Monitoring of Battery Energy for Hybrid PLTS and Picohydro Systems on Water Pumps

I Nyoman Sugiarta, I G.W. Antara Kurniawan, and I Nengah Suparta

Electrical Engineering
Politeknik Negeri Bali, Jimbaran, Bali, 8361, Indonesia
sugiartaelektro@pnb.ac.id, kurniawan_bali@yahoo.com, suparta@gmail.com

Abstract. The use and utilization of renewable energy must continue to be developed both in terms of science, human resource skills and its application in society. The use of solar energy as an alternative energy to generate electricity has been widely applied. One of them is to turn on a 250 Watt, 12 Volt submersible DC water pump. The author uses a 400 Wp solar panel. The output water discharge from the pump is used to drive a 150 Watt DC picohydro generator. Research conducted in 2 hours, the energy generated during the charge and discharge process of the Lithium Iron Phosphate Battery (LiFePO4) 100 Ah at the same time compared to the process of charging and discharging the battery at different times produces an average energy (320: 172.6 Wh (charge); 168.4: 152 Wh (discharge)) and an average capacity (24.58: 12.34 Ah (charge); 12.12: 11.65 Ah (discharge)). While the average ratio of SOC (State of Charge) is (88: 100% (charge)); (88: 57.5 % (discharge)). While the average of water generated during the discharge process (1374.25: 1333.81 liter/hour) and the output voltage of the picohydro generator (4.37: 4.195 Volts). It can be concluded that the average energy and SOC generated in the process of charging and discharging the battery at the same time is better. The electric voltage generated by the picohydro generator by utilizing the water discharge output is still relatively small, less than 12 volts.

Keywords: Solar panels, picohydro, battery energy, water pumps.

1 Introduction

The title of this research stems from student research using solar panels to drive water pumps in rice fields. In this study, students tested how much water discharge was generated by a pump with a power of 125 watts using a 200 WP solar panel connected in parallel. The average total energy produced by a 200 Wp solar panel for 5 hours is 257.4 Wh per day. The water pump can run for 1 hour per day to produce a volume of 520 liters of water carried out within 4 days while the next 2 days it produces a volume of 346.6 liters within 40 minutes per day and one day produces a volume of 260 liters within 30 minutes per day. This is due to different weather factors, so the solar panel charging process is also not the same every day [1]. Currently pumps that run water through pipes have not been used for any other purpose than to circulate water. In the process, the water that comes out of the pump has a volume and speed that can be used to drive the mill so that it can also generate electricity through a DC generator . In this

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study the authors try to monitor how much energy can be utilized through the movement of the water flow. From several journals that have been published, there have been many studies on the use of solar panels to turn on water pumps and also research on micro-hydro. Research with the title Design of Picohydro Turbine Power Plant Efficiency Test Equipment gets the average input water flow rate is 9.27 x 10 -4 m3 /s, the average output voltage is 1.21 V with a standard deviation of 0.04, the average output current is 0.053 A with a standard deviation of 0.006 [2]. Research Design and Realization of a 12 Volt 45 Ah Battery Charging System at a Pico-hydro Power Plant at UPI Bandung by utilizing river water flow for a pico-hydro generator. The plant produces 100 Watts of power and is used for lighting systems using incandescent lamps or energy-saving lamps. In this study, an attempt has been made to utilize this electricity for a battery charging system, in which a device is designed and realized to charge a battery with a charging voltage of 14.2 Volts and a maximum charging current of 4.5 Amperes sourced from a pico-hydro generator. The charging method used is the slow charging method, which is a battery charging by providing a charging current of 1/10 of the battery capacity, thereby extending battery life. The type of battery used is Lead Acid with a voltage of 12 Volts and a capacity of 45 Ah which is used for room lighting using a 12 Volt LED (Light Emiting Diode) lamp. The charging time for the 45 Ah Lead Acid battery is 12 hours with an initial voltage of 11.7 Volts, then stops at 12.8 Volts and the charging current decreases from 3.9 Ampere to 0.3 Ampere, while the loading time is 12 hours with an initial voltage of 12.1 Volts and 11 Volts when the battery capacity is empty for a load current of 3 Amperes [3].

2 Methodology

2.1 Research Flow Chart

The research flow chart can be seen as shown in the figure 1.

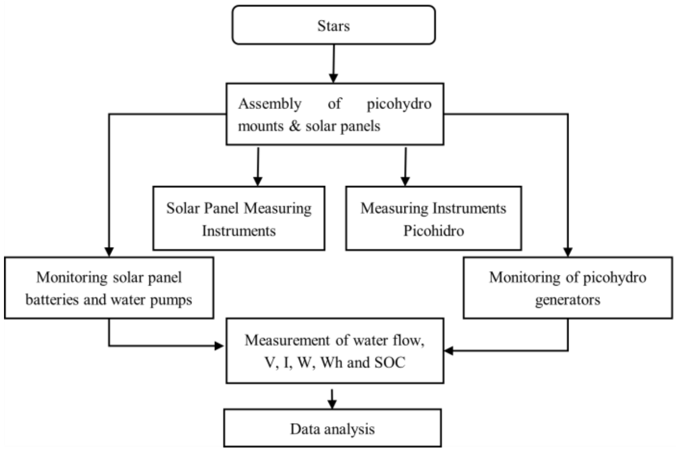

Fig. 1. Research Flow chart.

2.2 Materials and Instruments

The materials and measuring instruments used in this research are as shown in the table 1.

Table 1. Materials and Instruments

No	Tool's Name
1	Solar panel Polly Crystalline 4x100 Wp.
2	SCC MPPT Ever Solar Panel (20 A)
3	MT50
4	Multimeter
5	Water flow meters
6	PZEM-015 DC 100 A meter battery
7	Lithium Iron Phosphate Battery (LiFePO4) shoto battery and bms (100 Ah 12 V) max charging 50 A, max discharge 100 A
8	Pulleys and belt pulleys (3 in as 8 mm diameter)
9	DC Generator (150 W, 12-80 V, 2.5 A) 1500 Rpm
10	Wheel (Polypropyline material with 43 blades, 15 mm in length and 80 mm in radius. The outer diameter of the wheel is 170 mm and the inside diameter is 155 mm)
11	Digital Wattmeter
12	DC water pump (250 W ,12 V, 10 A) Outlet 25 mm ,max head 30 m, max flow 1.5 m3/h
13	MC4 Cable connector ,6 mm Solar Cell black / Red Power cable.
14	Lancon Micro 200 (Battery Tester)

2.3 System Planning

This Planning is needed to design and plan the installation of PLTS with water pumps and picohydro with wheels. The seat frame with LxWxH (100x80x120) cm is designed to use mild steel. The wheel box is designed with dimensions of LxWxH (40x40x25) cm according to the size of the wheel LxWxH (25x25x15) cm. Tool holder frame design can be seen as shown in the fig. 2. and fig.3.

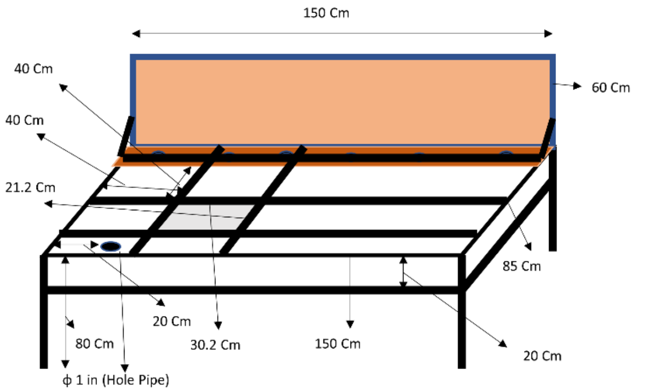

Fig. 2. Tool holder frame.

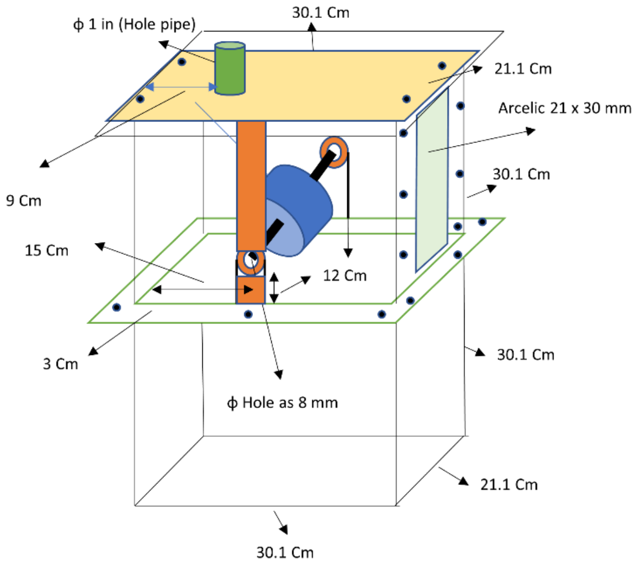

Fig. 3. Wheel holder frame.

3 Results And Discussion

3.1 Research Objectives and Location

This research was conducted at Kodya Denpasar, Bali Indonesia. Kodya Denpasar is located at coordinates 8.67 south latitude and 115.21 east longitude.

3.2 Research Data

This measurement and monitoring of data is done empirically. The process of charging the Lithium Iron Phosphate Battery (LiFePO4) pack EVE cell 4s 100 Ah by 4x 100 Wp solar panels (2 in series and 1 in parallel) was carried out for 2 hours of irradiation. The process of discharging the battery by submersible pump DC 12 Volt 250 Watt with a depth of 135 cm was carried out for 2 hours. The pipe used has a diameter of 2.54 cm with a pipe end of 1.9 cm in diameter and 20 cm long. The flow of water produced by the pump is used to drive the wheel and rotate the generator through a belt attached with a pulley diameter of 3.62 cm and spaced 33 cm between the axles. The wheel has an overshoot type with a number of 43 blades, a length of 0.15 cm and a radius of 0.8 cm. The outer diameter of the wheel is 17 cm and the inside diameter is 15.5 cm. The generator used for the picohydro has a power of 150 watts with Rpm 1500.

The process of charging and discharging the battery is done at different times. First, the battery charging process is carried out for 2 hours by a 400 Wp solar panel. Then we turn off the solar panel MCB to stop the charging process. The battery is left in a resting state for several hours (2-3 hours) to reach a steady state. The discharging process was continued using a pump load for 2 hours.

Measurement and monitoring of data is done empirically. The process of charging by solar panels and discharging the battery by submersible pump DC 12 Volt 250 Watt is carried out for 2 hours at the same time. First, the discharging process is carried out on the battery with a submersible DC 12 Volt 250 Watt submersible load. The battery is left in a resting state for several hours (2-3 hours) to reach a steady state. Before the simultaneous charging and discharging process is carried out, the battery is measured using a Lancon Micro 200 Tester. The measurement is again carried out after the charging and discharging process is complete. The results of testing for 2 hours are as shown in the table 2. and table 3.

Table 2. Charge And Discharge In The Different Time

No	**Charge and Discharge in The Different Time**		
	Parameter	***Charge***	***Discharge***
1	Average Energy (Wh)	172.6	152
2	Average SOC (%)	100	57.5
3	Average Capacity (Ah)	12.34	11.65
4	Average water discharge (Liters/hour)		1333.81

No	Charge and Discharge in The Different Time		
	Parameter	***Charge***	***Discharge***
5	Generator Average Voltage (Volts)		4.195

Table 3. Charge And Discharge In The SAME Time

No	Charge and Discharge in The Same Time		
	Parameter	***Charge***	***Discharge***
1	Average Energy (Wh)	320	168.4
2	Average SOC (%)	88	88
3	Average Capacity (Ah)	24.58	12.12
4	Average water discharge (Liters/hour)		1374.25
5	Generator Average Voltage (Volts)		4.37

4 Conclusion

In the process of charging and discharging capacity Lithium Iron Phosphate Battery (LiFePO4) pack EVE cell 4s 100 Ah in the different time within 2 hours resulted in an increase in the average voltage of 1.03 Volts and resistance in the battery of 0.79 mΩ when charging. In the discharging process, the average voltage drop is 0.9 Volt and the battery resistance is 0.96 mΩ . The average energy generated during the charging process is 172.6 Wh, SOC is 100% and the battery capacity has increased by 12.34 Ah. In the process of discharging the average energy used is 152 Wh, SOC is 57.5% and the battery capacity used is 11.65 Ah.

Utilization of water flow by the pump to drive the pinwheel on picohydro can produce an average volume of water of 1315.25 liters per hour and the voltage generated by a 150 Watt generator is an average of 4.19 Volts

In the process of charging and discharging the capacity of the Lithium Iron Phosphate Battery (LiFePO4) pack EVE cell 4s 100 Ah in the same time within 2 hours it produces an increase in the average voltage of 0.47 Volts and the resistance in the battery decreases by 0.172 mΩ . The average energy generated during the charging process is 320 Wh, SOC is 88% and the battery capacity increases by 24.58 Ah. In the process of discharging the average energy used is 168.4 Wh, SOC is 88% and the battery capacity used is 12.12 Ah.

Utilization of water flow by the pump to drive the wheel on picohydro can produce an average volume of water of 1374.25 liters per hour and the voltage generated by a 150 Watt generator is an average of 4.37 Volts

The charge and discharge capacity process of Lithium Iron Phosphate Battery (LiFePO4) pack EVE cell 4s 100 Ah at the same time is better than the charge and discharge process at different times. It can be seen from the energy generated when charging (320 Wh: 172.6) Wh), the resulting battery capacity (24.58 Ah: 12.34 Ah). When discharging the energy used (168.4 Wh: 152 Wh), the battery capacity is used (12.12 Ah: 11.65 Ah).

The energy generated during the process of charging and discharging the battery at the same time produces an average energy and average capacity that is twice as large as charging and discharging at different times. While the average discharge of water produced and the output voltage of the picohydro generator are relatively the same. This data was taken during cloudy and overcast weather conditions so that the measurement results obtained were not optimal. It can be concluded that the use of Lithium Iron Phosphate Battery (LiFePO4) batteries for solar panel-based dc submersible water pumps shows very good charge and discharge energy efficiency. Utilization of the water discharge output to rotate the picohydro generator is not optimal because the resulting voltage is less than 12 Volts.

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