Design of floating photovoltaic system for fish pond lighting

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Abstract. The floating photovoltaic panel is increasingly being used. This is one of the ways to reduce temperature rise in photovoltaic panel. The floating photovoltaic panel is used for lighting at the fish pond. A unit of 8-watt lamp for lighting supplied by 1 unit of 50 Wp photovoltaic panel and 1 unit of 12 V/3.5 Ah battery. The heatsink attached to the bottom of the floating photovoltaic panel transfers heat from the panel to the fish pond water. Sensors are connected to Arduino to measure photovoltaic panel output voltage and current, solar irradiance, photovoltaic panel temperature and fish pond water temperature. From the measurement, the voltage generated from the floating photovoltaic panel is 12.71 – 14.71 V and the current is 0.15 – 1.17 A. While the solar irradiance value is 71 W/m² to 396 W/m², the surface temperature of photovoltaic panel is 26.9°C - 32.4°C and fish pond water temperature is 27.1°C - 30.2°C.

1. Introduction
The use of floating photovoltaic panel is increasing every year, both in terms of capacity, placement location, and materials [1]. Various countries such as France, India, Japan, South Korea, United Kingdom, and the United States have developed multiple floating photovoltaic systems as a renewable energy source [2,3]. The average ambient temperature for floating photovoltaic panels is lower than on land photovoltaic panels, resulting in better panel efficiency [4,5]. Other advantage of floating photovoltaic panels is it can reduce the evaporation of large amounts of water, which will benefit hydroelectric energy sources [6]. Floating design and photovoltaic panels installation is currently being carried out in various places, such as floating photovoltaic system 145 MWac in Cirata reservoir [7]. Floating photovoltaic panels, which uses 10% of one of the largest reservoirs in Brazil [8], also in the tropical Gavião reservoir, located in the Northeast of Brazil [9]. Floating photovoltaic system in Pakistan, which can produce 2345 kWh [10] and design and techno-economic analysis of 1 GWh floating photovoltaic panels in Bakun reservoir, Sarawak [11]. In addition to technical innovation and economic considerations in developing the implementation of floating photovoltaic panels as an energy source, it is also necessary to analyze the environment and perceptions of the surrounding community so that this technology can be appropriately implemented [12].

The utilization of floating photovoltaic panels has also become one of the options for the electric energy needs, maintain aquatic ecosystems, and the lives and growth of fish in the waters [13], so that the combination produces aquavoltaics system [14,15]. The electrical energy generated from photovoltaic floating panels can also create a system to monitor pH, dissolved oxygen level, and temperature in the aquatic environment [16].

In this regard, a floating photovoltaic system will be implemented using 2-panel units of 50 Wp each as an energy source for LEDs used for lighting around the fish pond area, especially at night and in
places far from the main electricity network, to provide benefits for pond owners. Several important parameters, namely voltage, current, solar irradiance [17,18], efficiency, photovoltaic panel surface temperature and water temperature will be discussed.

2. Method
Photovoltaic panel is used to convert solar energy into electrical energy. The heatsink attached to the bottom of the floating photovoltaic panel transfers heat from the panel to the fish pond water. The output of the photovoltaic will be stored in the battery, whose charging process is regulated using a solar charger controller. The output of the battery will be connected to the load, namely DC lamp and photocell. Sensors are connected to Arduino, photovoltaic panel and load to measure and monitor photovoltaic panel output voltage and current, solar irradiance, photovoltaic panel temperature and fish pond water temperature.

![Figure 1. (a) Wiring diagram; (b) Design of floating photovoltaic panels for fish pond lighting](image)

Figure 1 (a) is series of wiring from sensors used, including the INA219 sensor to measure the voltage and current from the panel and the load, the DS18B20 sensor to measure the temperature of the water, the GY-302 sensor to measure solar irradiance, the DHT22 sensor to measure the photovoltaic panel surface temperature and ambient temperature, TCA9548A to combine SCL pin and SDA pin on Arduino and OLED Display to display the data. Then figure 1 (b) is the design of floating photovoltaic panels that supply electrical energy to lamps for fish pond lighting.

3. Results and discussion
Floating photovoltaic system for lighting energy sources in fishpond uses two photovoltaic units with a capacity of 50 Wp each. One photovoltaic unit is used to supply 1 unit of lamp with the real power of 8 watts. The photovoltaic panel temperature measured from the sensor ranges from 26.9°C - 32.4°C. Photovoltaic panel temperature measurements were carried out from 08.30 a.m. – 10.00 p.m., as shown in Figure 2 (a). The solar irradiance value is in the range of 71 W/m² to 396 W/m² with the average solar irradiance when measured at the location of 183.4 W/m² which is graphically shown in Figure 2 (b). In Figure 2 (c), the measured fishpond temperature is 27.1°C - 30.2°C from morning to night. Measurements until the night were carried out to test the lighting system's performance supplied from floating photovoltaic panels.

![Figure 2. (a) Temperature of PV [°C]; (b) Solar irradiance [W/m²]](image)
Figure 2. (a) Photovoltaic panel temperature; (b) Solar irradiance; (c) Water temperature

As shown in Figure 3 (a), the voltage generated from the floating photovoltaic system is between 12.71 – 14.71 Volts. While in Figure 3 (b), it can be seen that the current generated is 0.15 - 1.17 A. So that the real power produced is 1.9 – 17 Watts.

Figure 3. (a) Voltage monitoring result from floating photovoltaic panel; (b) Current monitoring results from floating photovoltaic panel

Figure 4. (a) Floating photovoltaic; (b) Lighting in a fish pond at night

Figure 4 (a) and (b) are the implementation of floating photovoltaic system which is used to supply electrical energy to illuminate the fishpond at night. The lights only turn on at night because the system is equipped with photocells. With 5 hours of lighting time, it is hoped to be a solution for lighting at the fishpond which is usually far from the main electricity network.

4. Conclusion
Floating photovoltaic system is one of the solutions to supply electrical energy for locations far from the primary power grid. The use of floating photovoltaic, which has good performance, can be used, among others, to supply electrical energy needs for lighting in a fishpond. The system that is currently being built is a light pole consisting of two arms. Each arm consists of 1 unit of 8-watt lamp supplied
by 1 unit of photovoltaic panel with a 50 Wp and 12 V-3.5 Ah battery capacity. The lamp used can be lit for 5 hours and automatically turns on using a photocell.

5. References

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