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Design and Construction of Electric Socket-Based Photovoltaic

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Abstract

Human needs for energy are increasing but the level of fossil energy is getting depleted, making energy sources dwindling. alternative energy or renewable energy is needed. Indonesia has a lot of solar energy potential as much as 4.8 KWh/m2, this amount is equal to 112,000 GWp, but only about 10 MWp has been used. To maximize the potential of solar power, researchers carry out designs aimed at maximizing the potential of solar power, especially providing energy at shelters so that they have an independent energy supply and are not dependent on energy sourced from conventional energy. From the results of observations related to the electrical design of the socket at the bus stop with a photovoltaic basis, it was found that the total load affects the use of solar power plant components, so it is necessary to determine the load first before the design process.

Keywords

Electric Socket, Photovoltaic, Renewable Energy

INTRODUCTION

Energy needs are increasing along with the increasing human population. This condition has implications for the reduction of the main source of energy reserves, namely fossils. Fossils are classified as non-renewable energy, meaning that the amount will always be depleted and even close to running out. Therefore, to remain sufficient for energy, renewable alternative energy is needed, namely energy that will not run out of time. To find sources of renewable energy, it is necessary to have a system that has large energy power and does not have a bad impact on the environment [1], [2]. The system that is being developed at this time is a solar power plant that emits heat and light during the day. The amount of energy that Indonesia has is very abundant, which is in the range of 4.8 KWh/m2 this figure is equal to 112,000 GWp, but only about 10 MWp is used. Recently, the Indonesian government has made a road map for the use of solar energy with the target of achieving a solar power plant installed until the year 2025 is 0.87 GW or around 50 MWp/year. This amount is a big effort in developing the potential of solar energy that will be used in the future. Therefore, efforts to maximize the power of solar power must be managed very well to have an effective and efficient impact in meeting energy needs.

Based on the facts mentioned above, the researchers were then interested in conducting research oriented towards maximizing the potential of solar energy, especially providing this energy as an alternative energy source at the bus stop. The use of solar energy can be quite useful in minimizing the budget for using electricity costs every day, especially at bus stops. Therefore, to utilize solar energy, we need a design system with a photovoltaic. The advantage of this tool is that it uses a photovoltaic with Electric Sockets so that it can minimize the use taken from conventional sources of electrical energy, and can be used to increase power including cellphones and other power for passengers who are waiting for transportation to arrive and the bus stop has its power supply [3], [4]. The usefulness of tool that will be designed by the researcher is useful for providing solutions to the community or industry users of direct current power plants, and as backup electricity commonly used at bus stops, as well as for emergency power when the house's electricity goes out. Not only as a backup power provider, but an inverter is also very important as a future electricity provider that is used daily. In addition, this research has safe limitations, only focused on the technical design, not discussing the existence of investment, operational, maintenance, and replacement costs for Electric Socket components at photovoltaic-based shelters while designing Electric Sockets at photovoltaic-based shelters and the design is carried out only for photovoltaic-based shelters [5], [6].

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RELATED THEORY

The development of solar power plant in Indonesia

Photovoltaic (PV) mini-grid in Indonesia emerged in the 19th century, or more precisely in the 1987s, the ministry that studied the application of technology established a power plant by utilizing solar power as many as 80 power plants to illuminate the villages in Sukatani village, province West Java. The development of this solar power plant then received special attention from the president in 1991, at which time the president assisted in the form of solar power plants installed in 13,445 villages. This program was to continue to supply solar power plants conducted by the government until the end of 1990. Then at the beginning of the millennium, namely in the early 2000s, solar power plants installed by the government were increasing, this was marked by the widespread application of these power plants. In the community until 2007 as 40.000 installations of solar power plants were installed throughout the archipelago. This was confirmed by the ministry of energy and natural mineral resources at the time.

Solar Power Plants are increasingly in demand, this is because the distribution program for this power plant has dimensions and weights that are quite light, making it easy to distribute even to remote villages [6]–[8]. Besides that, solar power plant II is considered cheaper, and easy maintenance, and of course, its use is felt to be very maximal. So that in the 2010s solar power plants were developed and upgraded with various variations, from the solar power plant which is used to pump water, as a terminal for supplying battery flow, a plant as a vaccine cooler, to the main purpose of the solar power plant which is to provide lighting in small cities in Indonesia.

Main Components of a Solar Power Plant Solar

Solar Panel

A special tool to capture exposure to the intensity of sunlight to produce electrical energy because basically, solar light contains energy called photons. If the energy touches the tip of the solar panel, the electron energy contained in the solar panel then moves and creates an electric wave. Solar panels can undergo a displacement process caused by a material called a semiconductor and in it, there is an element of silicon. Silicone itself has two kinds of layers, namely the positive and negative layers [9].

Solar Charger Controller

Components are used to control the distribution of power to the load and battery. This component functions to automatically move the power source. If the solar power plant does not allow distribution to the load, it will automatically supply the battery. The Solar Charger Controller can capture the battery's capabilities.

Battery

Batteries function as storage of direct current electric energy. Without using a battery, the supply of electricity from the solar power plant to electronic equipment will stop when the sun goes down or if the sunlight is covered by thick clouds.

Inverter

This tool is a part used to convert one-way direct current into two-way alternating current. This change is necessary because the pressure generated by the solar panels is direct voltage, while the load on the greenhouse uses alternating current, so a component is needed that can change the current so that it can be used by existing equipment in the greenhouse [10], [11].

Electric Sockets

Electric sockets or electrical terminals are devices that function to connect electric currents with electrically-based tools. For the electrical-based device to be connected to an electrical terminal, it requires various other connecting devices such as cables, power plugs, and the like which will then be plugged into the electrical terminal (Electric Socket).

Photovoltaic

PV is a system that sends light rays from solar radiation which are then converted into electrical energy. Effect photovoltaic is defined as a condition that creates an electric current through the contact of two electrodes that are both associated with utilizing liquids and solids from under the energy of sunlight. Solar energy or light radiation consists of having a photon charge in it and having unequal energy levels, different photon energy levels usually affect the length of the current through the light spectrum. When photons rub against the surface of the PV cell, the photons will automatically be absorbed and refracted to reach the PV cell. Photons absorbed by PV cells will provoke electrical energy [5], [12], [13].

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PROCEDURE

Description of the System

The system is designed to utilize solar energy by using solar panel modules. The input from the direct current pump is direct current in the form of batteries, solar cells, batteries, or other voltages. The output of the dc pump is 12V electricity. Thus, it is useful for reducing electrical energy from Indonesia Power Company to replace it with solar heat.

Research Flowchart

In general, this research will be carried out like the research flowchart in Figure 1.

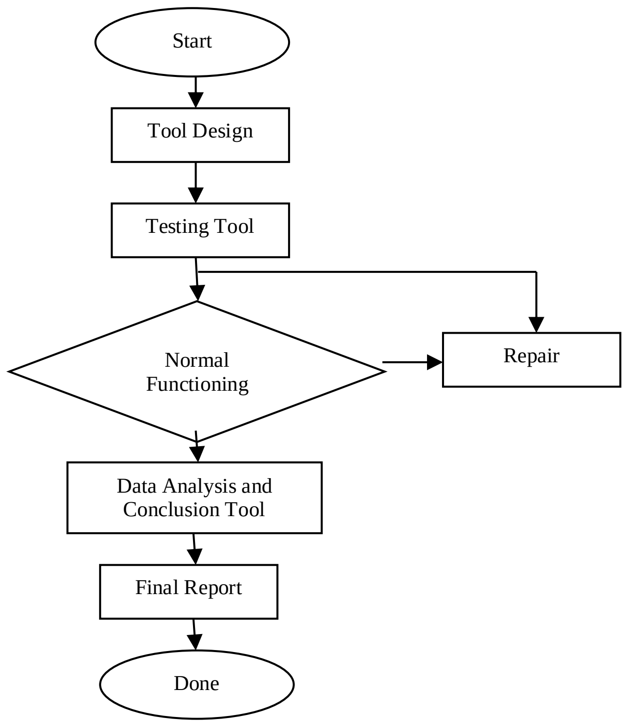

Figure 1. Processing flowchart for analyzing the problem

The diagram in the research flow in the picture above is a reference for researchers to carry out step-by-step research. This research was carried out by starting with the design of tools, after testing the tools whether they could function optimally or not. If it does not function properly, it will be repaired first by the researcher, and if it is ready to be used, it will continue to the analysis and conclusion stage. And the last is to make a final project report.

Electric Socket Flowchart

Previously shown in Figure 1, illustrates how the workflow and description of the electric socket-based shelters are photovoltaic with the design. In Figure 2 the voltage source comes from a solar panel that captures the heat of the sun with a polycrystalline panel type with a capacity of 50 Wp. The DC electric current that comes out of the panel will be stored in a battery 12V for the Valve Regulated Lead Acid with a capacity of 50 Ah. To regulate the electric current from the solar panel for charging the battery Solar Charge Controller (SCC) tool is used. SCC functions so that the battery does not experience overcharging. Charging voltage (Charge) 12-14.8 Volts (depending on battery specifications) to be fully charged. The electricity in the battery is current (DC) electricity, while the load on the electric socket-based photovoltaic for the bus stop requires current (AC) electricity, so it must change from DC electricity to AC using an inverter with a power capacity of 300 W with the pure sine wave. After being charged in the inverter through the formation of waves, the output is AC electricity with a voltage of 12V and a frequency of 30 Hz. Thus, electricity can be used to power a load or electric socket electrical equipment.

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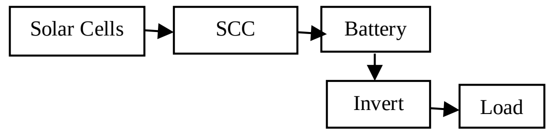

Figure 2. Flowchart electric sockets-based shelters photovoltaic

Battery Charging Flowchart

Flowchart of the battery recharge process starting from sunlight depicted in Figure 3, after that the solar panel receives radiation from the sun, the current is still unstable, and enters the solar charge controllers to be converted By stabilizing the current from the solar radiation, after the solar charge controller, the electrical energy goes directly to the battery to be stored.

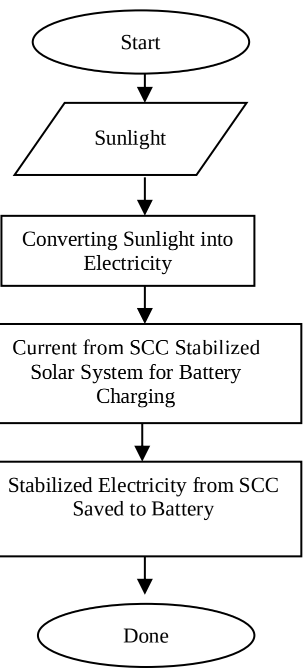

Figure 3. Research flow for the power plant system

Power Consumption Planning

In the design of an electric socket-based photovoltaic for a bus stop, there is an amount of power that must be determined in advance, both the power in each tool used and the power at the bus stop as component electric socket-based photovoltaics.

Solar Panel Power Planning

Determines the power of the solar module by finding the load power and the length of time the load is used on an electric socket-based photovoltaic, knowing the duration of solar radiation. Table I shows the various loads, load power, and duration of load used to determine the total energy in the load used in a day.

TABLE I
TOTAL ENERGY AT LOADS IN A DAY

AC Load			
Load	Power	Time (h)	Energy
iPhone Charger	10 W	2 hours	50 Wh
Laptop Charger	65 W	2 hours	130 Wh
Xiaomi Charger	18 W	1 hour	18 Wh
Total Energy AC Load = 168 Wh			

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Data Collection Method

The data collection method was carried out to determine the performance of the tool, from each part or as a whole to obtain research data. The purpose of this study was to determine the performance of small-scale solar panels, batteries, and electric sockets. Researchers need 7 days from 8 am to 10 pm to collect data by measuring voltage and current at the input and output of solar panels, batteries, and Electric Sockets. The measurements used a special measuring instrument called the Avometer, to measure the load current, the current entering the battery, and the current entering the load.

RESULT

For data collection on inverter performance in small-scale PV mini-grid, this study uses an inverter with 300W power and a solar module with 50 Wp power. The use of a 50Wp Monocrystalline type solar module which will later be paired with an electric socket aims to know its performance in measuring the output of solar panel voltage as well as battery performance on charger iPhone, laptop, and Xiaomi. The study began on March 19, 2022, until March 25, 2022, with the testing time from 08.00 to 22.00, according to the load usage. Avometer setting when the probe will be used as an alternating current pressure gauge as given in Table II, Table III, and Table IV.

TABLE II
KENIKA 300W INVERTER SPECIFICATION

Type	Pure Sine Wave (PSW)
Brand	Kenika
Maximum Power	300 W
DC Input Voltage	12 V
AC Output Voltage	220 V
Output Frequency	50Hz
Waveform	Sinus Murni / Pure Sine Wave
Dimensions (cm)	26 x 13 x 5,5 cm

TABLE III
SOLAR MODULE SPECIFICATIONS 50WP

Watt Peak	50 Wp
Brand	Shinyoku Polycrystalline
Max Power Voltage	16.5 V
Optimum Operating Current (Imp)	3.34 A
Short Circuit Current (Isc)	4.23 A
Max Power	50Wp
Dimension	775 x 680 x 28 mm

TABLE IV
BATTERY SPECIFICATIONS

Type	Sealed Rechargeable Battery
Current at Pmax	2,1 A
Voltage at Pmax	17,8 V
Open Circuit Current	21,8V
Short Circuit Current	35 A
Nominal Operating Cell Temp.	±50ºC

The use of a 50Wp Monocrystalline type solar module which will later be paired with an electric socket aims to know its performance in measuring the output of solar panel voltage as well as battery performance on charger iPhone, laptop, and Xiaomi. The study began on March 19, 2022, until March 25, 2022, with the testing time from 08.00 to 22.00, according to the load usage. Avo-meter setting when the probe will be used as an AC pressure gauge. Moreover, the following are the results and analysis of the solar panel test on the battery and the use of the battery on the charger. From the observation, it was found that sunny and cloudy weather affect the voltage generated by solar panels. From 08.00 to 12.00 the weather is indicated as sunny, so that sunlight can drain the voltage on the battery to its maximum (continues to increase). However, entering 13.00 hours, the weather was

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cloudy and sunny again at 14.00, this resulted in a decrease in voltage but was not significant. Cloudy weather enters at 15.00 to 22.00, as a result, there is no light from the sun, but the battery can be used even if the weather is cloudy and not exposed to sunlight. To find out the comparison of solar panels and batteries in terms of the amount of voltage and current generated can be seen in Table V.

TABLE V
HOURLY SOLAR PLANT PERFORMANCES

Time (t)	Weather	Solar Panel		Battery	
		V	I	V	I
08.00	Sunny	12.12	2.88	12.44	3.22
09.00	Sunny	12.22	2.79	12.33	3.18
10.00	Sunny	12.38	2.70	12.57	3.30
11.00	Sunny	13.08	3.09	12.73	3.39
12.00	Cloudy	12.92	2.59	12.17	3.09
13.00	Cloudy	12.72	2.42	12.25	3.11
14.00	Cloudy	12.67	2.17	12.13	3.17
18.00	Cloudy	-	-	12.39	3.27
19.00	Cloudy	-	-	12.27	3.12
20.00	Cloudy	-	-	12.13	2.91
21.00	Cloudy	-	-	11.85	2.08
22.00	Cloudy	-	-	11.72	2.42

From the observation, it was found that sunny and cloudy weather affect the voltage generated by solar panels. From 08.00 to 12.00 the weather is indicated as sunny, so that sunlight can drain the voltage on the battery to its maximum (continues to increase). However, entering 13.00 hours, the weather was cloudy and sunny again at 14.00, this resulted in a decrease in voltage but was not significant. Cloudy weather enters at 15.00 to 22.00, as a result, there is no light from the sun, but the battery can be used even if the weather is cloudy and not exposed to sunlight.

TABLE VI
Hourly charging condition

Time (t)	Load	DC Input (Battery-Inverter)		Output AC (inverter-load)	
		V	I	V	I
08.00	HP charger 1	12,32	1,67	223	0,04
09.00	HP charger 2	12,57	2,18	224	0,04
10.00	HP charger 3	12,61	1,79	226	0,7
11.00	HP charger 4	12,41	2,22	226	0,8
12.00	HP charger 3	12,87	1,35	225	0,5
13.00	HP charger 3	12,72	1,40	225	0,4
14.00	HP charger 4	12,63	1,37	226	0,6

Through the acquisition of test data presented in table 4.4, at 08.00-11.00 maximum sunlight is obtained because the weather conditions show sunny, and at 12.00 the weather is cloudy but the battery can be used even though n does not receive the voltage and current obtained by the sun directly as presented in Table VI. To find out the comparison of solar panels and batteries in terms of the amount of voltage and current produced, see Figure 4.3 and Figure 4.4. Both images show that the battery excels in comparison between the two.

CONCLUSION

Currents are concluded that in determining the need for small-scale PV mini-grid components, you must first know the total load on the small-scale PV mini-grid. The load used is 1 Electric Socket DC with a power of 50 W which is on for 3 hours with a total power of 150 Wh of DC load type inverter is pure sine wive used because the total power of the DC load used is 150 Wh and the pure sine wife is suitable for sensitive loads such as motors because this type has the same pure sine wave shape as that produced by Indonesia Power Company. Researchers suggest for further research, when carrying out panel module activities, more detail is required so that the battery charging process is more leverage and takes into account the weight of the solar panel module. The selection of

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components in a small-scale PV mini-grid is carried out more selectively and more efficiently without reducing the level of security and safety in the sprayer. Data collection activities are carried out for at least 4 days to find out the data in more detail and make it easier to analyze.

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