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Alternative and Environmentally Friendly Solar Power Plant (PLTS) with a Capacity of 500 Watts (Case Study: on Appliances and Household Appliances)

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ABSTRACT

Solar Power Plants (PLTS) are electrical energy that comes from exposure to sunlight and then converts into electrical energy that can be used for electricity in general. Solar Power Plants (PLTS) can be used as alternative energy to reduce the cost of electricity bills. This solar power plant is designed and built at the Bogor Academy of Technology which is very environmentally friendly because it does not emit pollution in the area. This study aims to determine the performance of off-grid solar power plants and at least can help reduce electricity bills at the Bogor Academy of Technology. This solar power plant can help students in the campus environment if they need to charge smartphones or laptops in the parking area can use it. This solar power plant can also be used as a source for other students' practices.
Keywords*: Solar Power Plant, Off Grid System, Environmentally Friendly, Alternative Energy.*

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Introduction

Indonesia is a country located on the equator which is always exposed to sunlight every year. The energy emitted by sunlight has many benefits for life on earth such as plants for photosynthesis. Sunlight can also be used for other needs, such as Solar Power Plants (PLTS).

Life in today's era is highly dependent on electrical energy. One of them is on the campus of the Bogor Academy of Technology. The use of electrical energy for operations used on campus is very large if you look at the electricity bill every month. The tariff electricity price from PLN reaches Rp. 1352 – 1699/kwh.

Solar panels are devices that can convert sunlight energy into electrical energy with Photovoltaic technology. Photovoltaic is a technology that converts solar energy into electrical energy directly. Solar panels are a collection of solar cells that are arranged in such a way that they effectively absorb sunlight.

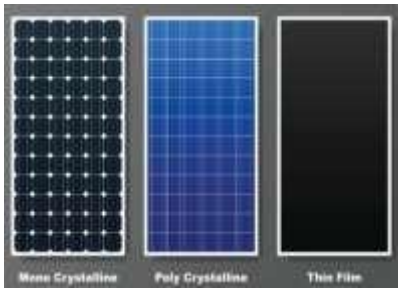

Figure 1. Solar Panel Type

From the image above, it can be seen that the types of solar panels on the market start from mono crystalline, poly crystalline and thin film types. Judging from the shape that distinguishes the patterns and structures that form solar panels.

Factors that affect the power produced by solar panels are:

1. Sunlight intensity means that the higher the intensity of sunlight, the more energy is absorbed by the solar panel and the higher the power produced.
2. Temperature, meaning that too high a temperature can affect the work of the solar panel and lower the power produced.
3. The size of the solar panel, meaning that the larger the solar panel used, the more energy is absorbed and the more power is produced.
4. The tilt orientation of the solar panel, meaning that the solar panel is directed directly towards the sun and at the right angle can optimize the energy absorbed by the solar panel.

Research Method

This study uses a quantitative research method to obtain accurate and valid values regarding the design of solar PV, which is measured with the measuring tools in this study, namely solar panel voltage, solar panel current, battery voltage, inverter voltage.

1. Solar PV Design Procedure

Solar PV is a new renewable energy source. It is called new renewable energy, because solar power is a power plant that utilizes energy from sunlight to produce electrical energy. This solar PV system is considered environmentally friendly and emission-free, and is a Green Energy solution for the Bogor Academy of Technology campus which aims to reduce electricity bills.

The design of this solar power plant has a capacity of 500 watts and is equipped with a microcontroller-based monitoring system. The solar power plant will be placed in the parking area of the Bogor Academy of Technology campus and the initial plan of this solar power plant is as an alternative source of electricity to help ease electricity bills. The design scheme of this solar power plant can be seen in Figure 2. below:

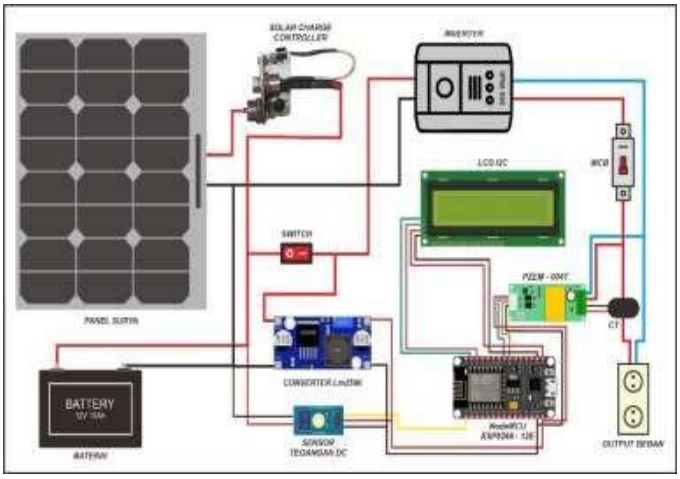

Figure 2. Solar Power Plant Network

It can be explained that the solar PV system will be built with an off grid system, which means that it will not be affected by PLN's electricity network. The way the solar power plant works is:

a. The solar panel will absorb the sun's light energy and convert it into DC electrical energy.
b. SCR as an Auto Switch switch for battery charging, SCR will regulate the electric current generated by the solar panel that enters the battery as a power store.
c. If the voltage of the solar panel is 0 volts, the SCR will be the protection of the reverse voltage to the solar panel.
d. The inverter will convert DC electricity from the battery into AC electricity which can later be used for electrical equipment with a capacity of 500 watts.

2. Solar PV Testing Analysis

Testing will be carried out after all solar PV components are installed. Testing is carried out directly using Lux Meter and Multimeter. The tests carried out include measuring the voltage generated by solar panels based on light intensity, voltage controlled by SCC to charge the battery, measuring the voltage generated by the inverter for load voltage needs, and testing the monitoring system. Testing is carried out by measuring and analyzing the measurement data. Measurements on the solar PV system are carried out every hour during the day at 10:00 WIB - 14:00 WIB to get optimal measurement results, because at that hour the solar system works optimally due to the Sun peak Hour. The following in Figure 3 is a block of diagrams that have been designed in the research conducted.

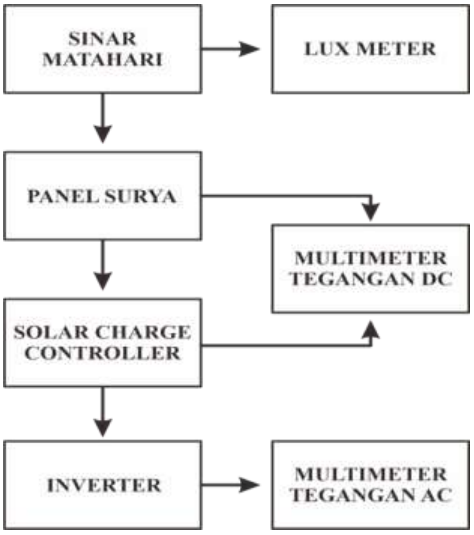

Figure 3. Research Block Diagram

Result and Discussion

Procedure for Making 500 Watt Capacity Solar Power Plant

1. 30 Wp Solar Panel Installation

The 30 wp solar panel is installed on the parking gate of the basemant campus of the Bogor Academy of Technology using an elbow iron mount that is attached to the concrete using dynabolt. The solar panels are placed 300 meters from the concrete surface aiming to get maximum results.

2. SCC, Inverter and Battery Assembly

The assembly of the SCC, Inverter and Battery follows the wiring diagram that has been planned at the beginning. Figure 4 shows where the positions of the three components are combined with the monitoring system.

Figure 4. 500 Watt Solar Power Plant Network

From the picture above, it can be explained that the output from the solar panel goes to the SCR and the SCR adjusts so that the electricity that goes to the battery is not too large. From DC electric batteries are flowed to the Inverter then converted into AC electricity and are ready to be used for 1-phase AC voltage loads with loads below 500 watts.

500 watt capacity solar PV testing

The 500-watt capacity solar power plant was designed and combined with a microcontroller-based monitoring system. Solar PV that has been completed must pass the equipment test, namely by component testing and load testing, as for the test to take data from the installed system. Testing

This tool uses tools such as fans, incandescent lamps, drilling machines, laptops, soldering. The testing of this solar power plant is as follows:

A. Solar PV Component Testing

1. Light Intensity Measurement

Figure 5. Light Intensity Measurement

In figure 5. above shows the results of measuring light intensity using a luxmeter. The measurement results above show the number 14552, which means that the intensity of the light produced is 14552 lux.

2. Solar Panel Vertical Measurement

Figure 6. Solar Panel Measurement

In Figure 6. Above shows the results of measuring the voltage of solar panels with a value of 18.6, which means that the voltage produced by solar panels is 18.6 Volts DC.

3. SCC Output Voltage and Current Measurement (SCR)

Figure 7. SCC Measurement

In Figure 7 above, the results of the voltage measurement with a value of 13.7V and current with a value of 0.15A are shown, which means that the SCC produces a voltage of 13.7 Volts DC with a current of 0.15 Amperes when charging the battery.

4. Inverter Voltage Measurement

Figure 8. Inverter Measurement

In Figure 8. The above shows the results of voltage measurements with a value of 237V, which means that the inverter produces a voltage of 237 Volts AC in accordance with the average standard voltage needs of electrical equipment in Indonesia.

B. Solar PV Load Testing

1. Load Testing with a drilling machine

Figure 9. Drill Load Testing

Figure 10. Applied power

2. Load Testing with a Fan

Figure 11. Fan Load Testing

Figure 12. Applied power Fan

3. Load Testing with Glow Lamps

Figure 13. Lamp load testing

Figure 14. Used power Lamp

4. Load Testing with Laptop Chargers

Figure 15. Laptop load testing

Figure 16. Laptop used power

5. Load Testing by Solder

Figure 17. Solder Load Testing

Figure 18. Applied power Solder

Table 1. Testing of PV equipment with Load

No.	Burden	Duration (minutes)	Inverter Voltage (VAC)	Arus Output (A)	Daya Output (Watt)	Battery Voltage (VDC)
1.	Bor	10	206	0.9	171	11
2.	Kipas	15	222	0.2	47	12
3.	Lamp	20	228	0.1	9	12
4.	Laptop	30	216	0.2	40	12
5.	Solder	60	220	0.3	46	11

Solar Power Plant Test Results

From the testing of the 500 Watt capacity solar power plant equipment carried out as a whole, the following data was obtained:

a. 30 Wp Solar Panel Testing

Table 2. Solar Panel Testing Data

Jam	Day					
	Monday, 11-09-23		Tuesday, 12-09-23		Wednesday, 13-09-23	
	VDC	A	VDC	A	VDC	A
10.00	19.63	0.17	17.10	0.15	19.47	0.25
11.00	19.73	0.20	17.68	0.19	19.33	0.31
12.00	19.83	0.27	18.53	0.22	19.24	0.19

Figure 19. Solar Panel Voltage Chart

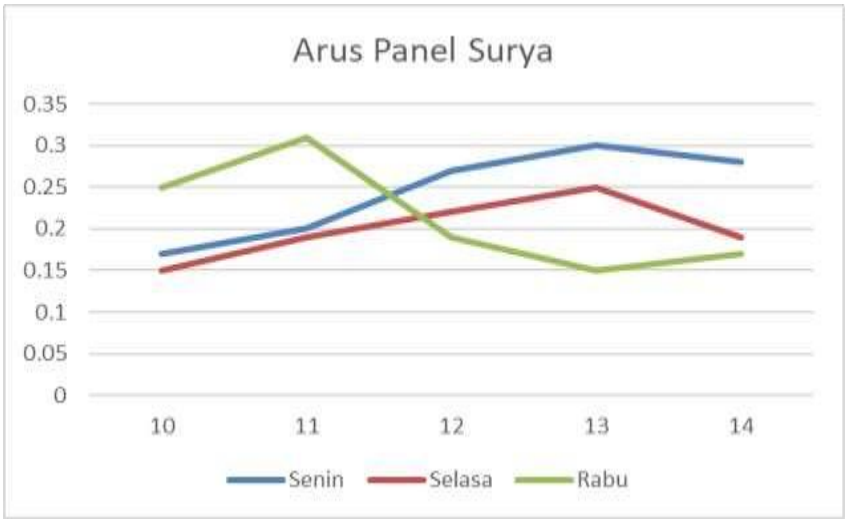

Figure 20. Solar Panel Current Graph

From the data above, the voltage generated by solar panels is relatively stable. There are several factors that affect the voltage produced, including weather conditions at the time of testing.

To fulfill a 35 Ah 12 V battery charger with a 30 Wp Solar Panel takes quite a long time. Battery fulfillment time can be calculated by the equation: 35 Ah 12 V battery 30 Wp Solar Panel

Solar panel efficiency 15% of Solar Panel capacity then,

P = 35 x 12 = 420 wh

H = P/(Wp - Efficiency)

= 420/(30 -15%)

= 420/(30-4.5)

= 420/25.5

= 16.47 jam

So it takes about 16.47 hours to charge the battery from empty to full and if rounded down to 16 hours.

b. Testing of 500 watt capacity solar power plants with load

Table 3. Load Testing Data

No.	Burden	Duration (minutes)	Inverter Voltage (VAC)	Arus Output (A)	Daya Output (Watt)	Battery Voltage (VDC)
1.	Bor	10	206	0.9	171	11
2.	Kipas	15	222	0.2	47	12
3.	Lamp	20	228	0.1	9	12
4.	Laptop	30	216	0.2	40	12
5.	Solder	60	220	0.3	46	11

From the data above, it can be seen that the test of a 500-watt capacity solar power plant with a load of 313 watts for 135 minutes or equivalent to 2.15 hours can be successfully fulfilled by the solar power plant. The inverter voltage drops when the installed load is large. From the table above, it can be seen that the voltage varies according to the trend of the power output by the inverter and is affected by the starting current of the load. The amount of power and the length of the duration of the load can affect the voltage of the inverter and the battery. Different battery voltages are also affected by the effective charging time of the battery.

Conclusion

From the main problems asked at the beginning of the planning process for the design and construction of this environmentally friendly 500-watt solar power plant, the author can draw the following conclusions:

1. A 500-watt solar PV can last for 2.15 hours with a load of 313 watts.
2. 500 watts of solar power plants drop voltage and overload if given a load above 350 watts.
3. Manual measurements with displays have a difference in value because the measuring instrument for which there is no standard is calibrated.
4. This solar power plant is very helpful for students who need a source of electrical energy.
5. SCC cannot charge if the electricity generated by the solar panel is below the required voltage of the battery.

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