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Solar Power Plant Optimization using Automatic Transfer Switch (ATS) and Low Voltage Disconnect (LVD)

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ABSTRACT

This automatic system model uses a Solar Charge Controller (SCC) as a battery charging stabilizer, an Automatic Transfer Switch (ATS) to transfer resources automatically. This study uses priority solar panels equipped with Low Voltage Disconnect (LVD) protection as battery safety. This study uses a 450WP Solar Panel, SCC MPPT 100A, 12V/100Ah Battery, and a 3000 Watt Modified Sine Wave Inverter, Miniature Circuit Breaker, Contactor, Relay Switch, Time Delay Relay and Indicator. This research method has several stages, namely literature study, solar panel system design, system testing, and validation. The ATS Panel testing stages include Low Voltage Disconnect Testing, Auto Cut Charging Testing, and Cycle Use Testing with Load. The results of the switching process test between the PLTS source and the grid with ATS control can run automatically in Grid Priority Mode, namely PLTS as a backup, or Solar Power Plant Priority Mode where the grid source is used as a power backup system. In the Battery Capacity Optimization System, Low Voltage Disconnect (LVD) Protection can work well, namely it can disconnect the voltage from the inverter if the battery is in a low voltage state at a rating below 10.8 Volts, Auto Cut Charging Protection testing can charge the battery up to 13.8 Volts and Cycle Use, namely the process of this system can work to store energy while releasing energy to run the load. The results of this study can be used as a reference for selecting the most efficient PLTS system.

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1. INTRODUCTION

The government has issued an appeal on renewable energy to encourage the use of environmentally friendly and sustainable energy sources, encourage research and development of new technologies in the field of renewable energy to increase efficiency and reduce production costs. This has encouraged the proposer to examine the efficiency of the Solar Power Plant (PLTS) system model from several automatic system models[1],[2]. There has been a lot of research on solar panel efficiency including dual axis solar panel tracking[3],[4], PID controllers[5], artificial intelligence[6], partial shading[7], and and other optimizations.. The automatic system model uses a Solar Charge Controller (SCC) to turn off the solar panel system at the minimum battery point so that the battery is safe and durable and an Automatic Transfer Switch (ATS) to automatically transfer the electricity network from Grid or solar panels[8],[9]. In this study, the system models will be compared; Solar Panel Priority (Automatic grid electricity is used if the solar panel is insufficient), grid Priority (Automatic Solar Panel is used if Grid electricity goes out), Timer system (Operation based on an automatic timer that determines what time to use solar panels and what time to use grid electricity), Hybrid system (Solar Panel priority with 2 cut out battery usage (minimum and maximum battery)[10],[11]. The results of this study can be used as a reference for the best choice of the most efficient PLTS system.

The problem with Grid priority is that Using Grid electricity as a priority is less suitable when there is a lot of sunlight during the day. While on Solar Panel priority: Using Solar Panel as a priority, less suitable at night. If it is the rainy season or often cloudy, the energy generated by the solar panel will not be sufficient. So using more Grid electricity and charging the battery which will cause energy waste (Grid supplies energy to the load plus battery charging). If it rains or is cloudy for days and the electricity goes out, there will be a lack of stored energy and it will go out.

System operating hours planning is required, for example at 07.00 - 17.00 WIB using Solar Panel and 17.00 - 07.00 WIB using Grid. SCC is required, to stabilize charging and switch the battery with a specified limit (for example 20% - 50%). A minimum limit of 20% is given so that the battery is not completely discharged (causing battery damage) and a limit of 50% so that there is remaining battery for backup electricity if Grid goes out. ATS is required to switch to choose solar panels or grid automatically.

A simple image of the Hybrid PLTS System can be seen in Figure 1:

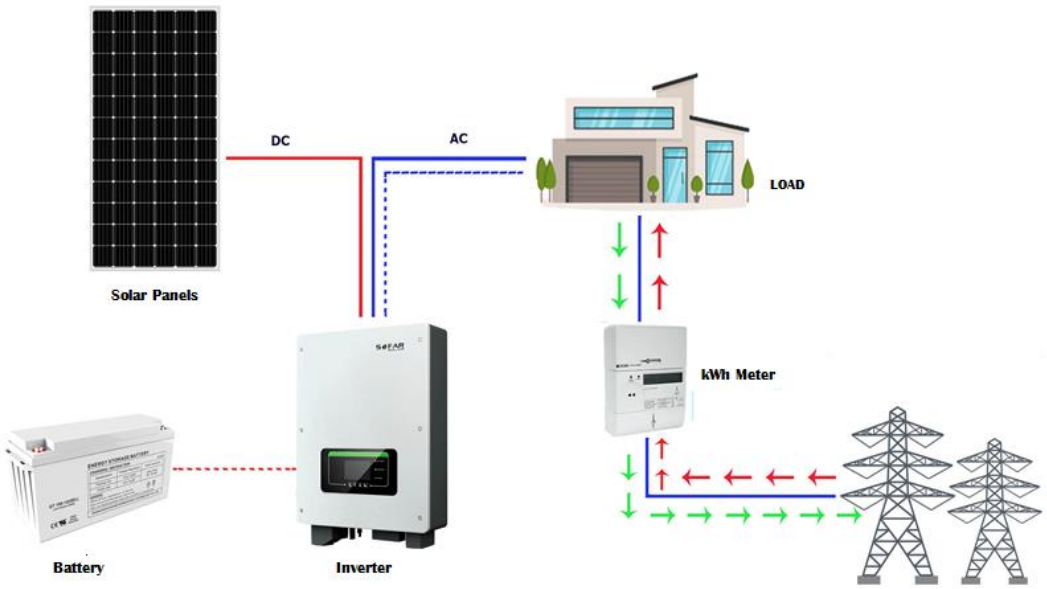

Figure 1. System PLTS Hybrid

Solar Charge Controller (SCC):

SCC is a device that regulates the flow of electricity from the solar panel to the battery. When the solar panel produces electricity, the SCC controls the flow of power and ensures that the battery is not overcharged or undercharged. SCC can also have other functions, such as protecting the battery from overcurrent, overvoltage, and other dangerous conditions[12][13].

Automatic Transfer Switch (ATS):

An ATS is a device that allows switching between different power sources automatically. In a solar panel system with energy storage batteries, an ATS can be used to switch between the power source from the solar panels and the battery, or between the battery and the grid power source (if available). When the solar panels are producing enough power, the ATS can switch the load directly to the solar panels or the battery for use[8][14].

2. METHOD

Research Stages The research flow diagram can be seen in Figure 2.

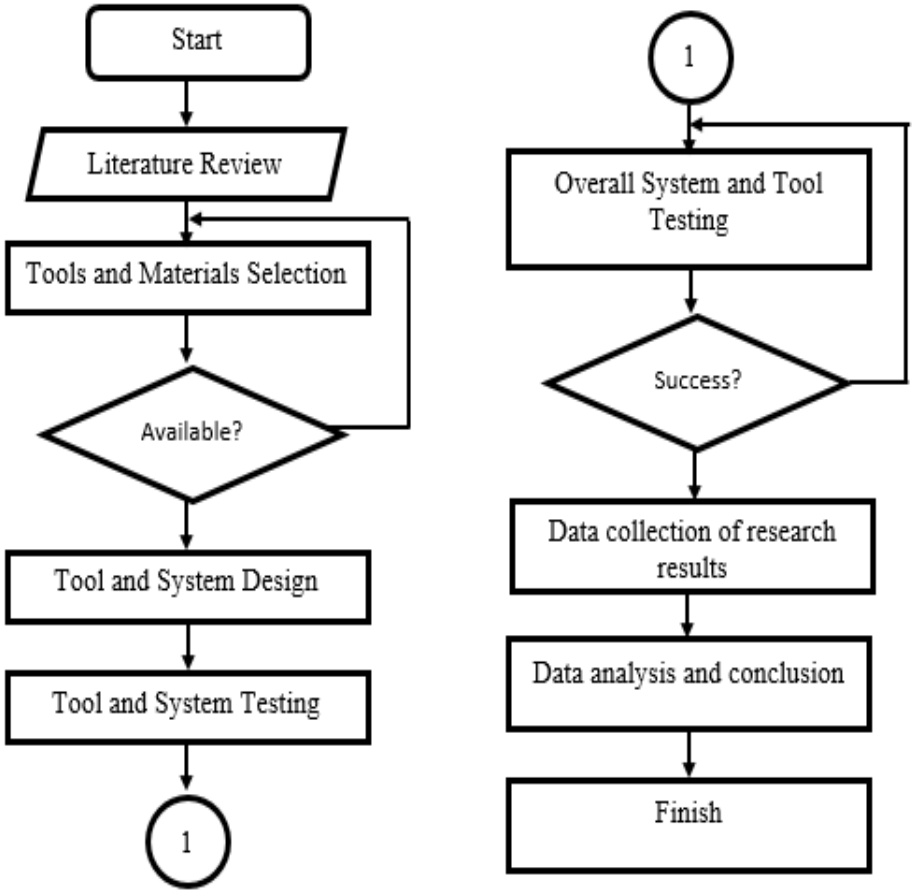

Figure 2. Research flowchart

Process Designing a solar panel system with several system models: System without SCC and without ATS, System with SCC without ATS, System with ATS without SCC, Hybrid system of SCC and ATS

3. RESULTS AND DISCUSSION

3.1. Determination of Electrical Energy

This planning will contain the determination of electrical energy that will be supplied to the load and the calculation of energy for 1 day. The determination of electrical energy to be supplied aims to determine the amount of electrical power needed according to the amount of load that will be installed for the loading experiment of the panel control system circuit. In this study, the load is planned for testing the equipment in the form of a 9 Watt Aquarium LED (Light Emitting Diode) Lamp and an 8 Watt Aquarium Filter Pump. The use of the load in Table 1. Power Requirements, because some people with aquascape hobbies must have standby electrical power to turn on the filter pump and lights to maintain pet fish if there is a power outage from PLN[15].

3.2. ATS Control Panel Assembly

The process of making the Automatic Transfer Switch control panel is done first with the design planning of the parts, so that the distance between the parts can be seen to be perfectly neat and perhaps the component parts are grooved according to the way they work and do not touch, useful to prevent short circuits that can cause components to be damaged. This arrangement includes: making wiring diagrams, designing control panel boxes and placing components in the control panel box[16].

Figure 1 is a picture that will be installed in the electrical panel assembly. This aims to make it easier for the author to assemble the control panel, so that the author gets an idea of the power flow and how the control panel components work properly, properly and correctly and of course to avoid short circuits. The calculation above shows that the number of loads to be used is 2 units, where the total load to be used is 17 W with energy usage for 24 hours of 264 Wh every day. It will also be useful to calculate how much energy is

expected each day to supply electrical energy to the load for 1 day with the aim of producing a total power for 1 day of 264 Wh. In the process of compiling a plts system, the needs of solar panels must be in accordance with their intended use where the size and configuration must be adjusted to the load to be used and the supporting tools to be used.

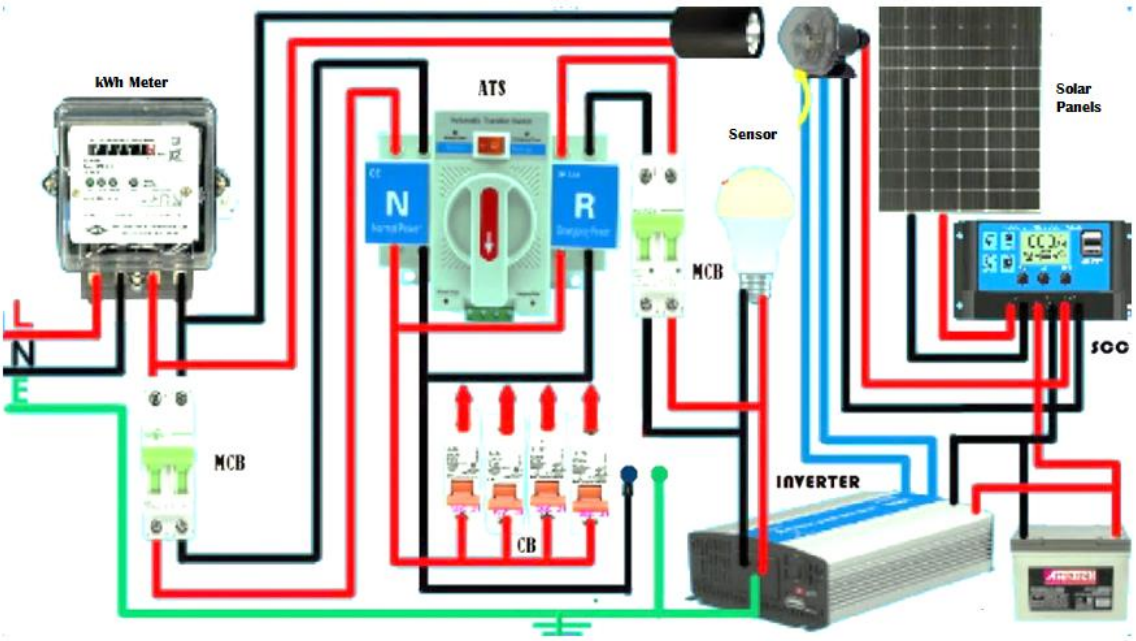

Figure 3. Wiring Control Panel with SCC and ATS

The installation of components is carried out according to the wiring diagram that has been made. After the tools and materials are complete, the next step is to apply the arrangement of components neatly such as the placement of duct cables, MCB rails, indicators on the panel door and terminal blocks.

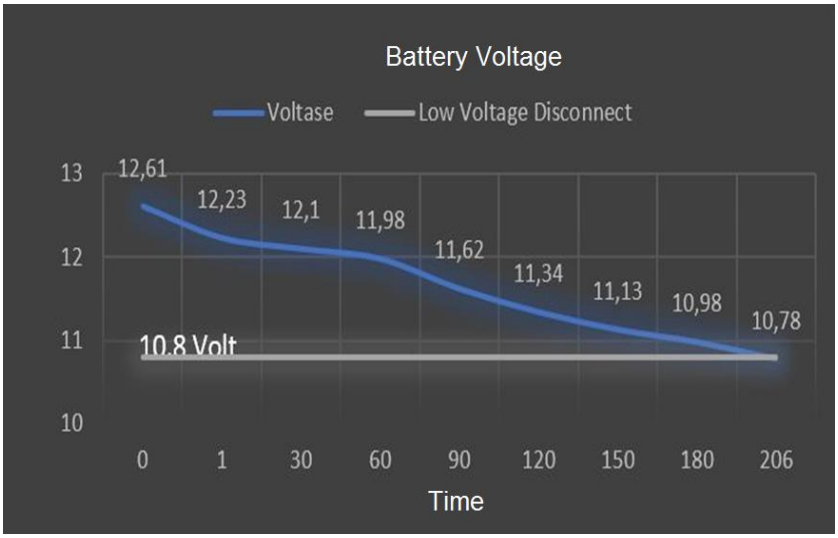

Figure 4. Battery voltage graph on ATS Control

3.3. ATS Panel Testing

After the assembly stage of all the tool components into one, testing is carried out to determine whether the performance of the ATS is in accordance with the design that has been made with the existing table or not, then the results of the tests that have been carried out with solar panels as the main source of supply are obtained..

3.4. Low Voltage Disconnect Testing

The Low Voltage Disconnect Protection test produces the following graphic image: From the experiment above, it is known that a battery at a voltage of 12.61 V to 10.80 Volts requires 206 minutes to turn on a load of 67 Watts and the LVD as a trigger can disconnect the inverter switch when entering the battery with a voltage of 10.7 Volts.

3.5. Auto Cut Charging Testing

Voltage and Current from solar panels are indicated to fluctuate indicating that the weather greatly affects charging. From a battery voltage of 12.24 - 13.80 Volts, it takes ± 10 hours to enter Standby Use or Floating Use.

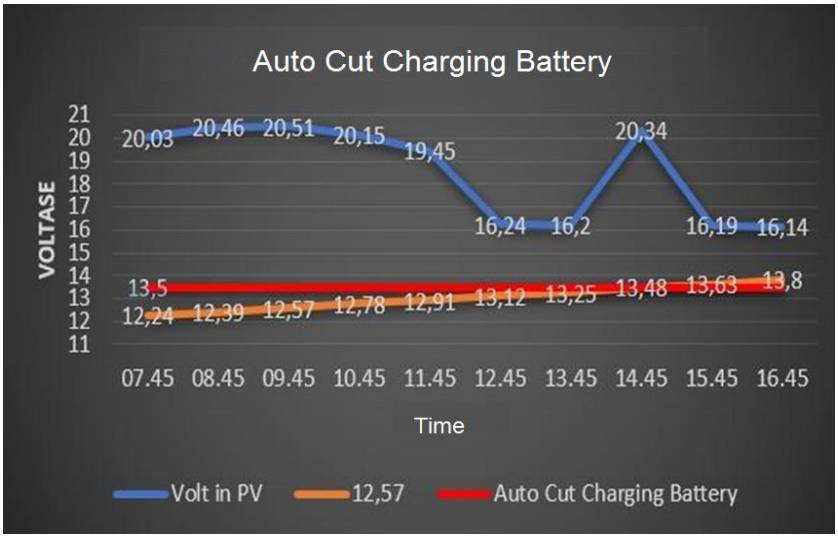

Figure 5. Auto Cut Charging Battery Testing

3.6. Cycle Use Testing with Load

Cycle Use testing on a battery with a load produces figure 2:

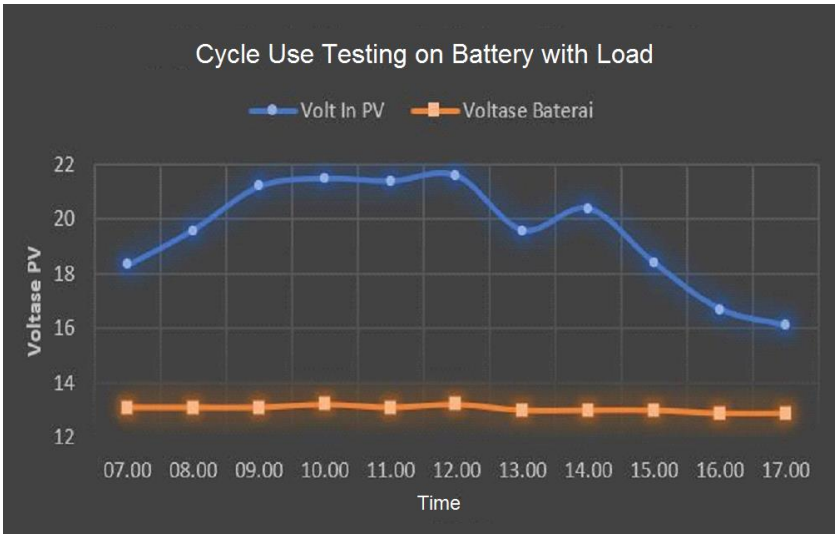

Figure 6. Cycle Use Testing with Load

From the results of the table data and experimental graphs above, it can be seen that the charging and discharging systems can run simultaneously.

4. CONCLUSION

From the previous discussion, it can be concluded that in this design the main components used for testing are 450 WP Solar Panel, 100A SCC, 12V/100 Ah Battery, and 3000 Watt Modified Sine Wave Inverter, Miniature Circuit Breaker, Contactor, Relay Switch, Time Delay Relay and Indicators. The results of the switching process test between the PLTS source and PLN with ATS control can run automatically in PLN Priority Mode, meaning PLTS as a backup, or PLTS Priority Mode where the PLN source is used as a power backup system. In the Battery Capacity Optimization System, LVD Protection can work well, namely it can cut off the voltage from the inverter if the battery is in a low voltage state at a rating below 10.8 Volts, Auto Cut Charging Protection testing can charge the battery up to 13.8 Volts and Cycle Use, namely the process of this system can work to store energy while releasing energy to run the load.

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