensure the energy consumption of 3 pumps with a total power of 3.5 kW for full operation during the day. In addition, there is reserve capacity for consumers who may be connected in the future. If it is planned to be used by consumers even at night, an accumulator battery and an inverter are necessary. And for this change, there is no need for a change in the power of PES. Table 3 presents the energy values that can be obtained from PES for months.

Figure 3: Greenhouse construction.

Table 3: The energy values that can be obtained from PES for months.

Winter	Spring	Summer	Autumn	Total annual energy
3.74 MW·h	5.54 MW·h	6.24 MW·h	5.54 MW·h	21.06 MW·h

So, based on theoretical calculations, when used in the maximum state, it can be said that such a PES provides 21 MW•h of energy per year. In addition, 0.7 kg of CO_2 gas released into the environment due to PES is avoided for every 1kW•h of energy [10]. When one litre of petrol is burned, it creates approximately 2.31 kg of carbon dioxide [11]. This prevents 4.2 tons of CO_2 from escaping into the atmosphere per year.

4 CONCLUSIONS

Against the background of technology development, PEB electric efficiency increased by 22%, and PESs became an energy supply system in various fields. The role of such energy systems in providing energy to water-releasing devices in the agricultural sector is extremely important. In the farm analyzed above, replacing the energy supply with PES is an effective solution, which avoids the cost of daily fuel delivery and fuel prices. The payback period of PES compared to PG is 3.5 years. In addition, 4.2 tons of CO_2 released into the atmosphere per year will be avoided. Using PES in energy supply while reducing desertification by creating a garden supports green energy capacities and guarantees long-term performance. It was found that there is an opportunity to use long-term green energy at almost no cost for the remaining 15-20 years. Instead of a system with a total power of 5kW, a PES system of 9.9kW was connected as an energy supply for irrigation works and an additional power source was also created. Our practical work proved that the most problematic desertification, water supply and green energy sources can be solved in one place.

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