Design of mobile electricity based on solar and garland micro hydro power plant for power supply in Namangan region mountain areas

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Abstract. In the article, the experiences of developed countries in introducing mobile solar and garland micro- hydroelectric power plants in the mountain regions cannot be directly applied to the conditions of Uzbekistan. Kosonsoy district, located in the east of Uzbekistan, belongs to the mountainous regions. Mobile solar and garland micro-hydroelectric power plant is an acceptable option for the electricity supply of small power consumers of the district. Preliminary data, drawings of my device, and an electrical connection scheme were developed for calculating and selecting a micro-hydroelectric power plant. According to the results of the preliminary experiments, the relationship between the speed of water flow m/s and the value of the power transmitted from one piece of paper to the shaft in the parts of streams, streams, and rivers flowing through the mountain regions of Kosonsoy district with a minimum slope was determined. A physical model of a mobile solar and garland micro-hydroelectric power station was created for mountain regions. When soft cables are used, a drop in the water level does not cause a change in power. It is safe and convenient to arrange the hydrofoils in a garland to take full advantage of the cross-section of the water flow, and it is cost-effective to use a single generator for many working fodders.

1 Introduction

Developed countries' experiences in using "solar and garland micro-hydroelectric power plants" cannot be directly applied to the conditions of Uzbekistan. Because in the conditions of Uzbekistan, there is a significant difference in the terrain of the mountain regions, seasonal water reserves, and even the slope indicators of some areas. Therefore, it is advisable to consider the region's uniqueness when introducing such technologies.

The first examples of garland hydroelectric plants were developed in the middle of the 20th century. Garland micro-hydroelectric power plants operating in free streams work without special devices for directing the water flow and without special hydrotechnical structures (dams).

The estimated annual total hydropower potential of the Republic of Uzbekistan's hydropower resources, excluding various natural and technological wastes, is 15.0 billion.

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kW/h, of which the capacity of small rivers, streams, and tributaries is 2,0 billion. It is about 1 kWh. To supply irrigation water for agricultural crops in the agrarian sector of our country, 75 large trunk and inter-farm canals with a length of 28,6 thousand km and internal irrigation networks with a length of 172,2 thousand km are operated in the irrigation systems of our country. In addition, there are hundreds of streams and springs with high waterfalls in a mountain and sub-mountain areas, and there are opportunities for cheap and environmentally friendly electricity generation using natural slopes (in rivers and streams).

Ensuring that the amount of power produced by renewable energy sources corresponds to the power consumed, regarding daily, seasonal and annual graphs of loads, V.I. Budzko, V. Yu. Hessen, S.E.Strebkov, S.K.Sheryazov, especially in the conditions of Uzbekistan, scientists such as R.A.Zokhidov, Q.R.Allaev, A.Mukhammadiev, A.Radjabov conducted research on electrical technologies in agricultural production.

In these studies, loads of electricity consumption are considered from the point of view of the construction of the power supply system of separate objects and regions and the issues of coordination of production and consumption of electricity in the selection of small-power power plants, especially renewable energy sources and the justification of their parameters are considered centralized or local-autonomous methods. The question of mobile supply has not been studied.

The area of Kosonsoy district is 0.51 thousand $km^{2,}$ and the population is 141.5 thousand people. The territory of the district belongs to the zone of mountain regions. Kosonsoy river are flowing Karatag, Mug, Kukumbay edges , Dam, Isporan, Yayık, Qısık, Karankul, Sarson and Yertikan, Boyoston foothills. About 1/3 of the district's territory consists of mountain regions [2].

Table 1. Information on the stream on which the garland micro hydro power plant will be installed

Name of stream (river)	Length, km	Water permeability, m^3/h	River flow areas
Kosonsoy	28.8	200	Kosonsoy and Turakorgan districts

2 Methods

2.1 Garland micro hydro power plant calculation and selection

The purpose of the study: scientific and technical justification of the electricity supply of mountain and sub-mountain areas based on solar panels and a mobile power station with a garland.

Research object: Methods of determining the energy potential of small rivers, streams, canals, and tributaries flowing through a mountain and sub-mountain regions. Theoretical foundations and principles of calculating and designing parameters of solar panels and mobile power plant with garland.

Scientific novelty of the research:

- Basis of structural parameters of "Solar panels and garland micro-hydroelectric power plants", construction of a physical model;
- Establishing optimal energy parameters of "Solar and garland micro-hydroelectric power plants";
- Determining the efficiency indicators of "Solar and garland micro-hydroelectric power plants" concerning loads;
- Developing theoretical principles of operation of "Solar and garland micro-hydroelectric power plants" in combined mode.

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The wings have been shown solely to give a sense of proportion. Because the resistance of the axis is smaller than that of the blades, a torque is generated. Garland micro hydro power plants are divided into single-row and multi-row types depending on the number of rows.

Table 2. Classification of hydro power plant by technical parameters [1].

Parameters	Pico hydro power plant	micro hydro power plant	Mini hydro power plant	Small power hydro power plant
Power	Up to 5 kW	From 5 kW to 100kW	From 100 kW to 1 MW	From 1 MW to 50 MW
Water consumption	Less than 0,1 m^3/h	Less than 0,4 m^3/h	0,4 m^3/h- 12,8 m^3/h	More than12,8 m^3/h
Turbine diameter, m	No general information, it depends on the design	Less than 0,3 m	0,3-0,8 m	More than 0,8
Power supply	For a separate house	For houses up to 100, small production, separate facilities	Up to 1,000 farms and production facilities	Autonomous provision of the region, department, industry enterprises, large production
Comment	Requires low water flow	For hydrological conditions with limited potential	Great potential can be obtained in small rivers. Construction costs are high.	Great potential is available in medium and large rivers. There should be enough water. Requires large costs

Table 3. Preliminary data for the calculation and selection of garland hydro power plant

Turbine diameter, D, m	The length of the active part of the garland, L, m	Water flow rate, *v*, m/h	The calculated efficiency of the turbine, η_h	Number of garland rows	Efficienc y of the reducer, η_{red}	Efficiency of the generator η_g
0.7	1	10	0.46	3	0.8	0.75

The formula for calculating the power of a single row of garlands:

$$N_{gir} = DL\frac{v^2}{2}\eta_h \qquad (1)$$

$$N_{gir} = 0.7 \cdot 1 \cdot \frac{16}{2} \cdot 0.46 = 2.56 \text{ kVt}$$

Where: N_{gar} is power, for a single-row garland, kW; η_h is efficiency depending on the quality of the turbine [2].

Generator power formula:

$$N_g = n\,N_{gir}\eta_{red}\eta_g, \qquad (2)$$
$$N_g = 3 \cdot 2.56 \cdot 0.8 \cdot 0.75 = 4.608\ \text{kW}$$

where: N_g is generator power, kW; η_{red} =0.9-0.7 depending on the number of changes; η_g =0.9-0.75 for low-power generators operating at low speeds.

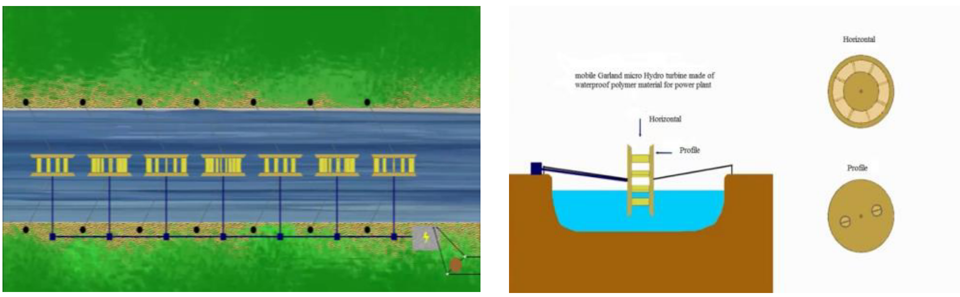

Fig. 1. For mountainous areas, top and front views of the mobile garland hydroelectric power plant are provided (4).

Table 4. Preliminary data for calculating and selecting the capacity of solar panels.

The energy of the sun, E, W/m^2	Additional units, E_q, W/m^2	The surface of the solar panel, *S*, m^2	Coeffi-cient panel, A	Solar panel effi-ciency η_h, %	Solar installation angle, α	Atmos-pheric compo-sition
730	65	6	0.73	20	50	Y

Calculate the power of the solar panel.

$$P = (E + E_q) \cdot \eta_p \cdot S \cdot \cos\,\alpha \cdot A = (730 + 65) \cdot 0{,}2 \cdot 6 \cdot 0{,}6 \cdot 0{,}73 = 417{,}9\,W$$

$\text{Cos}50^{\circ}$=0,6

Based on the calculations, we selected the default solar panel from the catalog.

Technical characteristics:

- Solar cell type – Mono crystalline;
- Power, W- 450 (0 ~ +6W);
- Format (W×L×H), mm- 1979 x 992 x 40;
- Weight, kg - 23.5 kg;
- Battery capacity, A • h- 200;
- Battery voltage, V- 24.

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3 Results and Discussion

3.1 Reconstruction of a mobile power plant based on solar and garland hydroelectric power

Based on the preliminary findings, it was decided to introduce a garland micro hydro power plant along with solar and wind power plants for mountain area consumers far from the power supply. For the construction of the garland micro hydro power plant, it was concluded that the working blades use water-resistant polymeric materials and soft shafts and couplings to transmit rotational motion to the generator. Due to the specifics of the foothills and the convenience of providing maintenance services to the garland micro hydro power plant, it was considered appropriate to create a mobile version of them [14].

According to the results of preliminary experiments, the relationship between the velocity of water flow in m / h and the value of power transmitted from one blade to the shaft in the low-slope parts of streams, streams and rivers flowing through the mountain regions of Kosonsoy district in the following views (turbine diameter 1.2 m): 0.5 m/h – 0.03 kW, 0.07 m/h – 0.06 kW, 1.0 m/h– 0.14 kW, 1.5 m/h – 0.31 kW, 2.0 m/h – 0.55 kW, 2.5 m/h – 0.86 kW, 3.0 m/h -1.24 kW.

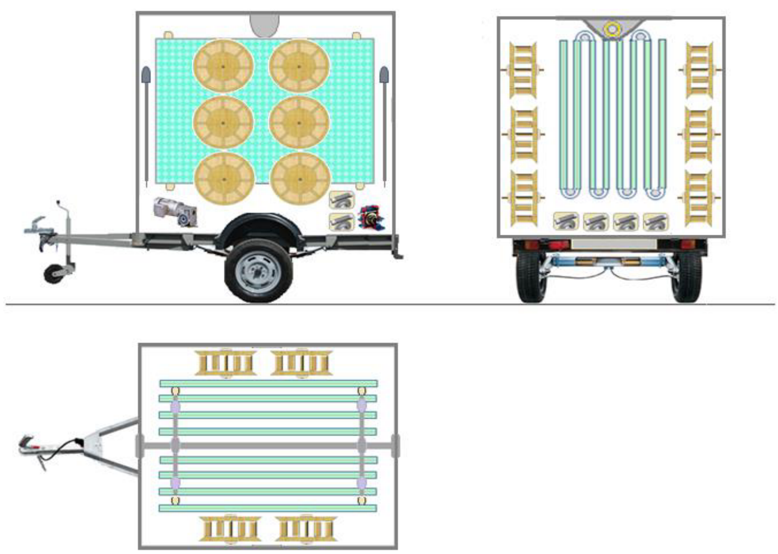

Fig. 2. A mobile solar and garland hydroelectric power plant prototype for mountain areas [5].

Table 5. Economic efficiency assessment

№	Indicators	Options		Changes
		Diesel generator (DG6000SE)	mobile solar and garland micro hydro power station	
1	Power, kW	5	5.3	0.3
2	Cost, USD ($)	600	1000	400
3	Weight, kg	150	500	350
4	Workforce	1	1	
5	Working hours during the day, hours	8	12	4
6	Fuel consumption, liters / hour	1.2	-	
7	Electricity produced per year kWh	14 600	23 214	8614
8	Electricity cost (1 year)	0.17	0.04	0.15
9	Profit, USD ($)	2950		

4 Conclusion

The hybrid solar and hydroelectric power plant is resource-saving and environmentally friendly in electricity generation. Cost-effective at nearly $3,000 per year compared to fuel-burning generators, and no constant worker supervision is required.

When designing mobile garland micro-hydroelectric power plants for mountain areas, it is necessary to use the maximum polymeric materials to construct areas with minimal water resources, seasonal processes, a garden with favorable relief, and the level of risk of natural disasters and construction.

The mobile garland hydroelectric power plant can be used in the mountain areas without electricity. When using a soft shaft, the drop in the water level does not change the power. It is safe and convenient to place water blades in a garland to take full advantage of the cross-section of the water flow, and for many working blades, it is cost-effective to use a single generator.

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