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Analysis of Solar Cell Utilization as an Automated Pump Driver in a Fishpond

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Abstract— *The purpose of making this final task is to apply the solar power system as a source of electrical energy to move the water pump automatically in fish ponds. This system works automatically with the Water Level Control tool sensor (WLC), so that if the water level drops or rises then the water pump will automatically work. On this automated system use the Smart Relay SR2B121BD and the ZelioSoft 2 application.*
Data retrieval carried out at 10.00 -14.00 WIB, obtained data pumps 1 and 2 for a height of 1 cm for 30 minutes and a height of 2 cm for 70 minutes. The amount of discharge the pump produces 1 and 2 ranges from 37 L/M to 45 L/M.
Pump 1 Test results obtained an average efficiency of 7.68%, with the highest efficiency of 11.03% and the lowest efficiency of 5.26%, while the average pump efficiency of 2, 7.05% with the highest efficiency of 10.66% and the lowest efficiency of 5.41%. The average efficiency of the solar panels is 11.20% with the highest efficiency of 14.60% and the lowest efficiency of 7.29%.

Keywords— solar panels, Water Level Control, Pumps

Introduction

Solar energy can be utilized to meet the public demand of electricity, moreover, its abundant availability for a long period of time and is environmentally friendly. The existing sunlight is converted into electrical energy by solar cells. Solar cell is a semiconductor device that converts the energy of light into electrical energy through photovoltaic principle.

The management process in fish farming activities has several problems, one of them is related to the condition of the water level in the pond. Usually, the water level changes due to high rainfall, or a long dry season. Water levels that are too deep or too shallow can interfere the fish activities in the pond. High rainfall can increase the water level and even overflow resulting fish to be released from the pond, while during the dry season a water supply is needed so that fish farming activities are not disturbed. Therefore, pump assistance is needed to increase or decrease the amount of water in the pond. The need for electricity to drive pumps in fishponds can be supplied by using the solar cell. The selection of solar cells as a provider of electricity needs is an application of efforts to utilize renewable energy so that it does not depend on electricity sources from PLN. The solar water pump is equipped with an automatic system with a water level control concept so that the pump can switch automatically when needed to fill or reduce water in the pond.

I. METHODS

There are three sections used in this final projects includes the PLTS system design method, tool storage, and automatic system design.

1.1 System of PLTS Design

1.1.1 Solar Cell

Figure 1.1 *Polycristalline* solar cell

In this final project, we used 4 polycreystalline SUNLITE type 156P-50 solar panels with dimensions of 545 x 675 x 25 mm.

1.1.2 *Solar Charge Controller*

Figure 1.2 *Solar Charge Controller*

Solar charge controller is a tool to regulate the amount of charging current in the battery to avoid overcharging and ensure the current consumption so that there is no full discharge and overload. The solar change controller has one

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input and two output which have positive and negative terminals, respectively.

3.1.3 Battery

Figure 1.3 Battery

A battery is a storage device for electrical energy in the form of chemical energy. In this final project, ROCKET type ESFT 50-12 battery were used, 2 pieces in total, with 50 Ah capacity for each. The voltage requirement in this project is 24V so that two batteries with 12V voltage were connected in series to produce 24 V voltage.

1.2. Tool Storage Design

1.2.1 Panel Box

1. Measure the display of measuring instrument to be attached on the panel box
2. Make a sketch of the size of the measuring instrument in the front side of panel box
3. Shape the front side of panel box according to the defined sketch using a cutting grinder
4. Smooth the cutting surface with a smoother
5. Attach the measuring instrument in the place that has been created

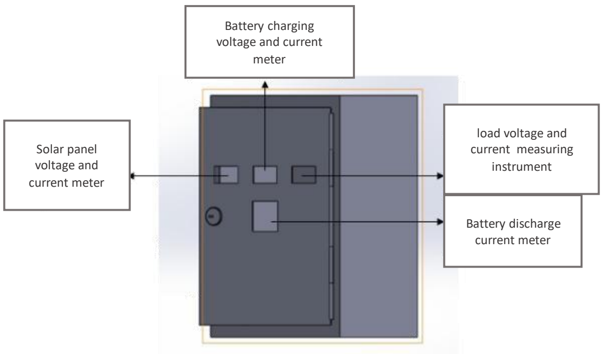

Figure 1.4 Panel Box

1.2.2 Battery Box

1. Define the battery dimension
2. Design the battery box according to the defined dimension
3. Prepare necessary tools and materials
4. Cut the L profile iron 28 cm
5. Coorperate the 6 mm (25x30 cm) iron plate with the 28 cm L-profile iron as shown in Figure 3.5

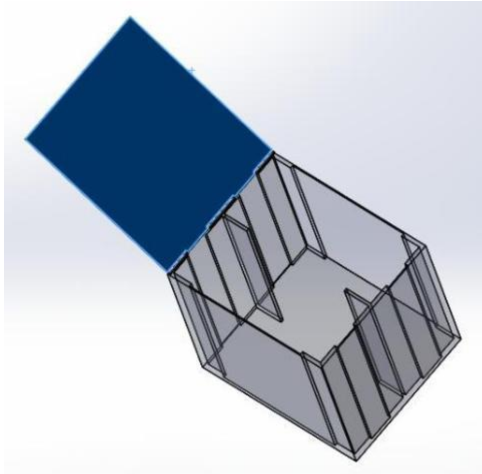

Figure 1.5 Battery box design

6. Cut a 2 mm iron plate to cover the battery box according to the size
7. Shape the 2 mm iron plate according to the design
8. Assemble the battery cover with the battery box
9. Attach hinges using two rivets using a ripe plier
10. Attach the front side of battery box

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1.3. Automated System Design

1.3.1. Smart Relay Program

1. Install Zelio Soft 2 application
2. Open Zelio Soft 2 application

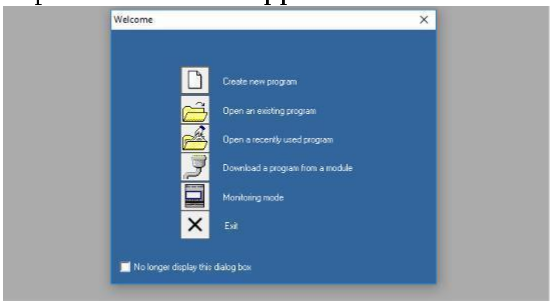

Figure 1.6 Zelio Soft 2 Application Home Screen

3. Select the desired type of smart relay, SR2B121BD

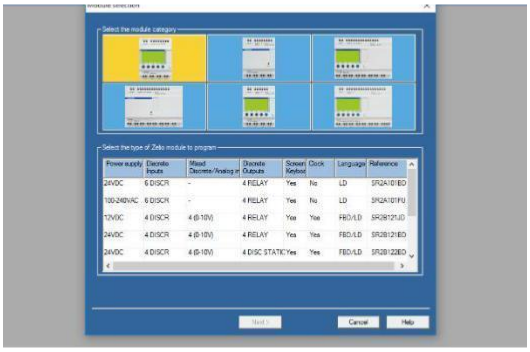

Figure 1.7 Select the type of smart relay in Zelio Soft

Design the waterlevel control system to activate the pump automatically.

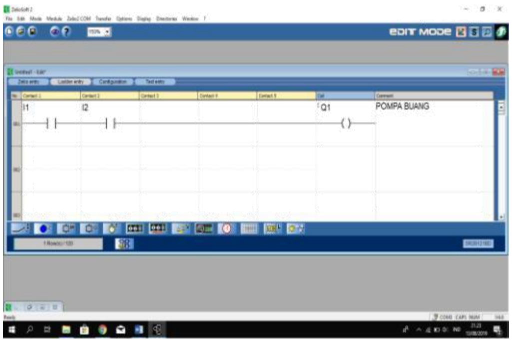

Figure 1.8 Control system making

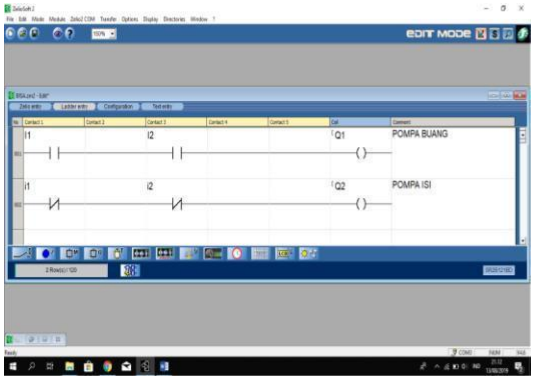

Figure 1.9 Diagram of Ladder Sensor WLC as a pump driver

1.4. Electricity Installation Design

1.4.1. Electricity Installation

Electricity installation procedure is listed below :

1. Prepare necessary tools
2. Sketch electricity installation design, as shown in Figure 3.10

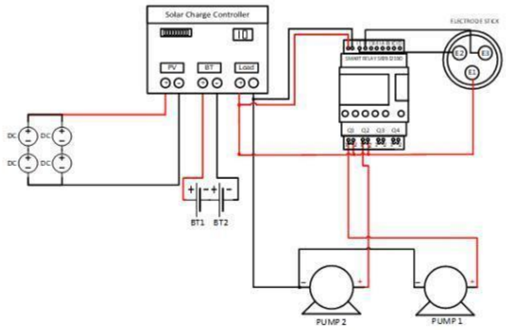

Figure 1.10 Electrycity installation

3. Set the solar cell modul in the rooftop
4. Install the solar charge controller and smart relay in the box panel
5. Connect the solar cell modul to the solar charge controller terminal together with the measuring instrument voltmeter and amperemeter to measure the electricity and voltage output from the solar cell.
6. Set the batteries in series and connect the terminals of the solar charge controller together with the measuring instrument amperemeter and voltmeter to measure the electricity and voltage of charge/discharge battery.
7. Connect the smart relay to the load terminal of solar charge controller
8. Install and connect the lower level rod of water level controller to 24VDC positive source
9. Connect the other two water level controller rods to the smart relay input terminal
10. Install the pump stand support

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11. Connect the pump to the output terminal of the smart relay according to Figure 3.16 together with amperemeter and voltmeter to measure the electricity current and voltage
12. Install the pump on the pump stand support
13. Install the required pipe
14. Clean up the cable installation
15. Turn on the MCB PLC and connect the USB data from the computer/PC to PLC.
16. Transfer program to PLC

II. Result and Discussion

2.1 Testing

Testing process is one of the procedures to examine the solar panel to drive the pump with water level control sensor and measure the solar panel power, pump power and pump working time for each water level. The water level was simulated at 1 cm and 2 cm to get panel and pump power.

2.1.1. List of Equipment

1. Solar cell installation as automatic pump driver with water level control sensor
2. Solarimeter
3. Stopwatch
4. Stationary

2.1.2. Measuring Parameters

1. Light intensity
2. Current and voltage generated by solar cells
3. Current and voltage charge/discharge battery
4. Load current and voltage
5. Filling/discharging water period in the fish pond

2.1.3. Operation Procedures

1. Set up the solar cell installation system with its automatic system
2. Ensure the condition of measuring instrument to be used in normal condition
3. Set the water level control sensor in condition requiring 1 cm of water
4. Press the switch ON to activate the load
5. Record the 5 parameters that have been determined periodically 10 minutes, until the load is automatically OFF.
6. Set the water level control sensor in condition excess 1 cm water condition
7. Press the switch ON to activate the load
8. Record the 5 parameters that have been determined periodically 10 minutes, until the load is automatically OFF
9. Set the water level control sensor in condition requiring 2 cm of water
10. Press the switch ON to activate the load
11. Record the 5 parameters that have been determined periodically 10 minutes, until the load is automatically OFF
12. Set the water level control sensor in condition excess 2 cm water condition
13. Press the switch ON to activate the load
14. Record the 5 parameters that have been determined periodically 10 minutes, until the load is automatically OFF

2.2. Result and Analysis

The solar power generation system as a source of electricity in fish farming ponds is used as an automatic pump driver with a water level control sensor. The tool was tested on 7, 10, 14 and 15 August 2019 with changes in water level of 1 cm and 2 cm so that the following data were obtained.

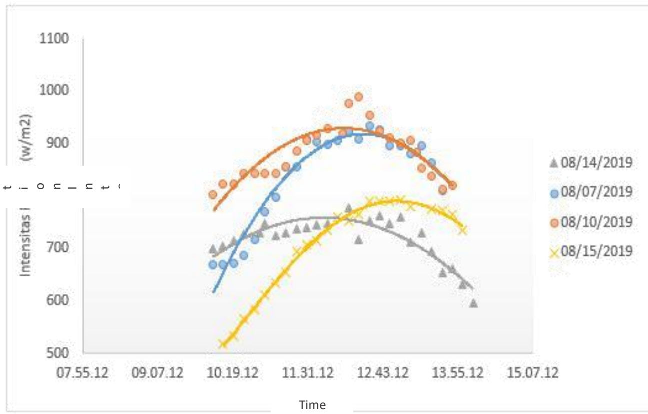

Figure 2.1 Time dependent graph of light radiation intensity

Testing of solar panels in generating electricity was carried on 8,10,14 and 15 August 2019 resulting in a time dependent graph of solar radiation intensity as shown in Figure 4.1. Based on this 4 times of testing the solar radiation intensity, as time went by, the value of the intensity of solar radiation is increasing up to a certain value and then decreasing. In the test on August 7 2019, the value of the solar radiation intensity at 10.00 WIB was 670 m2, the greater the afternoon the solar radiation intensity increased to a maximum at 12.30 WIB of 934 m2, then decreased to 14.48 WIB by 792 m2. In the test on August 10, 2019, the value of the solar radiation intensity at 10.00 WIB was 803 W/m2, the greater the afternoon the solar

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radiation intensity was getting higher up to a maximum at 12.20 WIB of 989 m2, then decreased to 14.51 WIT of 806 m2. In the test on August 14, 2019, the value of the solar radiation intensity at 10.00 WIB was 699 m2, increased up to 12.00 WIB by 763 m2, then decreased to 14.11 WIB by 586 W/m2. In the test on August 15 2019, the value of the solar radiation intensity at 10.00 WIB was 517 m2, increased to 13.00 WIB by 792 m2, then decreased to 14.04 WIB by 745 m2.

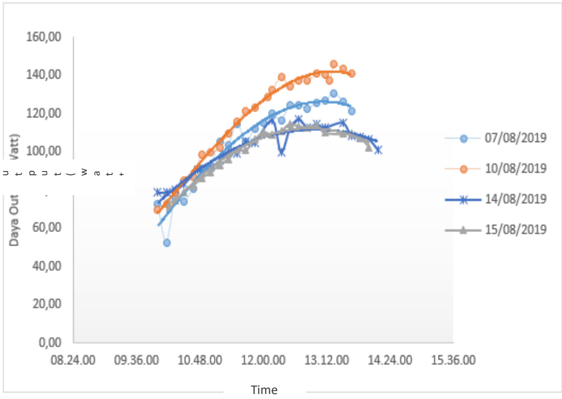

Figure 2.2 Time dependent graph of solar panel output

Tests carried out on 7, 10, 14 and 15 August 2019 resulted in a graph of changes in the output power of solar panels and pumps against changes in time as shown in Figure 4.8. The output power of the solar panels on August 7, 2019 at 10.00 WIB was 72.93 Watt, then increased to a maximum value at 13.20 WIB of 130.38 Watt, then decreased until the test at 14.48 WIB was 121.31 Watt. Tests on August 10, 14, and 15 had the same characteristics as those on August 7, 2019 where the power from the beginning of the test continued to increase, reaching the maximum point of output power, then decreased until the end of the test.

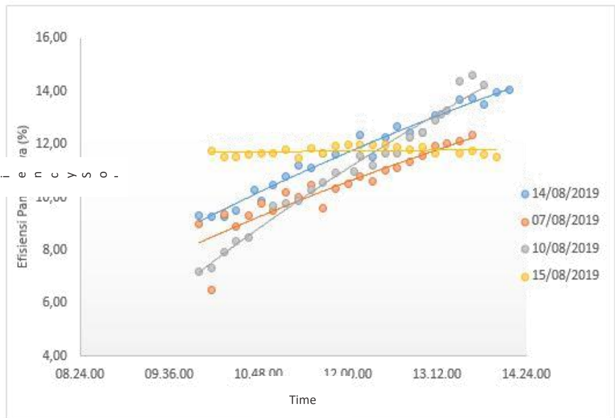

Figure 2.3 Time dependent graph of solar panel efficiency

The solar panel generation test which was carried out on 7, 10, 14 and 15 August 2019 shown in Figure 4.9 as a time dependent graph of solar panel efficiency. In the test on August 7, 2019, the results were obtained where the efficiency increased from 9% to 12.7%. In the test on August 10, 2019, the results showed that the efficiency was increasing from 7.19% to 14.6. In the test on August 14, 2019, the results were obtained where the efficiency increased from 9.03% to 14.04%. In the test on August 15, 2019, the efficiency of solar panels was relatively constant in the range of 11% to 12%, although there was a slight increase or decrease. Changes in the efficiency of solar panels can be caused by several factors, one of them is the position of the sun against the solar panel.

III. CONCLUSION

Based on the results of data collection and analysis that has been carried out, the following conclusions were obtained.

a. Solar panels that are installed as electricity generators produce different power according to weather conditions and sunlight that hits the solar panels. The largest power produced by solar panels was obtained on August 10, 2019 at 13.30 WIB with a voltage of 28.7 Volts and a current of 5.08 Ampere so that the resulting power was 145.80 Watts. The smallest power produced by solar panels was obtained on August 10, 2019 at 10.00 WIB with a voltage of 25.4 Volts and a current of 2.75 Ampere so that the power generated was 69.82 Watts.
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b. The efficiency produced by solar panels under conditions of an average load of 11.20% with the smallest efficiency obtained on August 10, 2019 at 10.00 WIB, which was 7.29% and the largest efficiency was obtained on August 10, 2019 at 13.40 WIB, which was 14.60%.

c. Pump ON and OFF according to the condition of the water level in the pond. The average discharge produced by pump 1 is 0.662 L/S, and the average discharge produced by pump 2 is 0.658 L/S.

The highest efficiency of the pump produced by pump 1 which was obtained on August 10, 2019 was 11.03%, and the smallest efficiency of the pump was produced by pump 2 which was obtained on August 14, 2019 of 5.26%.

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