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Portable Solar Photovoltaic Suitcase

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Abstract

This appliance is a micro-scale solar power plant intended for a temporary power source in areas affected by natural disasters in Indonesia that is portable, and is equipped with basic equipment such as a charger port and LED lights. The material used for the PV is aluminium with ceramic cooling which is designed in the form of a suitcase so that it is robust, water and fire resistant.

Keywords: Solar PV, Portable, Suitcase, Portable Suitcase, Micro Power Plant, Renewable Energy, Natural Disaster, Emergency Power Plant.

1. INTRODUCTION

Solar radiation is a radiant energy that comes from the nuclear thermo process that occurs in the sun. Solar radiation energy is a form of light and electromagnetic waves at the same time. The spectrum of solar radiation itself consists of two, namely short-wave rays and long-wave rays. Rays that include short waves are x rays, gamma rays, and ultra violet rays. While the long wave rays are infrared rays [1].

Huge amount of solar radiation can be used as electrical energy, one of which is by using a solar cell. Solar cell is a photovoltaic light sensor, which is a sensor that can convert light intensity into a change in voltage at the output. Photovoltaic is usually packaged in a unit called a module. The solar module consists of many solar arrays arranged in series or parallel [1,2].

In the process, the conversion of solar energy into electrical energy is influenced by several factors that affect how optimally the conversion of sunlight into electrical energy is [3,4], including:

1. Temperature

The performance of the solar cell is influenced by the high and low temperature. The higher the cell temperature, the lower the energy production. When solar radiation is at its strongest during the day, the cell can heat up to a temperature of 70° C. At high temperatures, solar cells are less efficient. As the heat of the solar cells increases, the voltage across each cell will fall so that, as the voltage decreases, the power will also decrease.

2. Solar Module Tilt Angle

The tilt angle has a big impact on the sun's rays on the surface of the solar module. Determination of the installation angle of the solar module is useful for correcting the direction of the solar module towards the equator (latitude = 0o)

In general, solar cells have a thickness of 0.3 mm in the form of slices of semi-conductor material with positive (+) and negative (-) poles. The expanse can absorb photons from sunlight and convert them into electricity. The solar cells are made of very small pieces of silicon coated with a special chemical to form the basis of the solar cell. In the solar cell there is a connection (function) between two thin layers made of semiconductor materials, each known as a "P" (positive) semiconductor and an "N" (Negative) type semiconductor. Silicon type P is a surface layer that is made very thin so that solar light can penetrate directly to reach the junction. The P-section is given a ring-shaped nickel layer, as the positive output terminal. Below the P section there is an N type section which is plated with nickel as well as the negative output terminal.

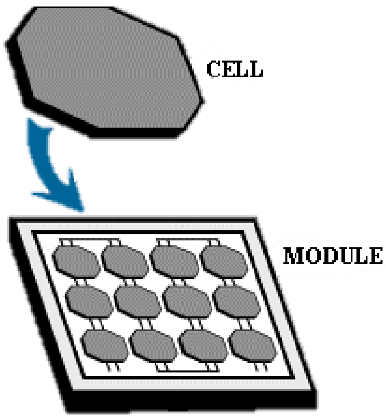

Figure 1: Modules of PV System [3]

On the other hand, natural disasters are one of the natural phenomena that threaten human survival. The negative impacts can be in the form of material and non-material losses. These disasters can be exemplified such as floods, landslides, earthquakes, there are also non-natural disasters such as fires, technology failures, modernization failures, social conflicts between groups and terror.

Figure 2: Natural Disaster-Forest Fires [5]

One of the negative impacts of disasters is the destruction of the electricity network infrastructure which will have an impact on power outages. If at the time of disturbance or disaster occurs at the location where the power plant is located, the safety system will immediately work by turning off the power plant, so that all loads connected to the power plant will also experience blackouts. The occurrence of power outages will certainly have an impact on people's lives such as the death of the lighting function.

The use of solar cells that are packaged in a concise and adaptive manner will help local communities when natural disasters occur. In designing this tool, the suitcase is designed as a medium for placing solar cells with materials in the form of ceramics and aluminium which also functions as a solar cell cooler. In addition, material selection is also carried out based on a robust system. Ceramic is a heat-resistant material (fire) so it is hoped that the solar cell suitcase is protected from heat, fire and rain.

2. METODOLOGY

The research procedure begins by conducting a literature study on micro hydro solar PV generators, then a product design for portable solar PV is carried out which is formed in a suitcase and charger adapter. After the product design is completed, the product will be developed and the testing will be then carried out.

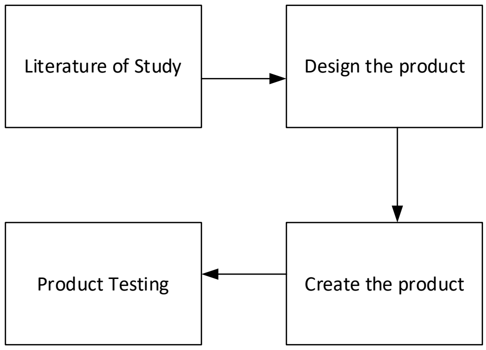

Figure 3: Block Diagram

The stages of technology application that will be carried out are:

1. Introduction Stage

1.1 In the preliminary stage, prepare aluminium material that will be used to make suitcases.

1.2 Cutting aluminium material according to size, can be rectangular or rectangular according to the desired pattern.

1.3 Designing the manufacture of the length of aluminium that will be needed for the suitcase.

2. Analysis of Survey Results

2.1 Attach the aluminium by attaching the bolts around it.

2.3 Installing Photovoltaic on the outside of the aluminium in the rectangular pattern of the suitcase.

3. Designing the manufacture of solar cells

3.1 Installing a lock handle to lock the solar cell in the form of a suitcase.

3.2 Assembling the Power Inverter, battery, solar charge controller

4. Testing the Suitcase.

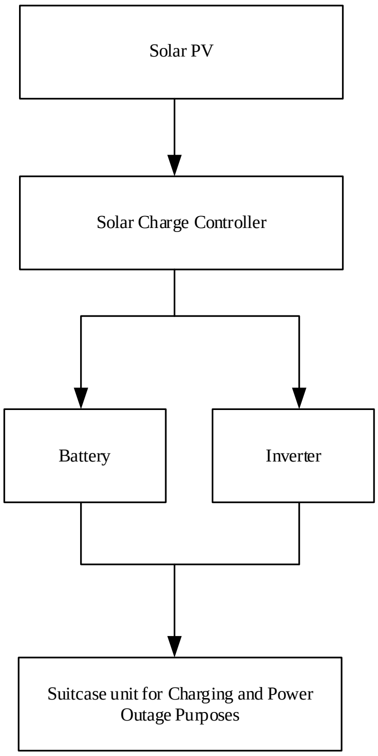

Figure 4: Diagram of the Arranged Equipment

3. RESULT AND ANALYSIS

To calculate the optimal position of the sun's rays, you can use the declination angle theorem. The declination angle is the angle formed between the compass needle and the earth's north or south pole. With this calculation, the position of the sun can be accurately known and used to determine the slope of solar PV in order to get optimal solar radiation. The result can be seen in the following table:

Table 1: Measurement Result

MONTH	1st	2nd	3rd
TILT ANGLE	17 °	9 °	1 °
MONTH	4th	5th	6th
TILT ANGLE	180 °	180 °	180 °
MONTH	7th	8th	9th
TILT ANGLE	180 °	180 °	1 °
MONTH	10th	11th	12th
TILT ANGLE	9 °	17 °	24 °

Based on the table, it can be seen that the tilt angle value varies depending on the month. This ratio of angle figures using the location of Batam, Indonesia, does not have extreme deviations when compared to four seasons countries, where the measured deviation lies between 0°-24° only. Based on this data, the maximum charging process in a fast time can be done if the solar panel faces the south position from the direction of the earth.

This result will be in accordance with the parameters in determining the tilting angle through the declination angle, where:

$$\delta = 23{,}45° \sin(260.\frac{284n}{365}) \text{ [1]}$$

Whereas:

δ= declination angle
n= day, in a month

And the sun azimuth angle using the equation:

$$\gamma_s = \sin^{-1}(\frac{\sin \omega t . \cos \delta}{\sin \theta_z}) \text{ [4]}$$

Whereas:

γ_s = azimuth angle

ω = angle

t = time

θ_z= zenith angle

The results of measurements using the trainer kit have a time difference for each track length or distance traversed. The resulting value proves that the greater the distance traversed, the greater the time required.

Figure 5: Mass Display on Energy Box Simulator

The solar PV used is 10 Wp. This means, if the battery used is 70 Ah with a voltage of 12 V, then the battery will be fully charged in 84 hours or the equivalent of 3.5 days or 1 week when considering no sunlight or night conditions.

With a battery power of 70 Ah using 1 load of 5-Watt LED emergency lights, meaning that this portable suitcase can be used for 168 hours non-stop or for 7 consecutive days. If the load used is a 10-Watt cell phone charger, this means that the portable suitcase can be used in emergency conditions without the need for charging for 3.5 days or a full 84 hours.

The following picture is an example of a voltage measurement that has been carried out in cloudy conditions (indoor) for solar PV which is used as a source of electrical energy in portable suitcase.

Figure 6: Voltage Measurement on Portable Suitcase

4. CONCLUSIONS

The solar PV technology in this portable suitcase is expected to help the community in designing portable technology that can store electrical energy. It is hoped that the energy storage can be used to charge small power electronic devices that lack power, especially in disaster-affected areas.

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